

# ROYAL COMMISSION FOR THE EXHIBITION OF 1851

England & Wales · Charity number 206123

## Details

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**Other names** 1851 ROYAL COMMISSION

**Status** Registered

**Legal form** Other

**Registered** 1962-09-22

**Register** [View on the Charity Commission register](#)

## Contact

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## Activities

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**Objects:** TO INCREASE THE MEANS OF INDUSTRIAL EDUCATION AND TO EXTEND THE INFLUENCE OF SCIENCE AND ART UPON PRODUCTIVE INDUSTRY.

**Activities:** Awarding Research Fellowships, Industrial Fellowships, Industrial Design Studentships, Fellowships in Design and the Built Environment, Enterprise Fellowships, Technical Teaching Fellowships and Special Awards and administering its South Kensington estate all with the aim to increase the means of industrial education and extend the influence of science and art upon productive industry.

## Classification

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- **How:** Makes Grants To Individuals, Makes Grants To Organisations
- **What:** Education/training
- **Who:** Other Charities Or Voluntary Bodies, Other Defined Groups

## Geography

- **Area of benefit:** NATIONAL
- Northern Ireland
- Scotland

## Finances

| Period end | Income     | Expenditure | Assets       | Employees |
|------------|------------|-------------|--------------|-----------|
| 2024-12-31 | £2,267,734 | £6,625,778  | £162,548,711 | 5         |
| 2023-12-31 | £2,565,941 | £5,723,796  | £143,838,891 | 5         |
| 2022-12-31 | £2,393,548 | £6,269,776  | £130,375,737 | 5         |
| 2021-12-31 | £2,259,666 | £5,182,525  | £150,029,559 | 5         |
| 2020-12-31 | £2,787,261 | £5,919,025  | £138,125,545 | 5         |

## Trustees

| Name                                           | Role  | Appointed  |
|------------------------------------------------|-------|------------|
| <b>Rt Hon Professor Lord Ajay Kumar Kakkar</b> | Chair | 2022-02-02 |
| Dame Alison Nimmo DBE                          |       | 2020-11-11 |
| PROFESSOR DAME Carol Vivien Robinson DBE       |       | 2021-07-07 |
| Professor Andy Hopper CBE FRS FREng FIET       |       | 2018-07-04 |
| Professor Christopher Mark Wise RDI FREng      |       | 2019-04-17 |
| Professor Dame Ann Dowling                     |       | 2020-02-03 |
| Professor Dame Sarah Marcella Springman DBE    |       | 2024-03-04 |
| Professor Eleanor Stride OBE                   |       | 2022-07-06 |
| Professor Jameel 'Jim' Sadik Al-Khalili CBE    |       | 2021-12-08 |
| Professor Sadie Anna Morgan OBE                |       | 2024-08-29 |
| Sandra Robertson                               |       | 2020-11-11 |
| The Rt Hon Lord Ian Burnett of Maldon          |       | 2023-09-08 |

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# Accounts

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# Royal Commission for the Exhibition of 1851

## Annual Report and Accounts

For the year ended 31 December 2024



### The Aims of the Royal Commission

The 1851 Royal Commission's governing document is its Supplemental Charter of 1851, which requires the Commission to  
*"increase the means of industrial education and  
extend the influence of science and art upon productive industry".*

This was originally interpreted as a requirement to create a centre of intellectual excellence, which resulted in the acquisition of the South Kensington estate and its subsequent development with museums, academic establishments and the Hall of Arts and Sciences (the Royal Albert Hall).

Later, in 1890, the emphasis was switched to the support of individuals, starting with the award of Science Research Scholarships from 1891.

Today the Commission runs its own schemes for:

Research Fellowships  
Industrial Fellowships  
Industrial Design Studentships  
Built Environment Fellowships  
Fellowships in Design

In partnership with others it supports:

Enterprise Fellowships  
Technical Teaching Fellowships

It also supports worthy individuals and appropriate organisations by Special Awards.

The total number of individuals being supported in 2024 was 136





## Contents

|                                                 |         |
|-------------------------------------------------|---------|
| Chairman's Report                               | 2 – 3   |
| Secretary's Report                              | 4       |
| The Work of the 1851 Royal Commission           | 5       |
| Public Benefit                                  | 5       |
| Grant-making Policies                           | 6 – 7   |
| Achievements in 2024                            | 8 – 15  |
| Future Plans                                    | 16      |
| Awards Granted in 2024                          | 17 – 26 |
| Awards Completed in 2024                        | 27 – 50 |
| Alumni Awards, Honours and Achievements         | 51 – 54 |
| Report by the Chairman of the Finance Committee | 55 – 57 |
| Statement of Commissioners' Responsibilities    | 58      |
| Independent Auditor's Report                    | 59 – 62 |
| Statement of Financial Activities               | 63      |
| Balance Sheet                                   | 64      |
| Cash Flow Statement                             | 65      |
| Notes to the Financial Statements               | 66 – 83 |
| Administrative Information                      | 84 – 85 |
| Commissioners, Committee Members and Staff      | 86 – 88 |
| Professional Advisers                           | 89      |

## Chairman's Report

Within the opening of his memorandum on the appropriation of the surplus of the Exhibition of 1851 Prince Albert considers "it becomes necessary for the Royal Commission to mature some plan for itself on a careful and conscientious consideration of its position, power and duties, in order not to find itself at the end of its important labours driven into the execution of ill digested projects by the force of accidents or popular agitation". Such conjecture was the driving force behind the realisation of the post Exhibition role for the organisation that it still fulfils today, and it is the test that I like to apply when reflecting on the passing year's activity. Judging the organisation's achievements using our first President's measure I am confident in reporting that the previous 12 months have seen commendable endeavour from all involved. With a commitment of over £5 million in charitable spending we have, amongst many things, welcomed another 38 outstanding young scientists, engineers and designers to the 1851 Fellowship community, supported an expanded sustainability and nature positive programme within the Albertopolis estate and embarked on a new and exciting national programme to support science teaching in the primary education sector.

2024 saw the award of 10 Research Fellowships, 12 Industrial Fellowships, one Design Fellowship and 11 Industrial Design Studentships. With an incredible spread of investigative study into such things as the hydrogen economy infrastructure, the design of analogue integrated circuits with quantum dot structures and decoding cellular communication, such projects represent a continuing and significant investment in emerging research talent within the United Kingdom. In addition, we continue to support innovation and entrepreneurship through the funding of Enterprise Fellowships in conjunction with our partners at the Royal Academy of Engineering. This year found four graduate start-up businesses supported in such a manner. We also welcomed the sixth and largest yet cohort of participants onto our Technical Teaching Fellowship initiative.

The Royal Commission recognises the value that external public engagements provide to our Fellowship holders. Such opportunities as participation in the annual Great Exhibition Road Festival, which is a tremendous showcase for all the cultural and educational institutions and organisations based in South Kensington, allows them to hone their communication skills as future spokespersons in the scientific community. This year, with the Commission's tent at the very centre of activity, 12 volunteers from our current programmes encouraged visitors to the festival to partake in experiments and demonstrations associated with elements of their research projects. It proved hugely popular with many – with one young participant announcing this was the only real "science stall" on the street!

Catering to an audience with more specific interests, we once again partnered with the BBC World Service to host and facilitate the ninth broadcast of *The Engineers* series. Eager listeners filled the Great Hall in Imperial College to capacity for the opportunity to listen to three renowned experts, working in different applications of Artificial Intelligence, discuss the promise and limitations of this rapidly expanding technology. Professor Regina Barzilay, Research Scientist at the Massachusetts Institute of Technology, Professor David Silver, Principal Scientist at Google DeepMind and Dr Paolo Pirjanian, a pioneer in developing emotionally intelligent robots to aid child development, provided fascinating insight and optimistic commentary on the opportunities this new global phenomenon presents to a world-wide radio audience of several millions.

The Royal Commission's special awards endeavour to reinforce STEM education in schools, and greater public awareness of the career opportunities in the science and technology environment, whilst also recognising the hugely important influence museums can play in igniting young people's imaginations and ambitions. This year the Commission gave grants to the Royal Observatory's First Light project and the National Space Centre's Outer Solar System Gallery redevelopment. Funding support was also provided to the Somerscience Festival and Durham University's Celebrate Science Festival as well as supporting the Institute of Physics summer public programme and the Royal Institution's ongoing Science in Schools initiative. Awards were also made to emerging and continuing work within the local SouthKenZEN+ project and the Royal College of Art. We also commissioned an exciting new five-year programme with STEM Learning to develop more inspirational teachers of science within the primary education sector.

The Royal Commission's greatest asset is its Fellows – both present and past – and we make every effort to encourage a spirit of community and pride within this grouping of nearly a thousand individuals. We arrange opportunities for the sharing of knowledge and achievement between the current Fellowship and their distinguished alumni colleagues. This year, six individuals from across all of the Royal Commission's permanent programmes shared their work with our President, Her Royal Highness The Princess Royal, current 1851 Fellows and committee members at the Presidential Dinner. In addition, four completing Fellows presented their research findings to a large audience, with a similar pedigree, at the Royal Society during the Alumni Science evening.

All such activity is only possible through the enthusiasm and dedication of the many volunteers that offer their support to our programmes. This may be through serving on our various committees or overseeing the governance and strategic direction of the organisation itself and I extend my deepest appreciation to all such individuals. This year we have seen the departure of a number of extremely distinguished and long serving members of our Science and Engineering Research Fellowships Committee as well as two Commissioners who have reached the end of their tenure of office. My heartfelt thanks go to Lord Mair and Jim Eyre who have served the Royal Commission with great distinction for the past decade, contributing selflessly to our objectives through committee membership, external representation, mentoring awardees and championing the Commission's actions and people at every opportunity. Fortuitously this does allow us to introduce new figures of distinction to the Commission and I have been delighted to welcome Professor Dame Sarah Springman and Professor Sadie Morgan to the Board of Management as new Royal Commissioners.

Finally, it is my privilege on behalf of the Board of Management to thank our President for her resolute patronage and interest. The Princess Royal's support for our activities, as well as her wider public example, provides inspiration and encouragement to all those involved with the Royal Commission. We are deeply honoured by Her Royal Highness's continued commitment to our purpose and people.

The Rt Hon Professor Lord Kakkar KG KBE PC FMedSci

## Secretary's Report

I can only add my own thanks to those of the Chairman for all the efforts of the incredible and rich mix of Commissioners, Committee Members, Fellows, Alumni and staff that make up the 1851 family. The Royal Commission is blessed to be supported by such a talented group of individuals and this report hopefully captures the notable achievements of many of that group.

One of the constant outputs of the Commission has been its encouragement of those seeking to find a suitable career in the STEM environment, and at a time when most young people are exposed to information overload and bombarded with choice, we are attempting to demonstrate relevancy and prospects through interaction with our awardees. Outwith the more normal elements of the Royal Commission's annual activity, we have extended outreach and external engagement opportunities for the current award holders this year. With the Great Exhibition Road Festival a key part of our calendar, we were excited to weave an additional element into the commitment through a project called London Wonder. This initiative offered Fellows the chance to visit selected secondary schools in East London – Barking and Dagenham - to talk about their research and personal experiences of their pathway to research or design careers to Key Stage 5 students, and to lead in exercises that encourage greater awareness of STEM talents and careers. The ultimate aim being for those students involved to also participate in the Commission's tent at the Festival itself. The pilot project received an extremely favourable response, and I am delighted to confirm that we will continue the programme for the next 4 years. Additionally, awardees have also represented the Commission at a number of All Party Parliamentary Engineering Group functions at the House of Lords as well as attending UK Engineering sponsored "Big Bang" at Parliament. In all cases they proved tremendous ambassadors for the Commission, whilst also perfecting their science communication skills by engaging with, and hopefully influencing, the many school students present. Current Fellows make tremendous role models for the next generation of scientists and engineers, and we will continue to seek out events that allow for such interaction in the future.

The problems and challenges faced by society today appear daunting but the generation of problem solvers and innovators that the Royal Commission supports always seem to confidently enjoy the prospect of making an impact in their chosen work environment. Complementing their efforts, but on a wider scale, are the labours of our partner organisations that are granted special awards by the Royal Commission, all of whom make a positive contribution in the STEM arena, whether it be in the classroom or the community. This report captures only a small snapshot of what is being achieved across the broad spectrum of "1851" activity and I hope that the reader will be as enthused by the individual or individuals undertaking the research or programme, as by their achievements.

John Lavery MVO

## The Work of the 1851 Royal Commission

The Commission's aim is to 'make a difference' by providing educational fellowships and studentships to the very best early career scientists, engineers and designers. Success is hard to measure within the confines of a single year but looked at over the longer term the Commission's achievement is evident, with 13 Nobel Prize winners and over 150 Fellows of the Royal Society among its previous award winners. The case studies of completing fellows and summaries of alumni achievements later in this report also bear witness to the Commission's success.

In addition to its core fellowship schemes, the Commission also provides special awards to its legacy institutions, to other organisations working to encourage STEM (science, technology, engineering and mathematics) education and to organisations that can help facilitate access to its incredible archives. Details of some of these awards and the impact they have made can also be found later in this report.

As well as the grants that it makes, the Commission itself organises a number of educational and networking events for the benefit of its award holders, alumni, legacy institutions and the general public, which together make a significant contribution to STEM education.

The Commission was originally established by Royal Charter in 1850 under the Presidency of Prince Albert, to organise and stage the Great Exhibition. Held in the spectacular Crystal Palace, constructed in Hyde Park, it was the first ever World Fair, and the most successful. With over six million visitors, it also made a substantial profit.

Consolidated by Supplemental Charter, and enjoined to invest the surplus from the Great Exhibition *strictly in accordance with the ends of the Exhibition...[to] increase the means of industrial education and extend the influence of science and art upon productive industry* the Commission purchased 87 acres of land in South Kensington and helped establish its three great museums, the Royal Albert Hall and renowned institutions of learning, including Imperial College and the Royal Colleges of Art and Music.

When this huge undertaking was complete, there remained sufficient funds for the Commission to initiate, in 1891, a programme of fellowships and studentships to support pure research in science and engineering, applied research in industry, industrial design and other projects.

The Commission continues its work to this day, both managing its freehold estate and awarding some £5m a year in research fellowships, design studentships and other grants. The provision of long leases to the legacy colleges and the Royal Albert Hall also makes a very substantial contribution to scientific, engineering and artistic education.

## Public Benefit

The Commission ensures that its work is for the public benefit and takes full account of the published Charity Commission guidance. The Commission's events and awards programmes and support of the legacy institutions represent identifiable benefits and are available to all eligible members of the public. They satisfy the primary charitable purpose of the advancement of education.

## Grant-making Policies

The Commission primarily pursues its charitable purposes through the award of grants to individuals and organisations. The Commission awards grants under a number of defined programmes. Full details of the terms and conditions for each programme, including application forms and deadlines where appropriate, are provided on the Commission's website. A brief summary of the major programmes which the Commission supports is provided below:

### **Schemes administered by the Commission:**

#### *Post-doctoral Research Fellowships in Science or Engineering*

These are intended to give early career scientists or engineers of exceptional promise the opportunity to conduct a research project of their own instigation; an ultimate objective is to contribute to the knowledge base required for a healthy and innovative national culture. Around eight to ten awards are made each year, including one or more Brunel Fellowships for engineering projects addressing the primary infrastructure needs of modern society. The awards are for up to three years, subject to annual review and encompass an annual stipend and some support for travel and other expenses.

#### *Industrial Fellowships*

These are intended to encourage profitable innovation and creativity in British industry. Projects in any science or engineering discipline will be considered. A variable number of awards – usually around ten to fifteen - is available each year depending on the financial value of individual awards granted. An ERA Foundation Fellowship for the electro-technology sector is awarded as part of the scheme. Fellowships are awarded to selected exceptional graduates with the potential to make an outstanding contribution to industry, for a programme of research, supported by their employing / sponsoring company, leading to a patent, product or process improvement in conjunction with a higher academic award. Awards are for up to three years, subject to annual review, and include a contribution towards living costs, a travel allowance, an honorarium for the host university and in appropriate cases a contribution towards university fees or towards the cost of enhancing the research project.

#### *Industrial Design Studentships*

These are intended to stimulate industrial design capability among the country's most able science and engineering graduates. A variable number of awards – usually around ten to fifteen - are offered each year for outstanding engineers or scientists who wish to develop their capabilities in industrial design by taking a recognised master's course and who aspire to become leading designers in British industry. The award is for up to two years and includes a stipend, materials allowance, travel allowance and contribution towards tuition fees.

#### *Fellowships in Design and the Built Environment*

Awarded in alternate years, these Fellowships each provide a stipend for up to two years to enable those at a more advanced stage in their career to explore important current issues, selected by the Commission.

### **Schemes administered by other organisations:**

#### *Enterprise Fellowships*

Awarded through the Royal Academy of Engineering (RAEng), these fellowships are open to outstanding UK-resident engineering graduates seeking entrepreneurial success. A package of tailored mentoring, training and grant funding will enable recipients to pursue commercialisation of their technological ideas. Originally three fellowships a year were available, but this has now been increased to six.

### *Technical Teaching Fellowships*

Awarded through the Education and Training Foundation (ETF), these fellowships are open to outstanding UK-resident Further Education practitioners who are recognised for their high impact teaching practice. Fellows are expected to share their expertise and learning across the sector as part of the award with the aim of supporting quality improvement in technical teaching and learning. Fellows will receive an award of £5,000 – £15,000 to support knowledge transfer activity and to ensure remission time is guaranteed. They will also be allocated a programme mentor to support them for the duration of the Fellowship and will attend developmental workshops.

### **Special Awards:**

Although the educational programmes described above represent the lion's share of its grant giving, the Commission also responds to all those requests for funding that commend themselves through the Special Awards procedure. Here the aim is to assist worthy individuals, organisations or projects whose aims in the broadest sense align to the Commission's, and all applications are carefully scrutinised at an appropriate level according to the amount of support requested. Grants range from a few hundred pounds to over a hundred thousand pounds. While Commissioners retain considerable flexibility in principle, in practice a majority of special awards are made either to institutions on the Commission's legacy estate or for educational outreach work by like-minded organisations seeking to draw the attention of the young to the opportunities presented by science, engineering and design. A small number of grants are also made to facilitate access to the Commission's archives.

In addition to the above schemes, the Commission also administers, in conjunction with the Sir Misha Black Awards Committee, two awards in the field of design education, for which nominations are sought each year. Full details are available on the Commission's website but in brief these are:

### *Sir Misha Black Medal for Distinguished Services to Design Education*

Global in reach, the Medal acknowledges the important contribution of individuals to the teaching of design at all levels, from anywhere in the world – as designers, as champions, as mentors and as educators.

### *Sir Misha Black Awards for Innovation in Design Education*

Salutes educators from across the United Kingdom and celebrates the innovative achievements of institutions and individuals. Recipients may receive a bursary of £10,000 to advance their work in innovative design education.

Together the Sir Misha Black Medal and Awards recognise those who by innovation, vision and contribution to theory or practice have measurably improved the education of designers and enhanced the profile of design education.



## Achievements in 2024

The core activity – and primary achievement – of the Commission is identifying early career science and engineering graduates of exceptional promise and supporting their work with its prestigious fellowships and studentships. Full details of the awards made during the year are given on pages 17 to 26.

The true impact of the Commission's award holders will only emerge over time, but some evidence of the success of the various programmes can be gleaned from the achievements of those Fellows who completed their awards during the year and the positions they go on to secure. A representative sample of case studies is provided on pages 27 to 50.

Many completing Fellows comment on the importance of their Fellowship to their success:

*Thank you 1851 for making my career!*

Dr Hannah Wauchope, Research Fellow 2020

*I would once again like to express my sincere thanks to the Royal Commission for the opportunities afforded to me; the academic freedom is unrivalled and certainly aided me in securing a full-time academic post.*

Dr Gregory Chaplain, Research Fellow 2021

*The three years I've spent on my 1851 Fellowship, hosted by the British Antarctic Survey in Cambridge, have been some of the best of my career so far. Having the freedom to pursue the research of my choice has been liberating and rewarding.*

Dr Jasmine Lee, Research Fellow 2021

*Receiving the Fellowship was transformative, providing not only financial stability but a strong community where I connected with inspiring, like-minded individuals. My PhD experience was greatly enriched by the fellowship's network, which kept me motivated over the past three years. I would like to extend my deepest gratitude to the 1851 Royal Commission and its dedicated team, who have been supportive, kind, and instrumental throughout my DPhil journey. This achievement would not have been possible without the support I have received.*

Dr Parijat Patel, Industrial Fellow 2021

*The awarding of an Industrial Fellowship has greatly improved my skills as an independent researcher and has enabled significant personal growth. Through the generous travel allowance, I have been able to attend and present my research at multiple international conferences. My dissemination and communication skills have greatly improved through delivering oral, power pitch, and poster presentations, and being able to attend such a breadth of conferences has taught me how to tailor my presentations to the relevant audience. At these conferences I have had interesting discussions with key opinion leaders, been able to obtain valuable feedback on my work, and have greatly expanded my research network. I have also been privileged to be able to discuss my work with the general public through presentations at events such as Oxford Pink Week and IF Oxford Science and Ideas Festival. These events enabled me to meet people whose lives are directly impacted by breast cancer which really drilled home the importance of this research area. The opportunity to present my research to HRH Princess Anne and to world-renowned scientists at the Presidential Dinner was unforgettable and will be a highlight of my career.*

Dr Isobel Gordon, Industrial Fellow 2021

*I am deeply grateful to the Royal Commission for supporting my academic and professional ambitions, which would not have been possible otherwise. The connections and friendships formed within this community have provided invaluable perspectives and solutions throughout the year.*

Julita Napieralska, Industrial Design Student 2023

For some, it is clear that without the award from the Commission, their project would not have gone ahead or would have been much more limited in scope:

*The fellowship enabled me to pursue a PhD while working in an industry I believe in, dedicated to developing the next generation of cancer treatments. I applied for this program because it offered a unique opportunity to enter cancer research directly, while advancing both my academic and technical skills. Unlike a typical PhD, this experience allowed me to guide the project's direction while gaining insight into the drug discovery and development process, expanding my technical and strategic understanding of scientific projects. Seeing my work's potential impact on the drug development pipeline added profound meaning to my research.*

*However, I encountered challenges following the acquisition of the original biotech (Adaptate Biotherapeutics) by Takeda,*

*The Royal Commission provided invaluable support throughout the project, particularly during challenges such as the company acquisition and my own health setbacks. This support was essential from the outset, as the project wouldn't have been possible without the Commission's funding, given the company's limited resources as a startup only a year into its establishment. Additionally, I found great fulfilment in the Commission's public engagement events, especially the school workshops, which reminded me of why I pursued cancer research*

Dr Shefali Bhumbra, Industrial Fellow 2021

*The Fellowship made it possible for me to work directly within industry while carrying out my PhD research, an invaluable and unusual position that enabled large-scale pilot trials in real-world settings. This direct implementation of lab scale research findings—particularly in field conditions at Hepworth Brewery—would not have been possible without the Fellowship, making this project uniquely impactful in translating laboratory results to industry applications and commercial case studies. The backing of the Royal Commission from as early as the proposal stage gave me confidence and support to my ideas that aimed to solve problems facing UK and international industry, invaluable for an early career researcher. This support is now paying dividends for WASE as we gain commercial traction in multiple industries from food and beverage to biodiesel, with integrated biosensing and control developed in this project being a key selling point for customers.*

Dr Kyle Bowman, Industrial Fellow 2021

Fellows appreciate the administrative support provided:

*One last thankyou to you for all your help over the past three years - everything to do with the Commission seems completely frictionless.*

Dr Gregory Chaplain, Research Fellow 2021

*Thank you for everything you do to support us (including but not limited to managing all the financial aspects! I love the simple claims process, and I don't look forward to going back to the bureaucratic university system).*

Dr Jasmine Lee, Research Fellow 2021

Academic and Industrial Supervisors are also very complimentary about the Commission's Fellowships:

*I would wholeheartedly agree that the interaction with the university department, in which an engaged and supportive academic supervisor has added a lot of value to the fellowship, has enhanced LifeArc's connection with the department and its work in areas of mutual interest. I would not hesitate to recommend the scheme to other organisations active in any relevant field, where suitable candidates and business objectives can be linked for the benefit of both.*

Dr Jonathan Large, Industrial Supervisor

*I would not hesitate to recommend the scheme to other organisations active in any relevant field. The scheme provides a unique opportunity to develop research links between academy and industry and the means to 'kick off' new research through a highly collaborative research model.*

Dr Richard Foster, Academic Supervisor

*The industrial fellowship has led to improved process development and validation of our Electro-Methanogenic Reactor. The research has led to further grant funding over £1 million and additional investment VC's and Corporate VC's including Engie and Hitachi.*

*A key piece of research was a pilot demonstration at a customer site – Hepworth Brewery. The successful pilot has led to a commercial contract with Hepworth Brewery worth £650,000. From the success of this it has led to additional customer interest leading to £1.5million in orders. We are now commissioning the first commercial Electro-Methanogenic Reactor plants at a variety of customer sites.*

*We have also further developed a relationship with the University of Westminster, and this has led to a Innovate UK grant with international partners in South Korea. Without the benefit of the Royal Commission Industrial Fellowship the pace of research and resources allocated to product development would have been significantly lower*

*We would recommend the industrial fellowship to other organisations, and we would also look to supporting other researchers to collaborate with WASE on collaborative PhDs going forward.*

Dr Thomas Fudge, Industrial Supervisor

A more complete picture of the impact of the Commission's awards comes from the honours and awards bestowed on more senior alumni – some highlights are given on pages 51 to 54.

Comprehensive data on the impact of the Commission's Fellowships is not yet available, but in respect of one programme, the Enterprise Fellowships awarded through the Royal Academy of Engineering, we do know that the awards offered to date, totalling some £2m, have resulted in at least 35 successful companies which have generated an additional £115m of external investment and created over 340 jobs, an impressive return on investment.

For other awards, we have only anecdotal data at present, but many alumni go on to achieve far reaching impact, as this example makes clear:

*After completing my studies as an Overseas Scholarship recipient at the University of East Anglia, I was immediately employed at the University of Nairobi, where I rose to become a Full Professor in Fisheries Biology in 2018.*

*As well as my academic duties, at different times I also served as the Principal Secretary and Permanent Secretary in the Ministries of Fisheries and Education, respectively, where I spearheaded major reforms and*

*policies. Notably, I led the development of Kenya's first-ever Oceans and Fisheries Policy, culminating in the enactment of the Fisheries Management and Development Act (2016). My leadership saw the establishment of key institutions for Kenya's Blue Economy, including the Kenya Fisheries Service, Kenya Fish Marketing Authority, Kenya Fishing Industries Cooperation (KFIC) and Kenya Fish Levy Trust Fund. My tenure was marked by significant milestones, including commissioning research and patrol vessels such as RV Mtafiti and RV PV Doria, and operationalizing Kenya's Fisheries Monitoring, Control, and Surveillance (MCS) Center. We also secured EU certification for the export of farmed fish products, enhancing Kenya's global fisheries trade.*

*As part of Kenya's Vision 2030 flagship aquaculture program, I championed initiatives that increased aquaculture production from 4 MT in 2009 to over 54 MT in 2012, generating an annual income of Ksh. 6 billion (c £37m). Since then, aquaculture has continued to grow into an important sector of the economy. I also played a pivotal role in the administration of higher education by leading reforms in university education funding and chairing a national committee in 2024 to review Kenya's new Education Funding Model.*

*Beyond my national contributions, I collaborated with the Lake Victoria Fisheries Organization (LVFO) of the East African Community (EAC) and other regional bodies, fostering sustainable fisheries management and development across Africa. In 2024, I initiated a specialized Master of Science program in Fisheries, Aquaculture, and Socioeconomics, aimed at professionalizing public service fisheries officers across Africa with a view to achieve sustainable fisheries management and development benefiting local communities with food and livelihoods as well as the economies of the African states.*

Professor Micheni Ntiba, Overseas Scholar 1986

Another example, this time from the world of design:

*Receiving the Sir Misha Black Medal inspired me to consider ways in which I could build upon education to have a larger impact in the world, addressing the kinds of societal issues listed by the United Nations' Sustainable Development Goals. The answer I came up with was to set up an international non-profit organization that rewards educational institutions that train people to address societal issues and gives awards to those at the start of their careers who do societal work. Institutions need to have a societal curriculum that has graduates doing this work. Why early career? Because that's when people need encouragement the most: when they are just starting.*

*Don Norman Design Award (DNDA), a non-profit whose mission is to champion humanity-centered design (HCD+) globally, held its inaugural DNDA24 Summit in San Diego, California, USA, with attendees from more than 20 countries. The DNDA24 Laureates included projects on palliative care in a tribal settlement in India and community kitchens in Brazilian Favelas, and education programs including the Innovation Design Engineering programme offered by the Royal College of Art and Imperial College which many of the Commission's Industrial Design Students take.*

Professor Don Norman, Sir Misha Black Medal for Distinguished Services to Design Education 2021

This was the first year in which the Commission awarded Technical Teaching Fellowships as part of its core programme, following a five-year pilot. Testimonials from some of those who took part in the pilot illustrate the potential impact of the new programme:

*One of the greatest benefits of the Technical Teaching Fellowship is the freedom it provides to focus on projects that align with passions and strengths. For me, this meant engaging in curriculum development, course organisation and professional development creation. All of which allowed me to inspire educators and improve pedagogical practices. There has been an unparalleled opportunity for collaboration and networking. Working with organisations like Gatsby, Wellcome Connecting Science, STEM Learning and the Association of Science Education has not only expanded my professional connections but also broadened my understanding of cross-sector education. These partnerships have allowed me to contribute to projects that bridge the gap between academia and industry, from authoring T Level resources to developing cutting-edge courses like AI and Genomics. Beyond professional development, the Fellowship emphasises giving back to the community. A major initiative for me has been to establish the fifth UK AMGEN Biotech Experience hub in 2024 to provide free CPD and lab resources to the south-east. The Fellowship cultivates a strong sense of community- a spirit of collaboration and shared purpose, ensuring that the impact of the Fellowship extends far beyond individual achievements. The Technical Teaching Fellowship has been not only a career milestone but also a transformative journey making a lasting difference in the world of education.*

Alison Ackroyd, Technical Teaching Fellow 2022

*Since being awarded the Fellowship, I have had the privilege of engaging with incredible individuals and organizations, which I never would have had the chance to meet otherwise. The variety of events I have attended, as well as the remarkable people I've encountered, have not only broadened my horizons but also provided invaluable insights into fields far beyond my own. This has been one of the most rewarding aspects of the Fellowship — the ability to connect with individuals from such diverse backgrounds and fields, enriching my own work in ways I never anticipated. I am also delighted to share that this experience has played a pivotal role in my decision to pursue a career path I had never previously considered: a PhD. Without the Fellowship, this would not have felt like a realistic option, and I am deeply thankful for the encouragement and support it has given me to take this significant step in my academic and professional journey.*

Mr Bradley Collier, Technical Teaching Fellow 2023

Sadly, the Commission does not have the resources to continue all of its programmes indefinitely and some of the Fellowship schemes offered previously are no longer available. That does not mean, however, that they do not have an ongoing impact, as these testimonials from former Rome Scholars illustrate:

*My artistic journey was profoundly influenced by the year I spent painting in Rome, it shaped my artistic trajectory and established my reputation as an international artist, with numerous shows to follow in New York. I still make regular visits to Rome, as the Artistic Director of the Rome Art Program which brings art students to study in Rome each summer.*

Carole Robb, Rome Scholar 1979

*I feel I owe very much of my success to my scholarship year in Rome. It gave me not only a new and lasting direction in my subject matter, but it is also where I started creating unique collages - which have been a strong feature of my practice ever since. As well as that - and perhaps most importantly - it gave me time to grow as a person and, most particularly, to develop the self-confidence that is essential for creating a career in the visual arts with all the bumps in the road that one encounters in this profession. I will be forever in the Royal Commission's debt for financing my scholarship year. It had, and continues to have, a truly lasting and enormously beneficial effect on my life and career.*

Anne Desmet RA, Rome Scholar 1989

As well as its core fellowships and studentships, the Commission also runs a very successful Special Awards programme, supporting individuals and institutions with similar aims to the Commission.

This year, for the first time, as well as its reactive grants programme, the Commission has proactively invited proposals for a multi-year programme aimed at improving primary STEM education and is delighted to be partnering with STEM Learning to fund bespoke training for primary STEM teachers. As in previous years, many of the more reactive awards also reflect the Commission's continuing commitment to raising the awareness of the young to the opportunities presented by science and engineering. As well as the awards to Royal Museums Greenwich, the National Space Centre, the Institute of Physics, the Royal Institution, the Somerscience Trust and Durham University mentioned in the Chairman's Report, these included awards to Kids Invent Stuff for an exhibition showcasing children's STEM inventions, to Number Champions to provide numeracy support in primary schools, and to Fun Kids Radio for a series exploring war time inventions.

The impact of such Special Awards may take some time to become apparent, but a brief look at some of the awards made in the last few years gives a flavour of what can be achieved.

In 2020, the Commission gave an award of £9,800 to Physics Partners. The award enabled Physics Partners to record 14 videos, all of which have been uploaded to YouTube and to their website, which cover the major topics at GCSE Physics which research has suggested teachers find it difficult to teach. Each film covers some physics subject knowledge, presented through explanation, models, diagrams and exam questions. They also contain some pedagogical content knowledge (i.e. how to teach the topic), including the sequencing of teaching, explanations, concept cartoons, demonstrations and practicals. They are useful for all teachers of physics, but especially those working outside their main field of specialism (e.g. biology and chemistry teachers). To date, the films have been viewed 7,469 times. When asked to rate the film's helpfulness in preparing to teach the relevant concept on a scale of 1 to 5, the average response so far is 4.68. When asked what aspects had been most helpful, over 50% of respondents said that they had incorporated ideas from the film directly in their own teaching. Physics Partners have been told that the videos will be recommended viewing for trainee teachers.

In 2023, the Commission gave £6,000 to the Geological Society to support their Megalosaurus Month initiative. Held throughout February 2024, Megalosaurus Month celebrated the 200th anniversary of the first scientific description of a dinosaur by the Geological Society's former president, William Buckland. The Commission's funding was fundamental in enabling this significant public engagement initiative, which exceeded the Society's expectations in both reach and impact. Megalosaurus Month was a month-long festival celebration of geoscience, combining history, education and art to engage diverse audiences. The centrepiece was a life-sized replica of a Megalosaurus skeleton, prominently displayed in the Society's Upper Library at Burlington House in Piccadilly, London. Over 3,200 visitors, ranging from families and school groups to university students and the general public, participated in a variety of activities held across February 2024 designed to inspire, engage and educate. The activities included practical experiments, schools workshops, interactive quizzes, a dinosaur puppet show, education resources, archival material, drawing classes, lino printing, historical reenactments and a free public lecture, delivered by Professor Michael Benton, a member of the Commission's Science and Engineering Fellowships Committee.

In 2018, the Commission gave £100,200 to fund the construction of Open City Lab, a pioneering public engagement facility within the heart of We The Curious (WTC) in Bristol which opened to the public in May 2021 as part of Project What If, a community-led 1000m<sup>2</sup> exhibition space aiming to remove barriers to participation and learning. Open City Lab displays citizen-shaped active academic research, hosting partnerships with researchers, universities and thousands of visitors shaping active leading research.

The venue was forced to close for two years due to a roof fire in April 2022. WTC took this time to develop relationships with their communities. Better understanding their needs and the barriers they

experience to engagement with STEM learning has informed significant developments in WTC's inclusive practices and programs. In response to feedback, they adapted their education and inclusion programmes to work in community spaces and schools, delivering over 300 free activities to 40,786 children, adults and young people. They also introduced inclusive adaptations to their building, including a multi-faith and sensory room, improved wayfinding and specialist learning tools. Upon reopening, they launched open concession tickets, free entry for community groups and 50% concession on entry for schools with over 22% of pupils on free school meals.

WTC also continued their public engagement in research outside the venue with over 800 participants across a range of projects. Diverse and underserved audiences directly engaged with ongoing research, with research partners gaining valuable insights into the perspectives of people outside their academic sphere and making positive improvements to their research processes and outcomes, as well as real world applications.

Projects included:

- Let's Connect: Brainstorming with Swarm Robots, in partnership with Merihan Alhafnawi from Bristol Robotics Lab - 294 participants
- Safari Park of AniBotics, in partnership with David Smee from AniBotics – 220 participants. This also led to WTC being a co-author of a paper submitted to a Robotics academic conference by their Swarm Robots partner, allowing the public to feed into the R&D phase of toy development and scaffold conversations around conservation with children.
- Shopping Trolley Secrets pilot in partnership with Anya Skatova from the University of Bristol's Medical School - 188 participants from West of England Centre for Inclusive Living (a local disability charity) engaged new audiences in the conversation on the use of shopping data for public health research.
- TRIAD event, in partnership with the University of Bristol and University of Bath – 45 visitors experienced different designs of spaces in VR to gather insights into their own personal reactions to differently designed environments, raising awareness of inclusive design and the impact of design on wellbeing.
- Seagulls Project with Hannah More Primary School, based in an underserved community which was led by their interest in seagulls - 1,074 interactions. This work is celebrated in a film and exhibition next to Open City Lab, which is being expanded into WTC's Curious Partner Schools program.
- Online Sleep project - Researcher Chrissy Hammond has indicated that the public responses from WTC's online survey could have an immediate impact on the direction of her research.

Since reopening in July 2024, WTC have hugely exceeded their forecast number of visitors over the summer period to September, with a total of 80,997 (vs 67,202 forecast), including 1,796 community members, 19,933 members and 5,189 education admissions, all of which are increasing daily. Within the Lab over this time, 16,866 people (approx. 20% of all visitors to WTC) participated in the current Lab project 'Shopping Trolley Secrets' in partnership with Anya Skatova from the University of Bristol's Medical School and codeveloped with the Digital Footprint team at Bristol University, leading to over 6,000 research contributions and 400+ postcards written to researchers by visitors. This programme looks to understand public attitudes towards the use of shopping data i.e., loyalty card data such as Tesco's Clubcard, for public health research, engaging them from the very early stages in what could be an invaluable source of data into people's shopping habits. Would people donate their shopping data for research? How much could researchers discover from people's shopping habits?

The Shopping Trolley Secrets activity is due to end in January 2025 and will be followed by a new programme currently in development named 'Plates For The Planet.' This new programme explores the effect of what we put on our plates on the planet and people: WTC's Open City Research team are working with Thalia Gjersoe and Kath Lee from the University of Bath on a project researching what their visitors (particularly children and young people) know about diet and sustainability. They will be asking visitors what they would do if they could make the rules to make their (and the nation's) meals more eco-friendly.

As the examples above illustrate, the Commission funds a wide range of innovative STEM initiatives at varying scales, recognising that not all will achieve huge success, but in the hope that most will transform individual lives, and some will go on to have considerable reach. Needless to say, not all Special Awards proceed completely smoothly. Nevertheless, anecdotal evidence suggests that it is interventions such as these that can make all the difference in stimulating young people to become the scientists and engineers of tomorrow and the Commission remains committed to doing what it can.

As well as funding STEM outreach projects, the Commission also provides Special Awards to enhance its legacy estate in South Kensington and help the world leading institutions of Albertopolis to extend their reach. As explained in the Chairman's Report, the main awards this year have been to support the Royal College of Art's project to refurbish and enhance its Darwin Building, including reinstating the main entrance on what is now 1851 Place, and to the Exhibition Road Cultural Group to support the ongoing programme of work to stimulate collaboration between the Albertopolis institutions in their efforts to transform South Kensington into a zero emission, nature positive neighbourhood.

These awards, often for major capital projects, can take many years to complete but also have significant impact. To take one recent example, in 2022 the Commission gave £0.5m to the Natural History Museum's Urban Nature Project. The Commission's grant contributed to the Evolution Garden. In recognition of the Commission's support, the part of the garden between the historic Waterhouse building and the new Garden Kitchen café has been named the 1851 Garden, with a brass plaque installed. The Gardens have been a huge success with critics and the general public. The Evolution Garden attracts over 100,000 visitors a week and has rapidly become a civic space full of life and breadth of use. Visitor numbers are expected to increase further when the Garden Kitchen opens this Autumn offering refreshments and other facilities. The Urban Nature Project more generally has also been deemed a great success, with 897 teachers trained, 18,632 school children engaging with bespoke workshops and almost 45,000 adults and children participating in family urban nature activities.



## Future Plans

Commissioners are conscious that the '1851 family' constitutes a tremendous resource of which much more use could be made. The Commission hopes to recruit an Alumni Manager to conduct research with alumni into what ongoing support from the Commission they would value, expand the offering for alumni and explore the scope for alumni to support current Fellows.

Commissioners also recognise that the Commission's archive is a fascinating and valuable resource to which there is currently only limited access. The Commission plans to embark on a ten-year programme to digitize the most significant parts of the archive to make them more readily available to researchers, the 1851 family and interested members of the general public.

2026 will mark the 175<sup>th</sup> Anniversary of the Great Exhibition and the Commission is continuing to plan a number of initiatives and events, including a new history of the Commission, research into the impact of the Commission's educational programmes, and a public lecture series. Commissioners also hope to capitalise on the anniversary to raise awareness of its award programmes amongst relevant audiences.

## Awards Granted in 2024

### Research Fellows

#### **Dr Mohamed Elzeadani**

*Subject:* Enhancing connection ductility for the safe design of timber structures

*University of Cambridge*

Engineered timber has emerged as a promising material for more sustainable structural design. However, improved methods of connection design are required to ensure ductility under extreme loading. This project will investigate a promising new connection design method using a combination of experimental, numerical and analytical approaches to provide comprehensive design guidance.

#### **Dr Daniel Heydecker**

*Subject:* Matching bounds in dynamical large deviations

*Imperial College London*

This project will investigate techniques in rare events (large deviations) of microscopic models. Often, the problem of whether a 'natural' quantification accurately describes the exponential unlikelihood of all trajectories is left open by a first investigation; this quantification is important for applications. This project will investigate physically important toy models.

#### **Dr Sophie Koudmani**

*Subject:* Simulating galaxies and supermassive black holes in the multi-messenger era

*University of Hertfordshire*

Nestled in large galaxies' cores, supermassive black holes significantly influence their hosts, yet this process remains poorly understood. This project will leverage insights from idealised, general-relativistic black hole simulations to craft a multi-scale cosmological model and make predictions for electromagnetic and gravitational-wave observatories, ultimately aiming to unravel the black hole–galaxy connection.

#### **Dr Adam McKenzie**

*Subject:* Into the void: a new architecture for next-generation semiconductor devices

*University of Glasgow*

This project will revolutionise semiconductor device design by pioneering a new paradigm for crystal growth, void-retaining epitaxy (VRE). It will unlock the potential of VRE as the manufacturing platform of choice for next generation devices and enable significant improvements in performance to meet the demands of key emerging applications.

#### **Dr Elise Needham**

*Subject:* Decoding cellular communication with focused systems genetics

*University of Cambridge*

Inside cells, communication occurs through intricate cascades of protein modifications. However, the regulators and functions of most modifications are unknown. This project proposes an approach that incorporates principles of targeted biochemistry with systems genetics to comprehensively decode cellular communication. This development could transform biology, providing varied applications in medicine and agriculture.

#### **Dr Harriet Stanway-Gordon**

*Subject:* CyPeMs: New modalities for targeting AMR and NDD

*Newcastle University*

Antimicrobial resistance and neurodegenerative diseases are significantly unmet areas of need in which conventional drug modalities are failing. This project involves the investigation of novel peptidomimetic structures (CyPeMs: cyclic peptide small molecule hybrids) for the identification of new therapeutic strategies within these areas, facilitated by DNA-encoded libraries.

**Dr Christina Woltz**

*Subject:* Tracking geochemical changes in organic fossils through time

*Imperial College London*

Organic microfossils record the emergence of eukaryotes over a billion years ago, yet most cannot be placed within eukaryotic lineages using morphology alone. By conducting vibrational spectroscopy of modern and fossilized eukaryotes, this project will test the robustness and utility of chemical signatures in the placement of microfossils within eukaryotic lineages.

**Dr Joseph Wynn**

*Subject:* Integrating across timescales for a dynamic perspective on avian migration

*University of Liverpool*

The yellow-browed warbler usually migrates from Siberia to South Asia, though has recently evolved a 10,000 km detour to Europe. Through genomic comparison of European birds to their Asian counterparts this project will determine the origins of this remarkable rerouting, in turn informing on how/why bird migration evolves in the Anthropocene.

## Brunel Fellow

**Dr Francesca Palmieri**

*Subject:* Damage and energy dissipation in clays due to cyclic loading

*Imperial College London*

This project will improve the modelling of clay degradation under cyclic loading. The proposed material model incorporates dissipated energy as measure of damage. The model is formulated based on experimental data and applied to the offshore wind turbines design addressing current challenges in soil-structure interaction problems.

## Ramsay Fellow

**Dr Aisha Bismillah**

*Subject:* Switchable supramolecular hosts capable of bio-inspired recognition and communication

*King's College London / Francis Crick Institute*

Enzymes are essential to life, for example they are key in processes like breathing. Through the unique combination of supramolecular self-assembly and chemical biology this project will create fully synthetic enzyme mimics, i.e., supramolecular hosts, with the functionality and binding specificity seen in their biological counterparts, raising their potential in applications including targeted drug delivery.

## Industrial Fellows

**Lucinda Abell Black**

*Subject:* Towards understanding sports injury epidemiology in women athletes: A multifactorial approach utilising novel smart leggings

*Sponsor:* KYMIRA

*Loughborough University*

The reasons why women athletes are ~3-6 times more at risk from anterior cruciate ligament injury compared to men is poorly understood, due to the inability to measure movement outside the laboratory. However, KYMIRA can enhance this much-needed research through smart leggings, which can measure kinematics in realistic sporting settings.

**Eve Andrews**

*Subject:* Circular economy for offshore wind - a bespoke metric and roadmap

*Sponsor:* SSE Renewables

*University of Strathclyde*

This project is focused on circular economy for the wind industry, particularly futureproofing offshore wind for sustainable decommissioning by making better decisions in design. This involves designing a bespoke metric which will measure the circularity of wind developments which will allow for incentivisation and drive behavioural change towards meaningful circularity.

**Tina-Maria Burova**

**Subject:** A high-throughput platform for reactive fragment screening in cells against protein targets of therapeutic interest

**Sponsor:** GSK

*University of Strathclyde*

The timely and efficient discovery of chemical tools for disease-relevant proteins is important for drug discovery. This project aims to develop a technology for the high-throughput screening of reactive fragments in living cells, expediting the development of chemical tools for 'undruggable' proteins that cannot be studied outside of the cell.

**Colm Dowling**

**Subject:** Transforming the prevention of suicide, self-harm, and interpersonal violence in care settings

**Sponsor:** Safehinge Primera

*Glasgow Caledonian University*

This research aims to identify ethical digital data science solutions to aid healthcare workers in efficiently identifying individuals at risk of suicide, self-harm, or violence by improving real-time health data collection, aggregation, synthesis and presentation, addressing the challenges faced by staff in mental healthcare settings and enhancing patient safety.

**Alberto Gomez Saiz**

**Subject:** Design of analogue integrated circuits with quantum dot structures

**Sponsor:** Quantum Motion

*Imperial College London*

This project proposes to explore the unique properties of circuit elements based on quantum dots in combination with traditional electronic components to deliver novel analogue integrated circuits. The key aim will be to demonstrate a practical use case in which a QD-based analogue circuit outperforms existing cryoelectronic solutions.

**Gareth Hart**

**Subject:** Enabling the hydrogen economy: Improving electrocatalyst performance and reducing iridium content through materials discovery

**Sponsor:** Johnson Matthey

*University of Warwick*

The production of renewable (green) hydrogen is key to defossilisation and prevention of further global warming. Current catalysts in these technologies rely on iridium, a precious metal with limited supply. This project will design new, efficient catalysts with reduced iridium content and scale up chemical synthesis for subsequent development.

**Charlie Hutchings**

**Subject:** The impact and mitigation of materials degradation on assets in hydrogen economy infrastructure

**Sponsor:** Frazer-Nash Consultancy

*University of Surrey*

Hydrogen is required for an affordable, resilient, and decarbonised energy system. This project will experimentally investigate and assess the pervasive impact of hydrogen on material integrity. The acquired knowledge and models developed will support asset operators, standards bodies, and policymakers in interpreting, managing, and mitigating materials risks associated with hydrogen.

**Katie Ollerton**

**Subject:** Transcending skin barriers: film formation, nanostrategies, skin mimic progress in personal care and pharmaceutical delivery

**Sponsor:** Unilever

*University of Liverpool*

This project seeks to develop innovative methods of characterising film microstructures and the delivery of active ingredients across numerous formulations, formats and environmental conditions using a non-animal skin model. Exploring formulation properties, particle size and residency time, this work will revolutionise transdermal research, benefitting both personal care and pharmaceutical domains.

**Harry Palmer**

**Subject:** Affinity-guided platform for the high-throughput generation of homogeneous antibody-drug conjugates

**Sponsor:** GSK

*University of Strathclyde*

Chemotherapy is a common cancer treatment, despite frequent adverse effects for patients. As cancer rates increase, there is a growing need for improved treatments: antibody-drug conjugates seek to meet this need. This project aims to develop a novel high-throughput platform to rapidly design and synthesise safer, more effective antibody-drug conjugates.

**Maja Schmidt**

*Subject:* Real-time magnetocardiography pattern recognition

*Sponsor:* Neuramics

*University of Edinburgh*

The project aims to develop scalable artificial intelligence-enabled software to analyse multi-channel magnetocardiographic signals recorded by wearable magnetic sensors. This innovation allows the detection and classification of heart arrhythmia after ischemia in real-time, which is currently impossible outside hospital environments. It enhances remote at-risk monitoring, reducing mortality and healthcare costs.

**Ryan Teo**

*Subject:* Designing new antibiotics with a focus on gut health

*Sponsor:* Ineos

*University of Oxford*

Antibiotics revolutionised medicine but are challenged by antimicrobial resistance (AMR). Newly developed antibiotics prioritise potency, neglecting the harmful effects on the gut microbiome, thus losing the beneficial protection of colonisation resistance. This project aims to synthesise microbiome-friendly antibiotics, understanding their selectivity to develop more effective drugs that simultaneously delay AMR spread.

**Karina Wojdat**

*Subject:* Investigation of molecular distributions in solid dispersions for applications in pharmaceutical formulations

*Sponsor:* Sygnature Discovery

*University College London*

Solid dispersions, often amorphous, while widely applied in many industries, can hardly be considered well understood. Molecular distributions of the components of such mixtures seem to determine their final nature and properties. Gaining an understanding of those systems and a way of investigating them, could speed up their pharmaceutical formulation timelines.

## Enterprise Fellows

**Anthony Camu**

*Company:* Theia Robotics

Theia is a patented, novel, handheld/wearable, semi-autonomous electronic travel aid for people with visual impairment. Theia's real-time-guidance-system uses a graph-based Visual-Simultaneous-Localisation and Mapping (V-SLAM) method, which fuses RGB-D and IMU data (i.e., Visual Inertial Odometry) using an Intel RealSense D435i camera and a Raspberry Pi 4B; after 50km of testing Theia achieved on average  $\pm 50$ cm localisation accuracy in challenging lighting/weather conditions and GPS-denied environments.

**Alicia Graham**

*Company:* MadeSweetly

There is an urgent need for sustainable and healthy food alternatives amidst rising health issues and a broken and unsustainable food system. This is especially key in relation to excessive sugar consumption, which leads to issues such as obesity, cardiovascular diseases, and diabetes. MadeSweetly's innovative solution combines precision fermentation and synthetic biology to utilise *Yarrowia lipolytica* yeast for the sustainable production of sweet-tasting proteins as a sugar substitute.

**Matthew Moore**

*Company:* Drone Tector [Financially supported by the ERA Foundation]

The dangerous uses of small drones are increasing at a rapid pace. Drones' usage in the Red Sea has doubled shipping costs globally since November 2023. The disruptive presence of drones in airports grounds all aircraft for hours - the 2018 Gatwick incident cost all stakeholders over £50m. And drones have become a key weapon of war in Ukraine with more than 1600 drone attacks per month in 2024. The problem is that drones are often invisible to conventional detection systems, blending in with birds and other flying objects. Drone Tector has developed a new millimetre-wave drone detection radar that can differentiate between drones and birds (and other flying objects) and, crucially, between different drone models, allowing friend or foe detection and threat estimation.

**Teja Potocnik**

*Company:* Nanomation

Manufacturing semiconductors with nanomaterials improves chip power efficiency and enables functionalities not possible with existing materials. However, it is currently impossible for industry to use these materials given their random distribution on substrates which requires human intervention to place integrated circuits on top of the nanomaterial on the chip surface. Nanomation has developed the first automated nanofabrication system aimed at the semiconductor industry, utilising a nanoscale-optimised location system, computer-vision algorithms, and in-situ circuit routing that eliminates the need for human labour. The technology is compatible with conventional semiconductor fabrication equipment, and can also solve critical challenges for adjacent industries, including advanced microscopy, sensors, photonic integrated circuits and bioelectronics.

**Alex Shakeshaft**

*Company:* Enturi Solutions [Financially supported by the ERA Foundation]

Enturi has developed a patent-pending, game-changing micro wind turbine design offering compact and high-efficiency clean-power-generation to diversify the UK's green energy portfolio. With this core turbine technology, Enturi is developing portable single-turbine (6kW) and multi-turbine (20-100kW) distributed energy systems for the UK maritime sector, the Enturi aeroCharger and Enturi eStation. These non-grid connected renewable energy systems are portable for rapid implementation and relocation, as well as backed up with an ISO-complaint IoT system for secure data interoperability and transparency.

**Adhesh Shenoy**

*Company:* Guerilla.Co

Urban runoff, laden with pollutants like microplastics, toxic hydrocarbons, and heavy metals, presents a looming threat to our waterways, ecosystems, and public health with toxicity comparable to raw sewage. Guerilla.Co has developed a retrofittable device for existing drains utilising cutting-edge, membraneless, and energy-efficient technology to effectively separate pollutants at the source, surpassing the capabilities of traditional solutions. Integrated smart sensors deliver real-time data streams on water quality and pollutant levels, revolutionising the limited data acquisition offered by current methods.

## Design Fellow

### Henry Hosker

*Subject:* Biodiversity by Design: TRACES

*Mentor:* Professor Alfried Vogler, Natural History Museum

Capable of revealing entire ecological communities from microscopic bacteria to whales, eDNA is a revolutionary tool for monitoring biodiversity and informing conservation initiatives. However, current methods are limited by filter clogging from non-DNA particles, making sampling slow, expensive, and inefficient. TRACES solves this challenge by employing hydrocyclones as in-line prefilters, dramatically increasing sampling efficiency and enabling the collection of larger eDNA datasets.

This fellowship focusses on the development of TRACES. Combining leading-edge technology with thoughtful design, TRACES aims to create and deliver a streamlined, rigorously validated solution that seamlessly integrates into existing aquatic environmental sampling practices. By engaging conservationists, researchers, field technicians, and other stakeholders through an iterative co-design process, the TRACES system will tailor to meet real-world needs, and demonstrate the value of merging innovative, inclusive design practices with high technology in the context of biodiversity conservation. Rigorous scientific validation will demonstrate the effectiveness of TRACES in diverse environments, ensuring that its claims are backed by evidence. This work will culminate in a series of pilot projects which will put TRACES into the hands of its users, providing critical feedback while showcasing its value in the field.

TRACES looks to make aquatic eDNA sampling faster, cheaper, and more accessible, empowering conservation teams to collect richer data and make more informed decisions on large scales. By accelerating biodiversity monitoring, protection, and restoration efforts, TRACES offers a vital facilitation tool for addressing the global biodiversity crisis and protecting the ecosystems on which we all depend.

## Sir Misha Black Medal for Distinguished Services to Design Education

### **Dr Patricia Moore**

### ***Moore Design Associates***

Dr Patricia Moore, President of Moore Design Associates is a dedicated educator, serving universities throughout the Americas, Asia and Europe. As a pioneering figure in design, she is a leading authority on consumer lifespan behaviours and requirements.

For a period of three years from 1979 to 1982, in a daring experiment, she travelled throughout the United States and Canada disguised as women of more than 80 years of age. This experience of responding to people, products, and environments as an elder enabled an empathetic approach to design that informed much of her future work.

Since 1990, she has designed more than 300 Physical Medicine & Rehabilitation Environments for healthcare facilities throughout North America, Europe, China and Japan. She is a frequent international lecturer, media guest and the author of numerous books, including: *Disguised: A True Story*, and *Ageing, Ingenuity & Design*.

She is a Fellow of the Industrial Designers Society of America. Named by ID Magazine in 1997 as one of the '40 Most Socially Conscious Designers' in the world, she was selected in 2000 by a consortium of news editors and organisations as one of the '100 Most Important Women in America'. She has been awarded Honorary Doctorates from Syracuse University, Hasselt University, Sheffield University, the College for Creative Studies, and the Rochester Institute of Technology.

Throughout her illustrious career, she has paved the way for more inclusive and empathetic approaches to design and has been the recipient of honours almost too numerous to list, including being named by the Industrial Designers Society of America as 'Most Notable American Industrial Designer' in 2016. She was the recipient of The National Design Award in 2019, and in 2020 the 'Changemaker Award' awarded by the Center for Health Design. Most recently the World Design Organisation recognised her impressive design legacy, influence and leadership in awarding her the 2022 World Design Medal™.

## Honorary Sir Misha Black Medal for Distinguished Services to Design Education

### **Ms Mary V Mullin**

Mary Mullin is the former Chairman of the Sir Misha Black Awards Committee. She joined the Committee in 1993 and served as Chairman from 2003 until she stepped down in March 2024. In that time, she oversaw the introduction of the Award for Innovation in Design Education in 1998, and more recently the move to the Awards' current home under the auspices of the Royal Commission for the Exhibition of 1851.

Mary is Trustee of the Robin and Lucienne Day Foundation, Trustee of INSPIRE Trust, and Regional Adviser to the World Design Organisation. She served as Secretary General of the International Council of Graphic Design (ICOGRADA now ICO-D) for fourteen years, and as a founding Trustee for the ICOGRADA Foundation.



Her contribution to the promotion of design and education is extensive. Positions held include being the first woman elected to the Board of ICSID, serving as Vice President and developing its Interdesign Programme of events across Ireland and continental Europe. She remains a Founder Member of the Crafts Council of Ireland, has been a consultant for UNIDO, and was National Chairman of the DIA. She was Founding Director of the National Centre of Culture and Arts in Dublin (now the Museum of Modern Art). She ran her own consultancy practice in design and special event management in London from 1981 to 1998. Clients included the 'Boilerhouse' at the V&A, the precursor of the Design Museum; the Science Museum; the Design Research Unit and other leading design practices and commercial clients.

Mary is an Hon. Fellow of the RCA, the University of the Arts in Bournemouth, the International Society of Typographic Design, and Honorary Life Fellow of the RSA. In 2017 she was awarded the RSA Bi-Centenary Medal "for encouraging and promoting design across education and industry". In 2018, with Sir Christopher Frayling, she co-edited *Fitness for What Purpose*, a book documenting the 40 year history of the Sir Misha Black Awards.

### Sir Misha Black Award for Innovation in Design Education

#### **Ms Zowie Broach**

*Royal College of Art*

Zowie Broach has been Head of Programme, MA Fashion at the Royal College of Art since 2015. Previously she co-founded the avant-garde design studio and brand Boudicca, which was the first independent British label to show during Couture Paris, as well as exhibiting at Arts Institute of Chicago and the Tel Aviv Museum. More recently Boudicca featured as part of the London Design Museum's 'Rebel: 30 years of London Fashion'.

Boudicca, having staged the first ever fashion show to be live streamed back in 2004 by SHOW studio, continued to investigate the digital interface as a tool, and the exploration of identity and material. Keeping her eye firmly on both present and future,

Zowie is a principal investigator into whether machine intelligence can support and relate to the manual intelligence of Haute Couture. This relates strongly to the long-term consultation for Cartier she was part of, with a project about craft futurism.

Zowie Broach embraces fluidity of gender and identity, the merging of the physical and the digital, and bringing together different fields to create new futures and thought processes that go beyond the usual graduate collections or fashion practices, challenging a new disruption to the industry from graduates across high luxury to research, questioning and impacting a fashion future.

Zowie Broach has been voted into the top 500 Fashion Leaders, Business of Fashion for the last 8 years.

## Industrial Design Students

|                       |                               |                                                |
|-----------------------|-------------------------------|------------------------------------------------|
| Zayna Ahmed           | Innovation Design Engineering | Royal College of Art / Imperial College London |
| Zachary Berry         | Innovation Design Engineering | Royal College of Art / Imperial College London |
| Daphné Biestro        | Innovation Design Engineering | Royal College of Art / Imperial College London |
| Luke Hale             | Innovation Design Engineering | Royal College of Art / Imperial College London |
| Gregory Hargraves     | Innovation Design Engineering | Royal College of Art / Imperial College London |
| Muhammed Saym Hussain | Design Products               | Royal College of Art                           |
| Khalil Ismail         | Innovation Design Engineering | Royal College of Art / Imperial College London |
| Jérémie Kofman        | Innovation Design Engineering | Royal College of Art / Imperial College London |
| Bana Quronfuleh       | Innovation Design Engineering | Royal College of Art / Imperial College London |
| Lucinda Tam           | Innovation Design Engineering | Royal College of Art / Imperial College London |
| Brigitte Zheng        | MRes Design                   | Royal College of Art                           |

## Technical Teaching Fellows

### **Jen Deakin**

*Runshaw College*

This project will investigate using AI to enhance teaching and learning and its potential to alleviate current challenges faced by the education sector, such as teacher workload.

### **Sophie Harris**

*Derby College*

This project aims to promote and embed sustainability within curriculum design.

### **David Jones**

*Pembrokeshire College*

This project aims to create and embed a range of resources and toolkits to enable staff to deliver and embed vocational skill development within special needs education.

### **Aine McGreeghan**

*South Eastern Regional College, Northern Ireland*

This project aims to identify education structures and approaches to support the increased retention, motivation and attainment of women and girls in engineering education.

### **Daniel Pritchard and William Davies**

*NPTC Group of Colleges (Newtown and Brecon College)*

This project aims to share best practice in the delivery of Electric Vehicle education through a series of collaborative projects with other colleges and industry partners.

### **Scott Rorrison**

*Humberside Engineering Training Association*

This project aims to harness the use of technology to help teachers imagine and create STEM lessons that are engaging and innovative.

## Special Awards Granted

### *STEM education and outreach*

**British Science Association** - Primary kit boxes  
**Somerscience Trust** - Somerscience Festival 2024  
**Kids Invent Stuff** - Exhibition  
**Big Ideas** - London Wonder  
**Number Champions** - Numeracy in primary schools  
**Durham University** - Celebrate Science 2024  
**Imperial College Union Design Engineering Society** - Hackathon  
**Foundation for Science and Technology** - Foundation Future Leaders Conference  
**Fun Kids Radio** - War time inventions  
**STEM Learning** - Bespoke training for primary STEM teachers  
**Royal Designers for Industry** - Summer schools  
**Royal Museums Greenwich** - First Light gallery  
**Royal Institution** - Science in Schools  
**National Space Centre** - Outer Solar System gallery  
**Institute of Physics** - Mimi's Tiny Adventure

### *Support for legacy estate*

**Exhibition Road Cultural Group** - SouthKenZen+ Project funding  
**Exhibition Road Cultural Group** - SouthKenZen+ Heat network  
**Royal College of Art** - Main entrance  
**Royal College of Music** - Colin Lawson Fund

## Awards completed in 2024

### Research Fellows

#### **Dr Thomas Breithaupt**

*Project:* Redefining the relationship between crystal defects and mantle flow

*University of Cambridge*

At the high temperatures and pressures of Earth's mantle, rocks flow. Over geological timescales, the resistance of rocks to flow controls plate tectonics. Over human timescales, it controls, for example, the response of the Earth's mantle to melting ice sheets, which in turn mediates sea level rise. However, to observe the flow of rocks in the laboratory, experiments must use forces far greater than those found in nature, making extrapolation unavoidable. However, historic models of rock flow were constructed from empirical power-laws, undermining confidence in their predictions.

During his Fellowship, Tom set out a radical new framework for modelling rock flow. By rooting this framework in the physics of interactions amongst the defects that accommodate rock flow, he placed extrapolation from laboratory to nature on a firm footing. In the manuscript detailing this work, published in the *Proceedings of the National Academy of Sciences*, he demonstrated that this framework could explain laboratory observations of steady rock flow. However, further work was required to test its underlying assumptions as well as demonstrate its applicability to non-steady flow. Tom subsequently conducted novel experiments to test the framework, involving both step changes and oscillations in the forces driving rock flow. The experiment results are in excellent agreement with the framework, increasing the credibility of its predictions for rock flow in Earth's mantle. The Fellowship also gave Tom the opportunity to develop fruitful collaborations across the rock deformation community with significant outcomes. One outcome of these collaborations is overturning the long-held belief that water weakens rocks at low-temperatures.

Tom is now a Research Associate at the University of Cambridge.

#### **Dr Gregory Chaplain**

*Project:* Novel development of elastic metamaterials

*University of Exeter*

Metamaterials are composite, structured materials which have exotic properties due to their underlying substructure (that is often periodic) rather than their chemical composition. There have been significant advances in the design and development of these exotic materials, particularly in the fields of optics and acoustics, where unprecedented wave control has allowed science-fiction-like invisibility cloaks to be realised. This Fellowship looked to advance elastic metamaterial counterparts to such devices, leveraging the additional physics present in the elastic system. Here the aim was to design, simulate and fabricate devices with a host of vibration control capabilities and then translate the physics unearthed back into acoustic (and electromagnetic) wave regimes, leading to new metamaterial paradigms for the control of waves in almost any system.

Significant advances in the modelling (both analytical and numerical) and experimental realisation of such structures has been achieved, with attention paid to the orbital angular momentum of elastic waves, particularly in pipes; the focussing of sound underwater (and analogously in electromagnetic antennas), using structured flat surfaces; beyond-nearest-neighbour metamaterials, that can control the flow of energy along structures with 'backwards' waves; topological (tuneable) elastic metamaterials, that allow 'protected' wave amplification; quasi-periodic acoustic metamaterials, that permit fractal rainbow trapping (the localisation of acoustic energy in designed locations); and the physical realisation and observation of predictions from theories in applied mathematics, particularly in the fields of Acoustic Rayleigh-Bloch waves on finite lattices, and Quantum Graph Theory.

In the realm of elasticity these devices have been poised as candidates for controlling vibrations, leading to enhanced isolation and energy harvesting capabilities.

Over the last three years Greg has published 12 peer-reviewed papers, with four more currently under review.

After the Fellowship, Greg is delighted to be staying at the University of Exeter as a Senior Lecturer in Metamaterials Physics and a co-investigator on an EPSRC Programme Grant (Meta-4D). His research will now focus on time-varying metamaterials, the ‘next-generation’ of this exciting field, where the properties of materials are structured in time, as well as space.

### **Dr Harvey Dale**

*Project:* Chemical origins of the genetic code: lost in translation

*MRC Laboratory of Molecular Biology*

The coded biosynthesis of proteins – the translation of genes into functional molecules – is a defining pillar of life, used by all organisms on Earth. It is widely believed to have underpinned the existence of our Last Universal Common Ancestor (LUCA), yet we know neither how this process emerged, nor what evolutionary pressure drove its emergence. Interestingly, whilst the underlying chemistry of this process is highly efficient when mediated by sophisticated biomolecules, it is virtually useless in their absence. Given that many of these biochemical aides are themselves proteins, this poses a clear dilemma: how did life first learn to make proteins?

During his 1851 Fellowship, Harvey sought to explore this question from the perspective of an organic chemist, working with John Sutherland FRS at the MRC LMB and with additional generous support from the John Henry Coates Research Fellowship at Emmanuel College, Cambridge (elected 2022). At the LMB Harvey designed a chemical model system for a key step in protein biosynthesis – transpeptidation – and then studied it in unprecedented detail to reveal key facets of the underlying chemistry. He confirmed, building on classic work from others, that a very specific subset of amino acids is in fact highly predisposed to assemble, without biochemical assistance and in water, into proteins, and he demonstrated the mechanism underpinning this predisposition. Harvey’s findings have potentially significant implications for the RNA world hypothesis.

Harvey has now joined the specialist Physical Organic Chemistry group at Syngenta’s Jealott’s Hill International Research Centre as a Senior Process Chemist.

## **Dr Amparo Güemes**

*Project:* Development of neurotechnology systems for improving glucose control

*University of Cambridge*

Amparo's work focused on developing bioelectronic devices and algorithms to interface with the nervous system, advancing our understanding of how neural activity regulates glucose metabolism.

A major outcome of this Fellowship has been the development of a multimodal analytical framework for decoding and classifying metabolic information from the vagus nerve in anaesthetised rats and pigs, which contributes to our understanding of how vagus nerve activity influences glucose control.

Beyond vagus nerve studies, Amparo co-led a project focused on the enteric nervous system, where she developed thin-film neural devices implanted in the colonic wall to investigate gut electrophysiology. Additionally, she co-developed a new method for enhancing neural recordings by coating tungsten microwires for higher quality brain and peripheral nerve recordings. As part of the research objectives, she explored non-invasive neuromodulation through Temporal Interference (TI) for hepatic stimulation, aiming to regulate glucose levels by targeting the hepatic plexus. This study provided a foundation for future research on non-invasive methods of metabolic regulation.

Beyond her research, Amparo has been involved in several societal initiatives, including co-creating a UK Patient and Public Involvement (PPI) network for neurotechnology development.

The Fellowship has led to 10 publications (with six as first or co-first author), participation in 12 national and international conferences, and the initiation of four new collaborations with universities across Europe and the UK. The preliminary results from this Fellowship have enabled Amparo to secure additional funding for a pilot clinical study as an Early Career Researcher and to increase the recognition of her work through the prestigious 2023 Engineering Rising Talent Award from the L'Oréal-UNESCO For Women in Science program.

The Fellowship has also facilitated her transition into the next phase of her career as a Senior Research Associate at the University of Cambridge, where she will continue her research on neuro-metabolic interactions in epilepsy with the support of a Royal Academy of Engineering Research Fellowship. This five-year fellowship will allow her to delve deeper into the preclinical and clinical applications of the technologies and methods developed during the 1851 Research Fellowship, advancing our understanding of the neural regulation of metabolism in different disease conditions.

### **Dr Jasmine Lee**

*Project:* Mapping conservation actions for Antarctic biodiversity facing rapid global change

*British Antarctic Survey*

Jasmine's project focused on understanding threats facing terrestrial Antarctic biodiversity and more importantly, what we can do about them. Answering these questions led to journal publications in *Global Change Biology* and *Plos Biology*, where she found that climate-induced habitat transformation is likely to have substantial impacts on Antarctic species, and that mitigating climate change would provide the greatest conservation benefit.

As a conservation scientist Jasmine is aiming for real world impact and policy change and the support of the Commission enabled her to not only do her research, but also to present it in appropriate forums. Some of the highlights of the last three years include presenting her work at the 2023 Antarctic Treaty Consultative Meeting in Helsinki, meeting colleagues from all over the country at the UK Antarctic Science Conference and providing evidence in Westminster about the UK and the state of the Antarctic Environment. She also treasured the opportunities given by the Commission to participate in the Great Exhibition Road Festival and engage with the next generation of scientists, which was hugely inspiring.

Next, Jasmine is heading to Melbourne, Australia to take up a Discovery Early Career Researcher Award (DECRA) awarded by the Australian Research Council. Her new project will examine cumulative impacts in Antarctica, thus continuing the work she started with her 1851 Fellowship.

### **Dr Benjamin Walker**

*Project:* Multifilament methods on the microscale

*University College London / University of Bath*

Throughout his fellowship, Ben has explored microscale problems with macroscale applications. He has focused on developing our understanding of how microorganisms (such as bacteria and spermatozoa) swim and how they ultimately navigate their environment. His research has centred on a new area of enquiry: how do variations over time (such as in the undulating shape of the long, slender appendages that many 'microswimmers' use to move) alter our predictions of their long-term behaviours? Throughout the Fellowship, Ben has incorporated various sources of temporal variation into classical approaches for predicting swimmer behaviour. Much to his surprise, these details have turned out to have large consequences on our predictions and the intuition built upon them. For instance, in a study of a motile alga (*Chlamydomonas reinhardtii*), the rapid, small-scale variations in its shape and swimming speed were found to be sufficient to drive an experimentally observed behaviour; without these small-scale variations, the experimental observations and mathematical predictions were in disagreement.

Ben's Fellowship also led him to an unexpected project: VisualPDE.com. Along with collaborators at Durham University, he created this resource for exploring and communicating mathematics to broad audiences, enabling play and interactivity without the usual barriers that mathematics is associated with.

Early on in the Fellowship Ben took up a lectureship at the University of Bath and he has recently moved to University College London as a Lecturer in the Department of Mathematics. His research continues to involve microscale swimmers and is branching out into the study of broader fluids problems and biological growth.

## **Dr Harry Miller**

*Project:* Geometric approach to optimisation in quantum thermodynamics

*University of Manchester*

Harry's project was within the field of quantum thermodynamics, which is an area of research aiming to understand how thermodynamics influences the behaviour of microscopic systems such as atomic-scale thermal engines and information processing in quantum computing.

The purpose of the project was to figure out, from a broad theoretical perspective, how to reduce irreversible effects and improve thermodynamic performance of controlled quantum systems. The main approach taken was to use ideas from differential geometry to understand how to find optimal processes in quantum thermodynamics. This ended up being a successful strategy; Harry found that one can reach optimal limits by driving a system along a 'geodesic path' which is the shortest curve connecting its initial and final configuration. The general concept was applied to a range of important problems in quantum thermodynamics. This included optimising the balance between efficiency and reliability of periodic quantum heat engines, exploring the role of quantum fluctuations in information processing tasks, and the derivation of fundamental thermodynamic trade-off relations for slowly driven systems. The Fellowship produced nine publications in total. Overall, the results of this research programme have helped to provide new insights into the nature of thermodynamic constraints in quantum regimes.

Harry now holds a Royal Society University Research Fellowship at the University of Manchester. His research is now focusing on extending these geometric methods to address systems that are driven significantly further from equilibrium over fast timescales, which promises to provide an even broader theoretical basis for thermodynamic optimal control.

## **Dr Hannah Wauchope**

*Project:* Understanding the biodiversity of the past to predict the future

*University of Exeter / University of Edinburgh*

Hannah's 1851 Fellowship aimed to understand how animal and plant species have responded to past climatic change, to enable us to make better predictions about the future. During her Fellowship, she demonstrated that smoothing of climate estimates over long time spans results in us often underestimating the amount of climate variability species have experienced since the last ice age, meaning we might also be underestimating many species' tolerances to climate change. Hannah tested the methodologies we use to forecast where species will occur in the future, by instead predicting models into the past, and testing these predictions against species' fossil locations. She found that our predictions of distributions often do not align with past locations – raising important questions for model trustworthiness. She is now working with students to extend these approaches and explore ways to calibrate the predictive models more accurately, to understand which species we can – and can't – make predictions for. Finally, during her Fellowship, Hannah continued to develop her portfolio of work in Arctic regions, by modelling Arctic species' responses to change and comparing these against past areas of climate stability, to see if such areas will remain stable into the future.

Hannah has now taken up a position as Lecturer in Ecology and Conservation at the University of Edinburgh where, based in large part upon her Fellowship work, she is developing a new undergraduate course focussed on understanding the impacts of climate change on environmental systems.



**Dr Matthew Westaway**

*Project:* Simple representations of modular Lie algebras

*University of Birmingham*

At the intersection of algebra and geometry lies Lie theory, and particularly “Lie-theoretic representation theory”. The goal of the research project was to deepen our understanding of the “modular representation theory of Lie algebras”, an exciting subfield of such research in which cutting-edge new tools had recently become available. Matthew’s research progressed along two tracks.

The first track involved exploring the application of tools from the related theory of “modular representations of algebraic groups” to the setting of Lie algebras. This track involved the publication of one paper, a preprint, and substantial progress towards another preprint (joint with Simon Goodwin). Matthew was able to generalise techniques from so-called “highest weight theory” to the world of Lie algebras (including “tilting modules” and “wall-crossing functors”), though also discovered the limitations to such an approach.

The second track focused on understanding a powerful tool called “parabolic induction” as it arises in Lie theory. In a preprint with Goodwin and Lewis Topley, he showed that in one important setting all objects with which we were concerned arise from parabolic induction. In another individual preprint, he obtained lengthy tables describing how (a form of) parabolic induction behaves on 289 objects called “nilpotent orbit covers”.

Finally, another preprint begins exploring the connection between these two tracks, and an ongoing collaboration with Goodwin and Topley aims to understand this connection further.

To continue this collaboration, Matthew has accepted a postdoctoral position with Topley at the University of Bath.

**Dr Niclas Westerberg**

*Project:* Reshaping the quantum vacuum for photon sources

*University of Glasgow*

Nic’s project focused on bridging the gap in our theoretical understanding between photon production and quantum vacuum forces on nano-optic scales. He approached this in a broad sense, setting out to study not only the production of quantum light itself but also its uses. Consequently, he developed new understandings of, and methods for tailoring, the production of quantum light by structuring the optical environment around an emitter. In collaboration with others, he also developed the Hong-Ou-Mandel microscope (which is where the quantum properties of light are used to produce images of objects that are invisible to conventional imaging) and established a new fluorescence lifetime sensing technique that works in entirely new regimes.

The Commission’s support allowed Nic to broaden his horizons further and study fundamental properties of light that are important in its interaction with matter. For instance, he determined the form of the helicity of light in structured optical media, a property which is crucial to understanding the interactions between light and many biologically relevant molecules.

Building on the work and connections made possible by the 1851 Fellowship, Nic will continue at the University of Glasgow as a Research Fellow, having secured grant funding as co-investigator on two grants – one on transformative healthcare technologies together with the Universities of Oxford and Ulster, and a second on light-atom based vector magnetometry working with the British Geological Society as well as European partners.

## **Dr Philip Wijesinghe**

*Project:* Revealing cell mechanics with light-sheet microscopy

*University of St Andrews*

“If the 20th century was the century of physics, the 21st century will be the century of biology.”—  
Craig and Cohen.

We have already witnessed remarkable breakthroughs, from rapid sequencing of the genome to tissue engineering, and are primed for new discoveries that will transform health and life. Now, the focus is on precision biology and medicine. Such endeavours require the quantification and modification of the function of life in its natural environment, and often on a molecular scale. It is imperative to support these efforts with new creative instruments and analysis methods.

Philip’s project has focused on developing a range of instruments and computational methods for functional imaging of life on the cellular scale. With colleagues, he has developed a method for rapid, 3D imaging of metabolic activity in living tissues using light-sheet microscopy, which can provide non-invasive assessment of embryos for in-vitro fertilisation. He has helped augment light-sheet microscopy with deep-learning based super-resolution for high-throughput and enhanced contrast. Another critical element to cell function is their motion and mechanics. Philip and his colleagues have developed an optical coherence microscopy method for quantifying such mechanics on a cellular scale, which can help unravel the mysteries of why some tumours metastasise while others remain benign. He has also fundamentally enhanced the depths to which these systems can image. To further assist analyses, Philip and his colleagues have developed a tool based on deep learning that can quantify motion in all microscopy methods. The Fellowship has enabled Philip to lead and contribute to this collaborative work as an independent academic.

The versatility of the 1851 Research Fellowship in terms of its remit and funding, has empowered Philip to take an unconventional approach to his research. Novel instruments require accessibility and translation to the end user, here, the biologist. The Fellowship has allowed Philip to develop and release software for computational imaging and motion estimation as open source without restriction. In contrast, the accessibility of hardware can come from rapid and efficient commercialisation. The Fellowship has facilitated Philip’s engagement with Scottish Enterprise at the University of St Andrews, and enabled collaboration with the University of Western Australia, resulting in two patents. Philip believes that innovation in advanced imaging for biomedicine lies in the close partnership of academia and industry.

After the conclusion of the Fellowship, Philip remains affiliated with the University of St Andrews and an adjunct fellow of the University of Western Australia, finalising the remaining advances for publication on a contract basis, as well as pursuing avenues for the commercialization of the technology.

## Brunel Fellow

### **Dr Edward Hart**

*Project:* Advancing main-bearing science for wind and tidal turbines

*University of Strathclyde*

The Brunel Fellowship allowed Ed to undertake extensive multidisciplinary work to establish a firm scientific foundation for the function and failure of main bearings in modern wind turbines. This included extensive modelling work concerning main bearing structural loading, lubrication, dynamics and micro-slip. These efforts revealed the highly variable nature of the operating conditions within a main bearing subjected to atmospheric turbulence. Existing design standards and processes were evaluated, critiqued and tested, revealing that current practice does not allow for the observed field failures to be accounted for. Ed led a significant international failure data collection and analysis exercise with international partners, revealing that main bearing field lives are close to half of their design life. Other important work included the rigorous reformulation and extension of a proposed bearing reliability methodology, allowing for improved granularity of life analyses when field data is incomplete or fragmented. Collaborative work with US partners allowed for high performance simulations of the atmospheric boundary layer to be undertaken, including the modelling and analysis of impacts of large-eddy passage on main bearing loading. Novel hydrodynamic bearing applications, as the main bearing in wind turbines, were also initiated and are ongoing. Further work was undertaken to evaluate main bearing operational conditions for tidal turbines, with important differences demonstrated compared to wind turbines. The Fellowship was successful in accelerating the development of our scientific understanding of this operations-critical component.

Ed is now a Senior Lecturer at the University of Strathclyde, where he continues to lead research in this and related fields. He was recently awarded a Researcher in Residence Fellowship to explore the role of digitalisation in drivetrain design, testing and monitoring.

## Industrial Fellows

### **Shefali Bhumbra**

*Project:* Developing a medicine designed to modulate cancer patients' immune system to selectively eliminate cancerous cells

*Sponsor:* Adaptate Biotheapeutics / Takeda

*Imperial College London*

Current cancer therapies often fail to fully eradicate tumours with minimal adverse effects, revealing a critical unmet need for many cancer patients. This project explored the potential of a novel antibody-based therapy with a focus on supporting Takeda's development of V $\delta$ 1-targeting antibody medicines. The therapy specifically engages V $\delta$ 1  $\gamma\delta$  T-cells—a unique immune cell type capable of recognizing and killing cancer cells—to enhance their effectiveness in eradicating B-cell leukaemias, a cancer affecting certain white blood cells. In her research, Shefali developed and validated this therapeutic approach, demonstrating that targeting V $\delta$ 1  $\gamma\delta$  T-cells with antibody-based medicines could improve their ability to eliminate these cancerous cells while maintaining safe activity in the presence of healthy cells, thus potentially reducing harmful side effects for the patient. The project demonstrated the efficacy of the V $\delta$ 1 therapy and began to clarify the mechanisms underlying its ability to enhance the V $\delta$ 1 cytotoxic response, providing insights for optimizing Takeda's V $\delta$ 1 engagers as cancer therapeutics.

This research has inspired Shefali to pursue a more comprehensive understanding of the immune system to effectively harness its potential in immunotherapy. While she gained in-depth knowledge of V $\delta$ 1  $\gamma\delta$  T-cells, she is eager to expand her expertise in immunology, believing that a broader perspective will enable her to develop more impactful therapeutic strategies for patients.

## **Kyle Bowman**

*Project:* Accelerating the commercial implementation of electromethanogenic reactors

*Sponsor:* WASE

*University of Westminster*

Kyle's Fellowship has significantly accelerated WASE's progress in developing its electromethanogenic reactor (EMR) technology. EMR efficiently converts wastewater into renewable energy through a bioelectrochemical process, demonstrating significant commercial viability and environmental impact by allowing businesses to utilise their waste to reduce fossil fuel usage.

Key milestones achieved include the successful pilot trial of the world's largest EMR at Hepworth Brewery, which treated real brewery wastewater. This pilot led to commercial sales of EMR units valued at over £650,000 and sparked additional orders exceeding £1.5 million. This success was instrumental in attracting £8 million in funding, with over £1 million of grants directly linked to the project's contributions.

The development of automated control and biosensing systems allows EMR to self-regulate and leverage electrical signals from microbial interactions as biosensors, a groundbreaking advance in monitoring reactor health and actively controlling reactor behaviour. Kyle also conducted metagenomic analyses, revealing how microbial communities interact differently within EMRs compared to anaerobic digestion (AD) systems.

Finally, Kyle conducted a techno-economic analysis to identify where EMR technology can most effectively enhance existing AD systems, showing that EMR integration can significantly boost their performance.

After the Fellowship, Kyle plans to continue advancing this technology, addressing new questions raised during the project to help WASE deliver sustainable solutions for wastewater treatment and renewable energy generation. This ongoing research will further strengthen WASE's ability to provide innovative, impactful solutions for the environmental and energy challenges faced by industries worldwide.

## **Liam Bussey**

*Project:* A quantum optical receiver for ultra-sensitive wireless digital communications

*Sponsor:* BT

*University of Birmingham*

During the course of the Fellowship, Liam significantly advanced the experimental capabilities of both BT and the University of Birmingham in developing a groundbreaking Rydberg atom-based radio frequency (RF) receiver. This innovative receiver offers a passive approach to converting RF signals into the optical domain, addressing the limitations of traditional metallic antennas and receivers. By enhancing the experimental setup, Kyle helped secure 20 patents in this cutting-edge technology and published three peer-reviewed papers, solidifying BT's position as leaders in this field.

The Rydberg atom-based receiver provides substantial improvements in sensitivity, tunability, and design simplicity, which can greatly enhance the performance of communication systems within BT. This technology promises to facilitate ultra-sensitive RF sensing and communication, making it ideal for applications in next-generation wireless networks, including 5G and beyond. The integration of this technology can lead to better signal quality, ultimately improving the reliability and efficiency of BT's services.

Following the completion of the Fellowship, Liam plans to continue working on the commercialization of quantum technologies, collaborating with industry partners to further pursue real-world applications.

Additionally, he aims to explore opportunities for expanding research efforts in quantum sensing and communications, through a career change moving to a larger research community.

### **Thomas Corner**

*Project:* Development of potent AspH inhibitors as novel small-molecule anti-cancer therapeutics

*Sponsor:* GSK

*University of Oxford*

Human 2-oxoglutarate-dependent (2OG) oxygenases catalyse the hydroxylation and N-demethylation of protein, polynucleotide, and small-molecule substrates. Catalysis by 2OG oxygenases is fundamental within biological processes, including e.g., hypoxia sensing, metabolism, epigenetic regulation, and DNA-damage repair. However, the functional and (patho)physiological roles of many 2OG oxygenases, and the therapeutic relevance of their inhibition, remains poorly understood.

During his industrial fellowship, Thomas' research focused on the design, synthesis and biochemical evaluation of small-molecule inhibitors that target the human 2OG oxygenases JMJD6 and FIH. Structure-based design, in combination with mass spectrometric (MS) studies, was employed to generate the most efficient and selective inhibitors of JMJD6 and FIH yet reported. In addition, a robust MS-based assay suitable for high-throughput JMJD6 inhibition studies was developed. It is anticipated that the JMJD6 MS assay will be highly valuable for future JMJD6 inhibitor development efforts.

Increased levels of JMJD6 are associated with tumorigenesis and cancer progression. JMJD6 is also reported to be involved in the generation of the androgen receptor splice variant 7 (AR-V7), which causes resistance towards anti-androgen therapies used for the treatment of advanced prostate cancer. JMJD6 inhibitors developed by Thomas were found to reduce the levels of AR-V7 in human prostate cancer-derived cells in a dose-dependent manner, a result that indicates JMJD6 inhibition may have therapeutic benefit for prostate cancer treatment.

FIH and the related 2OG oxygenases PHD1-3 regulate the response to hypoxia in humans. Small-molecule PHD inhibitors are used for anaemia treatment; by contrast, few selective inhibitors are reported. Thomas' optimised FIH inhibitors will be useful tool compounds to investigate the pleiotropic functional and physiological roles of FIH.

Following the Fellowship, Thomas has accepted a postdoctoral position at Yale University.

### **Jessica Crompton**

*Project:* Synthesis of quaternary stereocentres via hydrogen borrowing catalysis

*Sponsor:* GSK

*University of Oxford*

Medicinal chemists working in drug discovery often gravitate towards drug candidate molecules which are very 2D-like in shape, largely as a result of more simple synthesis. However, it has been demonstrated that the inclusion of quaternary stereocentres, which serve to make drug candidate molecules that are more three dimensional, can confer desirable properties onto the resulting molecule, potentially resulting in a more effective drug. However, many methods to make this motif use large excesses of hazardous reagents, generating large amounts of toxic waste. This project aimed to employ a more sustainable method – hydrogen borrowing catalysis – to enable the synthesis of useful quaternary stereocentres using benign starting materials and generating much less waste, which is an underexplored area in the literature.

Throughout the course of the project, Jess developed a variety of conceptually linked approaches to form a variety of small fragments using hydrogen borrowing catalysis, each containing the quaternary stereocentre motif. Jess initially developed two complementary approaches for the formation of small cyclic compounds (three-membered rings) using her method. Such small rings are often employed in drug discovery to block sites which can be metabolised, preventing rapid excretion of the drug candidate. This motif can also make the resulting molecule more rigid, resulting in greater complementarity to its proposed biological target. Her later approaches revolved around the synthesis of larger cyclic compounds, allowing more complex fragments to be synthesised for further functionalisation. Jess has published these approaches in high impact international journals demonstrating to the chemical community, including the pharmaceutical industry, that such useful fragments can be synthesised in a short sequence using more sustainable methods: a key focus for the industry.

On completion of her PhD, Jess will be taking up a position as a Synthetic Chemist at AstraZeneca, a leading UK pharmaceutical company.

### **Isobel Gordon**

*Project:* Quantitative MRI of the breast parenchyma to improve detection and diagnosis of breast cancer

*Sponsor:* Perspectum

*University of Oxford*

Breast cancer is the most common cancer in the UK and the worldwide leading cause of cancer death amongst women. MRI is widely regarded as the most sensitive technique in breast cancer imaging, but clinical protocols require the patient to receive an injection of contrast agent and to lie in an uncomfortable prone position. Furthermore, interpretation of patients' images is reliant on radiologists' experience and is semi-quantitative at best.

Isobel's research aimed to develop non-contrast, quantitative MRI methodologies to improve the diagnosis of breast cancer. Her work primarily focused on non-invasive measurement of the properties of breast adipose tissue. She identified biomarkers with the potential to improve lesion characterisation through examination of perilesional fat, and to improve breast cancer risk assessment through examining fat 'quality'. Isobel also evaluated a quantitative approach to measurement of breast density and assessed the feasibility of imaging women in the comfortable supine position using a specially developed support device known as the MR Bra.

Isobel's research has resulted in the publication of one paper and five abstracts, and she has contributed to two patents and one design registration. Isobel has presented her work at several well-respected international conferences and was selected as a scientific speaker at IF Oxford Science and Ideas Festival and Oxford Pink Week.

Perspectum are now considering the commercialisation of Isobel's research which has potential for implementation into several product offerings and for use in pharmaceutical collaborations.

Following completion of the Fellowship, Isobel will continue her research at Perspectum; she plans to further develop the MRI methodologies and to oversee the implementation of her research into product.

## **Amelia Markfort**

*Project:* AI technologies for the next generation of quantum imaging

*Sponsor:* Photek

*University of Leicester*

The ability to detect single photons has broad applications, ranging from particle tracking in large particle accelerator experiments like those at CERN, to medical imaging, space-based weather prediction, and LiDAR. The challenges of implementing algorithmic methods differ across these fields. They include handling large volumes of data and finding efficient ways to compress Gigabit-per-second (GBps) data streams, as well as de-noising MRI scans to improve the accuracy of medical diagnoses.

By leveraging machine learning techniques, Amelia's research has demonstrated a ten-fold improvement in spatial reconstruction compared to analytical methods, while maintaining a competitive timing resolution. Proof in principle studies have demonstrated that applying these techniques to a charge-sharing detector configuration is expected to enhance the spatial resolution of microchannel plate photomultiplier tubes while preserving picosecond timing precision.

To further ameliorate this result, statistical techniques such as Fisher's discriminant analysis reduce the dimensionality of the data, allowing a separation of 'correctly' reconstructed and 'incorrectly' reconstructed data to be observed linearly. Amelia's research provides a feasibility study of utilising these techniques to remove systematic errors from the data, demonstrating an increase in the reconstruction capabilities of a recognition image, with comparison of the modulation transfer function of both the analytical and machine learning methods of reconstructing single photon events using a multi-anode photomultiplier tube.

With current single-photon technology, there is a trade-off between spatial and temporal resolution. These results highlight the potential for achieving high resolution in both domains, which is crucial for applications like quantum sensing.

Following the Fellowship, Amelia remains at Photek where she has begun to undertake projects to develop particle detector products.

## **Poppy Oldroyd**

*Project:* Conducting polymer electrodes for interfacing with the brain

*Sponsor:* Johnson Matthey

*University of Cambridge*

Many implantable medical devices, such as pacemakers and deep brain stimulators, require replacement surgeries due to material degradation and electrode failure, posing significant risks and burdens for patients. Poppy's project aimed to address this challenge by developing more durable, flexible, and biocompatible electrodes using advanced materials and fabrication techniques. Traditional implantable electronic medical devices (IEMDs) rely on rigid metal electrodes that are prone to corrosion and structural failure. To improve long-term stability, Poppy investigated conductive polymers, particularly PEDOT:PSS, which offer superior flexibility, conductivity, and resistance to degradation. Poppy's work demonstrated that PEDOT:PSS electrodes lasted ten times longer than conventional metal alternatives, a modelled lifetime of 10 years in a patient compared to less than one. Additionally, Poppy developed a novel encapsulation method using PDMS, a soft and stretchable material, which significantly enhanced device longevity—achieving the longest-reported stability to date, with failure rates as low as 4.7% compared to 81% in standard metal electrodes. These advances pave the way for a new generation of all-polymer IEMDs that are safer, more reliable, and better suited for chronic neuromodulation.

Beyond neurological applications, Poppy successfully adapted this technology to monitor and stimulate the gastrointestinal system, where traditional rigid electrodes were ineffective. This work has the potential to revolutionize healthcare by reducing the need for repeat surgeries and improving patient outcomes. Poppy's research has been highlighted in two first-author publications, two first-author review papers, and one methods paper, demonstrating its broad impact on the field of bioelectronic medicine.

This work has directly benefited Johnson Matthey by advancing expertise in implant characterization and material performance. The company's medical device team gained insights into novel polymer-based implants, fabrication techniques, and reliability testing methodologies.

Following the Fellowship, Poppy transitioned to a postdoctoral research position at UCSF in the Department of Neurological Surgery with Professor Ritchie Chen. Here, she is leveraging the skills gained during her Fellowship to develop advanced optical devices for interfacing with the brain, further bridging the gap between materials science and neuroscience.

### **Parijat Patel**

*Project:* AI to improve cardiometabolic risk evaluation using CT (ACRE-CT)

*Sponsor:* Caristo Diagnostics

*University of Oxford*

Parijat's research project achieved significant success, leading to findings beneficial not only to her work but to other projects across the University's academic groups and Caristo's Cari-Heart product. The primary goal was to develop diagnostic models to predict diabetes from routine CT scans. This goal has been met, and Parijat is now planning a clinical trial to validate these findings for clinical use. The project used data from the ORFAN cohort, a research initiative applying AI to predict cardiovascular disease risk from a sample of 250,000 patients across the UK and internationally. Parijat was the first student in her group to work with this large dataset, which involved 100,000 patients' data. Through this, she developed data processing pipelines that store, process, and analyse raw CT data, enabling automated predictions applicable across various imaging projects within the academic group.

Parijat's work with CT data revealed valuable insights. Intensive quality control on predictions and selected analysable scans provided a better understanding of CT data, including image noise and artefacts, allowing her to enhance model robustness for use across diverse scanning environments. Looking ahead, she aims to further strengthen the diagnostic models. While the past three years have established a strong foundation, there is more work needed to transform this research into a viable product that could benefit society.

After the completion of her PhD, Parijat is eager to continue supporting Caristo by helping to translate this research into a practical and impactful tool over the next 2–3 years and hopefully start other similar interesting work side by side.



### **Shaun Smart**

*Project:* Determination of boundary conditions for occurrence of weld metal hydrogen cracking

*Sponsor:* TWI / Stainless Metalcraft

*University of Leicester*

This Fellowship has enabled work to better understand the mechanism of weld metal hydrogen-assisted cold cracking in high strength carbon-manganese steel weldments.

Shaun has investigated weld metal hydrogen-assisted cold cracking in a systematic engineering way, including the cracking mechanism and morphology, cracking susceptibility, and the factors that contribute to cracking such as hydrogen behaviour during welding and hydrogen-steel microstructural interactions.

Shaun's research has helped to provide an understanding of the conditions in which hydrogen cracking may initiate, and which process variables, such as preheat, heat input and post heating, may be effective at eliminating weld metal hydrogen-assisted cold cracking.

The findings show that preheating is the most effective procedural parameter for reducing susceptibility to weld metal hydrogen-assisted cold cracking. Additionally, this work confirms that current guidance specified for the avoidance of heat affected zone hydrogen-assisted cold cracking is also effective for avoiding weld metal cracking. The work has also progressed the understanding of when weld metal cracking becomes dominant over heat affected zone cracking.

The results will be disseminated to the TWI membership base and used to shape industry guidance for the avoidance of weld metal hydrogen-assisted cold cracking.

Following the Fellowship, Shaun will continue as a Senior Welding Engineer at Stainless Metalcraft.

### **Elliott Smyth**

*Project:* Discovery of novel small molecules for the treatment of human coronaviruses

*Sponsor:* LifeArc

*University of Leeds*

Elliott's Fellowship has focussed on identifying small molecule therapeutics to treat human coronavirus infections, including COVID-19. Despite widely available vaccines being in place, novel small molecule therapeutics and innovative approaches will continue to find important complementary applications in addressing different stages of COVID-19.

Elliott's project aimed to characterise and target a coronavirus-specific protein, non-structural protein 14 (NSP14). This enzyme is responsible for maintaining replication fidelity of coronaviruses, and in its absence, viral reproduction is severely affected. No marketed drug exists that targets NSP14, and there is strong evidence to suggest that inhibition could be a promising therapeutic strategy.

To investigate this, Elliott set about identifying molecules which could stop NSP14's enzymatic function. Optimisation of these molecules was carried out, aiming to synthesise potent inhibitors of NSP14 with suitable properties for oral treatment, by profiling these compounds in a suite of drug discovery assays. A pipeline of high-quality lead molecules was prepared and evaluated in anti-viral assays – showing an effective reduction in viral replication – and are in a promising position for further future development. This work has significantly de-risked NSP14 as a suitable target for the treatment of human coronaviruses, and enabled LifeArc to further strengthen and develop collaborations within industry and academia.

Following the Fellowship, Elliott will continue to work at LifeArc as a Senior Scientist in the Chemical Biology team, leading small molecule drug discovery projects. In particular, he will be applying the skills and knowledge he has gained to support LifeArc's 'Translational Challenge' areas of therapeutic interest.

## Industrial Design Students

### Mohamed Azman

*Course:* Innovation Design Engineering

*Imperial College London / Royal College of Art*

During his course, Azman worked on the systemic decentralisation of technological infrastructure, aiming to address vulnerabilities inherent in traditional centralised systems. His primary focus was on designing frameworks that enable equitable and resilient ecosystems, preserving the benefits of global connectivity while minimising the systemic risks associated with centralisation.

Azman's emphasis has been on developing robust foundations for decentralised open platforms capable of hosting diverse digital products and services. This approach seeks to empower local economies, mitigate monopolistic practices, and ensure fair trade. For instance, he explored open-source, cooperatively managed alternatives to conventional platforms, such as food delivery services, e-commerce platforms, and ride-hailing platforms, with the aim of creating a level playing field for local businesses through transparency and equitable free market opportunities.

The project also examined applications across various other domains such as next-generation urban mobility, green energy trade, financial market infrastructure, and other avenues. By embedding systemic decentralisation principles, these frameworks are designed to make economies more adaptable to external shocks and less vulnerable to influence from concentrated power structures, while retaining operational efficiencies and the advantages of economies of scale typically associated with centralised systems.

Azman is now continuing his work, focusing on the practical deployment of these frameworks. His efforts are centred on ensuring scalability, fostering synergy between top-down and bottom-up interests, and addressing socio-economic and regulatory challenges. By enabling businesses and communities to thrive independently yet cooperatively, this project aspires to transform technological and economic landscapes, paving the way for a more equitable and resilient future.

### Chris Bellamy

*Course:* BioDesign

*Central St Martin's*

Chris initially studied engineering at the University of Cambridge before starting his career at Jaguar Land Rover, helping to develop their first electric vehicle, the Jaguar I-Pace. He then stepped into the footwear and apparel industry, developing customisable and recyclable shoes, in the hope of reducing the impact of the 20+ billion pairs of shoes made each year.

After realising the incremental improvements to plastics and metals would never be sufficient to meet climate targets, Chris decided to change his career to work with living things.

He also identified the irrational side of human behaviour as critical to making sustainable innovations a success, and as such sought to pursue training in design and the arts, to better understand how to work in this space.

Chris's research during his degree focussed on how living materials could be used in our everyday lives, by co-evolving traditional knowledge with the latest scientific research.

His graduation research project *Lucid Life / Marama Ora* was inspired by corals' symbiotic relationships, and he developed a contemporary living material encapsulating bioluminescent micro-algae, which emits light in response to touch.

In collaboration with Polynesian artisans, traditional knowledge and science came together to co-create a series of artifacts which demonstrate how living materials can reconnect us to nature through intercultural and interspecies collaboration.

His work received multiple awards including winning the Arts Thread Global Creative Graduate Showcase, the Mills Fabrica Prize for Innovation, the Swarovski Prize for Biodesign and making the NOVA Shortlist for Fresh Creative Talent.

Chris is now continuing to work as a biodesigner full time. He has received commissions for his work from prestigious clients such as Somerset House and is collaborating with renowned designers and organisations internationally to further develop his research around living materials.

### **Grace Broom**

*Course:* Global Innovation Design

*Imperial College London / Royal College of Art*

During her Global Innovation Design course, Gracie focused on research into nightlife and safeguarding. In Tokyo, she collaborated on an immersive, sensor-based lighting installation for a nightclub in Shibuya, designed to respond dynamically to the crowd. In New York, she undertook a spatial design project aimed at creating sustainable, affordable housing. As part of this, she worked with the domestic abuse shelter Safe Haven in Texas to co-design a 3D-printed transitional home for survivors moving out of shelters. These projects shaped her final work, exploring the intersection of nightlife safety, women's safety, and safeguarding.

This research led to *Reporti*, a real-time incident reporting platform designed to enhance safety at live events such as concerts, festivals, and nightclubs. *Reporti* allows attendees to discreetly report incidents such as medical emergencies, assaults, or suspicious behaviour, without the need to physically search for security or medical staff. Particularly beneficial for bystanders and individuals with mobility challenges, the platform operates without mobile data or app downloads, creating a direct digital link between the crowd and the control room. Ultimately, *Reporti* supports venues and event organisers better understand and manage safety incidents.

After successfully pitching *Reporti* and securing investment, Gracie is now developing it as a business, refining the platform for commercial release.

### **Joseph Jones**

*Course:* Global Innovation Design

*Imperial College London / Royal College of Art*

Joseph's background is in Mechanical Engineering. He enrolled on the Global Innovation Design program to gain a more holistic insight into the creation process and to work as part of a multicultural and multidisciplinary team.

The course gives students the opportunity to be immersed in different cultures to better understand the influences that cultural and geographic factors can have on the design process. International exchanges took Joseph to Tokyo and Singapore where he developed design skills and also greatly improved his personal confidence.

Starting in Tokyo and continuing in Singapore he entered a design competition run by the Design Education Trust to reimagine an everyday object and make it more engaging through the use of motion. For his proposal, Joseph was inspired by Shibuya crossing in Tokyo to reimagine pedestrian crossing lights, combining them with an orrery planetarium and Calder mobile. This design saw Joseph win the competition and receive £8,000 to turn the design into a reality.

For his final project upon returning to London, Joseph worked with the London wheelchair rugby team, the GB paralympic wheelchair rugby team and his dad (an ex-paralympian) to create a machine learning based computer-vision tool for sports analysis and broadcast graphics with the intention of generating more interest in the sport and making it more accessible.

Following the Studentship and in the run up to the Paris Paralympics there was a great deal of interest in his final project and Joseph appeared on several broadcast and radio programs discussing it, including ITV London, London Live, BBC Radio London, and BBC World Service. Joseph hopes to continue working in the field of design for disability into the future.

### **Tarika Kumar**

*Course:* Global Innovation Design

*Imperial College London / Royal College of Art*

During her Studentship, Tarika focused on how design can be used to make technology more accessible and responsive to different needs. She explored ways to bring together insights from architecture, design research, and digital tools to create products and systems that work well for a broad range of people. This included looking at how we communicate beyond words and symbols—things like touch, movement, and space—and considering how those factors shape the way we interact with the world around us.

Tarika says one of the most rewarding parts of the experience was working with others who are also thinking about these challenges. Conversations with designers, engineers, and researchers enabled by the Commission helped her refine her ideas and test them in practical settings. Along the way, she developed approaches that help designers think more critically about inclusivity, not as an afterthought but as a fundamental part of the design process.

Since finishing the course, Tarika has continued this work in her academic research and involvement in projects that apply these ideas outside of academia, bringing research into real-world practice. She is clear that the support of the Studentship was invaluable in giving her the space and resources to develop these ideas, and she is excited to see where they lead next.

### **Lucie Legrandois**

*Course:* Innovation Design Engineering

*Imperial College London / Royal College of Art*

During her Studentship, Lucie transitioned from her prior experience as a mechanical and material engineer, to a transdisciplinary design engineer. Combining her technical skills with human-centred research, she expanded her practice to deliver socio-ecosystemic innovations, for social and environmental challenges.

During her Master's, Lucie worked on a wide variety of projects, including flood prevention, natural glue for low-carbon clothes, waste sorting in new areas, sexual abuse reporting, and low-tech passive sensors for small greenhouses.

Her final solo project, *TOUPY*, is a toolkit developed for therapists interested in movement therapies and playful approaches for trauma healing, working particularly with survivors of sexual assaults in regaining confidence in interpersonal connections. This research, at the intersection of exposure therapies, social circus practices, consent games, and psychology, was shortlisted for the Helen Hamlyn Design Awards.

Following her Studentship, Lucie has joined the multi-awarded biomaterial start-up *Carbon Cell*, as a design engineer. At the same time, she co-founded her own venture, *OmniLabs Research*, a studio dedicated to care technologies. Their first product is designed to gamify stroke telerehabilitation through music, mixed reality, and assistive robotics. The company is working across Singapore and the UK, and recently won two research grants, as well as being supported by different programmes and competitions. Lastly, Lucie has joined the pool of Teaching Assistants at Imperial College London, to keep working closely with the staff that supported her during her studies.

## **G Antonio Alberti Leonett**

*Course:* Design Thinking

*Cranfield University*

Antonio joined Cranfield University with a background in mechanical and manufacturing engineering, seeking to combine his technical expertise with design and innovation. Throughout the course, he explored a variety of taught modules and contributed to several impactful projects.

One of his group projects involved redesigning airline passenger service products with circular economy principles, aiming to eliminate single-use plastics and ensure effective recycling or upcycling. Another project focused on creating an educational toy for disabled children, addressing user behaviour trends, sustainability, and technology to promote inclusivity. Additionally, Antonio collaborated on developing a start-up concept to support families in third countries, providing an educational platform that preserves heritage, culture, and language for children.

During his first year, Antonio worked on a dissertation that aimed to develop a model enabling effective collaboration between fluid dynamic engineers and designers using Design Thinking principles.

For his individual thesis in the second year, Antonio addressed the challenges of lysimeter design at Cranfield University's Large Glass House facility. By integrating principles of Design Thinking and Engineering, his research tackled health, safety, and environmental inefficiencies. The innovative lysimeter design reduced health and safety risks, eliminated repetitive and prolonged tasks, and significantly improved workflow efficiency with a sixfold reduction in soil layer processing time. The modular, user-centred design incorporated stakeholder engagement, usability testing, and iterative refinement, resulting in a robust and adaptable solution that aligns with modern research needs.

Antonio's work highlights his ability to bridge technical and creative disciplines, delivering innovative, sustainable solutions. His projects reflect a strong commitment to addressing real-world challenges through interdisciplinary collaboration and design-led approaches.

Antonio is now starting a new position as a Technical Service Manager for the EAME region at International Paper, a global leader in fibre-based products. The company specialises in manufacturing corrugated packaging, pulp, and paper products, supporting customers in diverse industries with sustainable and innovative solutions.

## **Julita Napieralska**

*Course:* Product Design Engineering

*Brunel University*

During her master's year, Julita focused on enhancing her design skills with an emphasis on human factors and future-focused innovation. The course's international cohort broadened her perspective, and her projects primarily tackled sustainability, client briefs, and RSA competitions. Highlights included being shortlisted for the Roberts Radio client brief and the RSA "In Your Skin" project, refining her client communication and industrial brief analysis skills.

Julita is particularly passionate about medical design, as demonstrated in her undergraduate work addressing diverse health challenges. Projects included developing a smart device and app for physiotherapy, combining data-driven clinical insights with gamified user experiences, and during the master's, a patch-testing system using chromogenic nitrocellulose paper to map skin-based vitamin deficiencies. These efforts aimed to foster better self-awareness and challenge societal beauty standards.

For her master's major project, Julita designed wearable technology for anxiety screening. This discreet armband collects passive and active data, distinguishing between anxiety and depression across their spectrum. The device integrates with an app to provide personalized feedback, leveraging Cognitive Behavioural Therapy and aligning with NHS and private healthcare systems. It evaluated sensor accuracy and algorithmic analysis to identify individual behavioural patterns when experiencing anxiety. The project prioritized data privacy and extensive user studies, ensuring inclusivity and user willingness to share sensitive information.

Alongside her studies, Julita worked part-time as a workshop technician at Plus X, honing her expertise in design for manufacture and material selection. Post studies, Julita has secured a full-time role as a design engineer at Cordon Technologies, an agritech company specializing in vineyard spraying machinery. Her role involves developing precision technologies to minimize over spraying and deliver targeted nutrition to vine clusters, advancing sustainable agriculture practices. Julita has also opened her own limited company to pursue freelance consultancy work, as she has done for the past four years.

### **Ori Nevares**

*Course:* Global Innovation Design

*Imperial College London / Royal College of Art*

During his Global Innovation Design course, Ori focused on behavioural change design. He explored ways a behaviourally informed research approach and design intervention can target and change specific behaviours. His first application of this was on the topic of misinformation and fake news. He created a prototype for a digital overlay on one's phone that prompts the user to select if they think a news article is credible or trustworthy. This extra level of friction on one's news sources aims to help develop critical thought which is the most effective means to tackle this pervasive issue of our time.

In his final project Ori focused on exploring ownership psychology of books and how a gamified intervention could help reduce the hoarding of these items in our homes. The outcome was an app which allowed users to place tagged books into the world and track where and who they encounter as they move from reader to reader. The more people they reach the more points the owner gets. This aimed to encourage more collaborative and circular consumption behaviours.

Ori has now taken up a product design role with a local fintech startup (Lendable) where he is applying his behavioural design toolkit to help people improve their financial position. He is designing interventions to help people properly manage their debt, improve their credit scores, and reach their financial goals.

### **Peter Neyra**

*Course:* Design Products

*Royal College of Art*

During his Studentship, Peter merged design, science, and engineering to tackle challenges in both biodiversity and audio innovation. His primary project was *Selva*, an airborne eDNA sampling device delivering real-time ecological data for regenerative agriculture. This work achieved commercial validation with major partners, including a 10,000-acre pilot commitment from rewilding initiatives and interest from Danone and Swiss Re. It was shortlisted for the Terra Carta Design Lab, leading Peter to pitch to Sir Jony Ive and present at the Royal Society, illustrating how design-led solutions can drive environmental progress.

In parallel, Peter explored cutting-edge audio research, visiting IRCAM in Paris to study wave field synthesis and immersive sound experiences. Peter developed an electronic drum system built with open-source technology from the Centre for Haptic Audio Interaction Research in Weimar. Peter is now co-applying for an IMPACT research grant with a PhD candidate at Queen Mary University to translate neural-network-based material-sound modelling into a hardware interface that allows real-time, expressive manipulation of digital timbres.

Since completing his Studentship, Peter has continued refining *Selva's* commercial roadmap while advancing new frontiers in interactive audio. This cross-disciplinary approach — combining applied research, inventive prototyping, and market impact — reflects the Commission's vision of innovation that benefits both society and the environment.

### **Tori Simpson**

Course: Global Innovation Design

*Imperial College London / Royal College of Art*

Tori came from a background in social data science and fine art - having completed a BSc in Social Science and Data Science at UCL, and a Foundation Year in 3D Fine Art at City and Guilds of London Art School. Her work experience prior to her master's degree includes working for In2ScienceUK as a data analysis intern, and co-founding Opportutoring Edinburgh, a non-profit providing English language education to refugee children.

During her studentship, Tori focussed on design towards social good, across a range of fields including conservation, healthcare, generative AI, and disaster preparedness. She completed placements at Nanyang Technological University in Singapore - where she collaborated with The University of the Philippines Cebu to work on a designed toolkit for community action in disaster preparedness, and Tsinghua University in Beijing. She also spent a summer working as a visiting researcher at Kyushu University in Japan, focussing on design for citizen-led conservation initiatives.

Her major project, *co-cook*, explores how stroke survivors and family carers can better collaborate towards stroke survivors' long-term rehabilitation, following the stroke survivor's return home from clinical care. *Co-cook* is a rehabilitation platform, with accompanying tools, that allows stroke survivors to do their rehab whilst cooking with family members, providing an example of how we can better consider the home ecosystem when designing rehabilitation tools. *Co-cook* was co-designed with stroke survivors, their family carers, and clinicians, and the project was completed in collaboration with The Helix Centre, as well as supported by The Stroke Association and Stroke Hub Wales.

Tori is now a UX/UI designer at The Helix Centre, working across projects in stroke, dementia, and healthy ageing.

### **Holly Souza-Newman**

Course: Global Innovation Design

*Imperial College London / Royal College of Art*

Before starting her master's in Global Innovation Design, Holly worked as a biological scientist with skills in laboratory and computational biology. During her studies, she developed *SolidSound*, a community calendar that was shortlisted in the Top 12 of the Grand Challenge. In her first year, she co-founded *Cyanoskin*, a biotech startup that created a living paint designed for carbon capture. *Cyanoskin* won Imperial College's Venture Catalyst Challenge (VCC) in 2024, receiving a £30,000 prize and several awards for innovation, sustainability, and future cities.

For her final master's project, Holly focused on creating an AI application for gut microbiome prediction, which developed into *Gutted*. She also participated in several other competitions, winning the Interplay £8K Sculpture Award for Urban Elegance, the Hercules Cambridge Design Tournament, and placing third in the Generative AI Cambridge Hackathon.

The Studentship played a key role in supporting her studies, allowing her to fully dedicate herself to her coursework and projects without financial worry. The Studentship also enabled her to explore entrepreneurial and creative opportunities, such as competitions and collaborations.

Holly has since been invited to join an early stage fintech startup focusing on female financial empowerment. She is also continuing to develop her coding and technical skills, using her experience to take on new challenges and grow in the tech and innovation space.

### **Julia Szewczyk**

*Course:* Integrated Industrial Design

*Loughborough University*

Thanks to the studentship award, Julia was able to pursue a master's degree that significantly enhanced her core design knowledge and expanded upon the skills she gained during her undergraduate studies. The program allowed her to delve into more complex and specialized areas of industrial design, equipping her with advanced techniques and a deeper understanding of the industry.

The Studentship enabled Julia to work with cutting-edge technologies such as artificial intelligence, which are becoming pivotal in the design process. One of the highlights of her year was developing an extravasation detection device for premature newborns. This project was met with enthusiasm by both medical and industry professionals, and the award was instrumental in enabling her to create high-quality prototypes and conduct in-depth testing.

Additionally, Julia had the privilege of competing in the Ford Smart Mobility Challenge alongside her team. They designed an innovative dockless bike parking solution aimed at addressing e-bike littering in urban areas. Their design prioritized restoring pedestrian access, particularly benefiting individuals with disabilities. The project earned 3rd place in the Ford Mobility Accelerator 2024 - an achievement of which Julia is incredibly proud.

Overall, the Studentship has been transformative, providing Julia with the resources and opportunities to advance her skills, explore new technologies, and gain valuable experience. It has laid a solid foundation for her future career in industrial design.

Following the course, Julia will be starting a graduate role as a designer at Arup.

### **Sabrina Tian**

*Course:* Global Innovation Design

*Imperial College London / Royal College of Art*

During her Studentship, Sabrina completed her second year of the MA/MSc Global Innovation Design program with Merit. With a dual background in design and cognitive science, she refined her skills in prototyping, electronics, policy, and research to tackle multidisciplinary challenges. In her first year, Sabrina integrated psychology, electronics, and cultural ethnography, bridging technical and social sciences to create impactful solutions.

The program's global approach allowed her to study media design in Tokyo and industrial design in New York. In New York, she collaborated with Pratt's K-12 Center to co-design a smart kite that enabled children to collect air quality data as part of NYC's 2050 climate goals.

For her thesis, Sabrina developed *Ubiroot*, a system embedding nano-sized tags for real-time chip monitoring and traceability, revolutionizing the semiconductor industry. By addressing the \$75 billion faulty chip market, *Ubiroot* minimizes reliance on rare minerals, reduces e-waste, and supports circular supply chains. The project gained international recognition, being exhibited at Asia Design Week 2024, receiving an Honourable Mention at the 2024 Design Intelligence Awards, and featuring in academic publications on sustainability and biodesign.

Following her studies, Sabrina is continuing to design interactive experiences and products as a Research Fellow at MIT's Senseable City Lab, an urban innovation lab that explores how digital technologies are transforming urban environments and uses data-driven insights to create interactive solutions that enhance cities' sustainability, efficiency, and quality of life.



## **Jacob Wellsbury**

*Course:* Innovation Design Engineering

*Imperial College London / Royal College of Art*

Jacob's Studentship allowed him to bolster his mechanical engineering skills with a design thinking approach, giving him the means and confidence to tackle a broader range of problems with new approaches.

In his first year, Jacob had the opportunity to work with an incredible range of collaborators, from architects to fashion designers, and with both the private and public sectors. During this time, he was able to develop his aesthetic, collaboration, and design process skills.

In his second year, Jacob applied these skills to a project where he was able to leverage both his background in engineering and his heritage. He developed STACKS, a software and hardware package to help sustain dry-stone walling as a culturally and economically valuable activity. With inadequate funding and few dry-stone wallers to repair the 85% of the UK's 180,000 miles of dry-stone wall that are in disrepair, STACKS lowers the skills barrier for walling by non-experts.

Since graduating, Jacob has been working as a Prototyping Engineer for Shellworks, creating home-compostable alternatives to plastic cosmetic packaging. He has also been continuing his research into dry-stone walling, with the Heritage Science Lab at UCL showing interest in STACKS.

## **Enterprise Fellows**

### **Anthony Camu**

*Company:* Theia

*Technology:* Electronic travel aid for the visually impaired

There are 338,000,000 visually impaired people in the world, yet 28,000 guide dogs. The guide dog is a very effective aid, although it is not a scalable solution. Theia Robotics have been developing a device that replicates the main features of a guide dog, using similar technologies found in autonomous cars yet scaled down into a product visually impaired users can hold comfortably in their hand. With a goal to significantly reduce levels of cognitive load required when walking and navigating, Theia have developed a novel feedback interface to pair with their navigation system. Based on generating gyroscopic forces, Theia's handheld device can intuitively communicate complex walking manoeuvres and physically 'lead' users much like a guide dog pulling you along a path. Anthony and his team of robotics engineers have tested their prototypes through several iterations with encouraging results, notably with non-sighted test participants walking within a maximum deviance of 50 centimeters from their routes. Theia plan to bring their first product to market by Q4 2025.

### **Idan Gal-Shohet**

*Company:* Fibe

*Technology:* Textile fibres from potato harvest waste

Fibe is a material science startup developing textiles out of potato harvest waste. Since Idan was awarded the prestigious Enterprise Fellowship, Fibe has successfully closed its £1m pre-seed investment round led by Patagonia's investment arm. Fibe has also raised a total of £750k in grants and £50k in industry funding since beginning the programme. During 2025 Fibe will be opening its seed fundraise with the aim of raising £3m to build a pilot production facility and generate revenue for the first time.

Fibe's technology has gone from TRL2 to TRL4-6 including a patented fibre extraction bioprocess that is non-toxic, free of harsh chemicals, and safe for aquatic ecosystems. The company has also developed the world's first potato stem harvester for industrial-scale feedstock collection and proprietary bench-top fibre extraction technology, outperforming off-the-shelf solutions in efficiency and versatility. Most importantly, Fibe successfully spun the world's first yarn and swatch from potato fibres using a cotton line in late 2024.

The team has grown from 6 to 14 including senior biochemist Dr. Richard Amaee and farmers to support Fibe's scale-up operation. The company has developed an in-depth recruitment system and performance expectations including a company culture manifesto. Fibe expects its team to reach 20+ by next year.

### **Beren Kayali**

*Company:* Deploy Tech

*Technology:* Flat-packed concrete water storage units

During her Fellowship, Beren was selected for UNICEF's Innovation 30 programme which gave her a lot of exposure to the NGO/Humanitarian Aid sector. She also made it into Forbes 30 Under 30 in the manufacturing category and was selected for the Women of the Year Vodafone Business Award. Meanwhile, DeployTech won a grant from the World Food Programme for \$100,000 to deploy 17 of their units in Jordan for a pilot project.

### **Alex Shakeshaft**

*Company:* Enturi

*Technology:* Micro wind turbine [Financially supported by the ERA Foundation]

The support from the Commission has been instrumental in accelerating growth and impact at Enturi Solutions Ltd. Over the past months, Enturi has made significant strides in commercial readiness, securing key funding, advancing intellectual property protections, and expanding its operational footprint. Enturi successfully closed a pre-seed investment round with SFC Capital and Britbots in April 2024, providing essential match funding for an Innovate UK SMART Grant award, enabling Enturi to conduct full-scale system trials at a major UK port, demonstrating the viability of the technology for decarbonising maritime operations. In recognition of Enturi's commitment to sustainable energy solutions, Enturi was nominated for the Earthshot Prize 2025, further validating the company's efforts to drive meaningful carbon reductions in the maritime sector. To support Enturi's expanding operations, the company moved into a newly renovated facility in Queensferry, North Wales. This new space provides the infrastructure needed for advanced R&D, testing, and assembly, positioning the business for the next phase of growth. Additionally, Enturi made substantial progress in securing intellectual property protections, successfully registering three design rights and four trademarks in the UK, strengthening the competitive advantage and reinforcing the brand moving forward. These milestones highlight the transformative impact of the Commission's award, and the team at Enturi are excited for what's ahead as the company continues to push the boundaries of clean energy innovation.

### **Sanzhar Taizhan**

*Company:* TaiSan Motors

*Technology:* Sustainable battery technology for electric mobility [Financially supported by the ERA Foundation]

The Fellowship was pivotal in transforming Sanzhar's battery startup vision into reality. It helped him to raise £1.3m and get customers onboard. This collaboration facilitated access to state-of-the-art facilities and mentorship from leading experts, accelerating the development of innovative energy storage solutions. Sanzhan comments that the Commission's commitment to fostering innovation and bridging academia and industry has been instrumental in advancing his work, contributing significantly to the progress of sustainable battery technology.

## Technical Teaching Fellows

### **Kevin Pollard**

*Mid Kent College*

The objective of Kevin's Fellowship project was to engage with colleagues to raise awareness and debunk negative perceptions of technology in learning. Using the Technological Pedagogical Content Knowledge (TPACK) model framework, he researched current practices and needs, while workshops, events, and conferences facilitated collaboration and knowledge sharing.

Kevin provided multiple briefings to industry collaborators showcasing innovations in training and tools that can enhance learning outcomes. These briefings also resulted in securing funded projects and future collaboration opportunities. Other briefings have resulted in collaborative partnerships, providing secondment opportunities for the lecturers who want to expand their learning and development knowledge.

Visits to other colleges highlighted exceptional practices in technology use by lecturers, enhancing efficiency and effectiveness. At City of Wolverhampton College, Kevin exchanged best practices and identified additional skills to share. This led to online workshops, hints, and videos on software optimization, particularly MS360, which were shared with colleagues at Mid Kent College through articles and workshops.

Participating in an online JISC Roundtable discussion allowed Kevin to contribute insights on technology-enhanced learning for Technical Education and T Level learning, focusing on Gen Z & A, impactful tech implementation, and supporting lecturers and students.

Overall, the Fellowship project enabled Kevin to conduct valuable research, share best practices nationwide, and foster collaboration between lecturers, emerging technology companies, and educational hierarchies, enhancing understanding and promoting the benefits of these technologies.

Kevin has now been appointed Senior Learning Development Manager for Mid Kent College.

### **Bradley Collier and Dr Kumaran Rajarathinam**

*Blackburn College*

This Fellowship aimed to promote and implement integrated curriculum design and assessment practices in engineering education through partnership working between educational institutions, industry professionals, and sector colleagues.

Throughout the project, Bradley and Kumaran had the opportunity to share their project, its progress and outcomes, with various key audiences including T Level mentors and staff from across the country and significant employers such as AMS Neve and Accrol Papers. By participating in 1851 events, including the Presidential Dinner and Great Exhibition Road Festival, and a local Festival of Making, they were also able to share their work with the wider 1851 community and the general public. They delivered cross-college CPD on how others could use the framework designed as part of the project in their own teaching, supporting other colleagues as appropriate. The primary focus for impact has been employer engagement within the Lancashire area alongside using the framework to impact project-based learning across the engineering curriculum. Without the funding from the Commission, employers would not have engaged in the way they have. Equipment purchased during the project has informed project-based learning across the North West.

Following the Fellowship, Bradley has been inspired to do a PhD.

## Alumni Awards, Honours and Achievements

A selection of the alumni appointments, publications, honours and awards notified to the Commission. The Commission encourages all alumni to keep their alumni profiles up to date so that their successes can be celebrated.

### Overseas Scholars

Professor David Black (1960)

- Awarded Doctor of Science (honoris causa), University of New South Wales

Professor Jennifer Martin (1986)

- Appointed Professor Emerita, University of Queensland
- Awarded Lawrence Bragg Medal, Society of Crystallographers in Australia and New Zealand
- Delivered the Bragg Lecture at the SCANZ Crystal35 conference in Fremantle

Professor Robin Stuart (1981)

- Appointed Honorary Fellow, Royal Canadian Geographical Society and awarded a specially struck Quest Medal

### Research Fellows

Dr Jo Ashbourn (2002)

- As the Director of the St Cross Centre for the History and Philosophy of Physics, organised conferences on Physics and the Science of Living Things, The Philosophy of Cosmology and Paradoxes in Physics

Dr Susannah Bourne-Worster (2018)

- Awarded Royal Society University Research Fellowship, Department of Chemistry, Durham University
- Appointed Assistant Professor, Department of Chemistry, Durham University

Professor Edwin Constable (1982)

- Appointed Founding President, Council for Scientific Integrity, Switzerland

Dr Stephen Cox (2017)

- Appointed Assistant Professor in Computational Chemistry / Data Science, Durham University

Dr Russell Garwood (2012)

- Awarded Humboldt Research Fellowship

Dr Xianxin Guo (2020)

- Lumai (start-up formed during Fellowship) successfully raised £7.2m to continue development of the world's most energy efficient AI accelerator powered by optical computing
- Selected into the Schott Scale Up Accelerator Programme hosted by the Royal Academy of Engineering

Professor Dong Liu (2015)

- Appointed Associate Professor in Engineering Science, University of Oxford and Tutorial Fellow at Trinity College
- Appointed Secretary, Engineering Ceramics Division, American Ceramic Society and Co-chair of the UK Chapter
- Appointed a member of the EPSRC's Research Infrastructure Strategic Advisory Team

Professor Apala Majumdar (2006)

- Elected Fellow of the Royal Society of Edinburgh

Professor Rachel Oliver (2003)

- Awarded OBE for services to materials engineering

Professor Emilio Martínez-Pañeda (2019)

- Received John Argyris Award, International Association for Computational Mechanics

Professor KC Sivaramakrishnan (2015)

- Awarded SIGPLAN Programming Languages Software Award for work on OCaml programming language

## Industrial Fellows

Dr Christopher Baylis (1999)

- Appointed Chair of the British Standards Institute Committee AW/9 (Microbiology)

Dr Laurence Devesse (2017)

- Awarded Rosalind Franklin Society Award

## Industrial Design Students

Mr Matt Batchelor (2010)

- Designed an aluminium packaging system for personal care and cleaning products that uses the global beverage can supply chain but has a different cap and crenelated seam to differentiate it from a normal drinks can for the sake of safety. The system has won several industrial design and industry awards, including a Red Dot Best of The Best, an iF award and a D&AD Wooden Pencil and will be launching shortly through his companies Instrument and Meadow

Mr Michael Korn (2005)

- Launched Blue Garage, a social enterprise to support creative designers, engineers and entrepreneurs in SE London
- KwikScreen (medical furniture company) appointed preferred partner of Steelcase in USA

## Enterprise Fellows

Mr Ryan Beal (2022)

- Recognised in Forbes 30 under 30 list for sports
- Closed second funding round for SentientSports for the continued development of work in AI in sports including technology to help protect athletes from online abuse

Mr Joseph Bentley (2022)

- Accepted on to the Royal Academy of Engineering Enterprise Hub's EXPLORE programme focused on market expansion for ACT Medical, a device that stops catastrophic bleeding from open wounds

Ms Rebecca Donaldson (2021)

- Blue Tap, which designed a chlorine dosing system that inserts the correct amount of chlorine into a piped water system according to WHO guidelines, was acquired by Thermofluidics Ltd

Mr Henrik Hagemann (2016)

- Puraffinity raised £6.7m to drive development of its customised membranes for the removal of PFAS chemicals from water

Mr Gregory Hargraves (2023)

- Page Braille, a device which creates braille files that can be stored, downloaded and shared, will be available through Sight and Sound Technology, the UK's leading provider of hardware and software for the blind

Mr Ming Kong (2016)

- TGO raised £2m to drive development of its smart 3D sensing material to replace buttons and trackpads

Mr Fergal Mackie (2022)

- Metacarpal has secured £800k in seed funding to accelerate development of its mechanical bionic hand

Ms Bella-Trang Ngo (2020)

- Brarista, which has developed AI-enabled bra-fitting software that replicates the process of professional fitting online, is now receiving support from Tech Nation's Libra programme

Dr Atif Syed (2018)

- Wootzano, which has developed an electronic skin for robots, was named North East Business of the Year

Ms Reka Tron (2021)

- Multus Biotechnology opened a new production facility capable of producing 500 tonnes of cultivated meat per year

## Built Environment Fellows

Dr Tijana Blanus (2021)

- Exhibited outcomes of Fellowship project (on the advantages of mixed hedging for wildlife and flood control) at RHS Chelsea Flower Show
- Co-convened 3rd ISHS Greener Cities symposium at RHS Wisley

Ms Roberta Marcaccio (2015)

- Published *The Hero of Doubt: Selected Writings by Ernesto Nathan Rogers*

Ms Deborah Saunt (2009)

- Following her tenure as the Eero Saarinen Visiting Professor of Architectural Design at the Yale School of Architecture, *What about Learning?* is being published in book form by the architectural publishers Actar

## Rome Scholars

Ms Anne Desmet RA (1989)

- Held a major exhibition *Anne Desmet: Kaleidoscope/London* at Guildhall Art Gallery (first ever solo exhibition by a woman artist at this museum)
- Participated in *Mini Picture Show* and *Society of Wood Engravers 87<sup>th</sup> Annual Exhibition* at Bankside Gallery
- Participated in *Countercurrents* podcast with Professor Roger Kneebone
- Member, RA Summer Exhibition Committee

Ms Carole Robb (1979)

- Fulbright Commission acquired a Carole Robb painting as part of a new permanent art collection by Fulbright Scholars

# Report by the Chairman of the Finance Committee

## *Introduction*

The Board of Management has appointed the Finance Committee as a sub-committee to supervise the Commission's finances and investments; this Committee meets at least twice a year. I would like to thank all members of the Committee for their ongoing valuable contribution in overseeing the Commission's finances.

During 2024 there were four formal meetings of the Committee. In the January and February meetings we reviewed the Commission's investment policy and discussed the most appropriate investment strategy to achieve the Commission's investment objectives. At the May meeting we interviewed and appointed new investment managers to implement the agreed investment strategy. We also reviewed the annual accounts and met with the Commission's auditors. At the November meeting the Committee reviewed and appointed new legal advisers.

## *Investment Objective and Spending Policy*

The Commission is expected to exist in perpetuity, and it is not anticipated that the demand for its funding will diminish. Accordingly, the financial objective of the Commission is to at least maintain the real value of its assets whilst generating a stable and sustainable return to fund grant making. Over the long term, the Commission aims to disburse 4% of the trailing three-year average value of the portfolio per annum. The investment objective is to achieve at least a 4% real return over the long term.

## *Investment Performance*

While inflation and interest rates are hopefully stabilising, tighter monetary policy, geopolitical uncertainty and market volatility are all set to continue, with the risk of a recession in some markets. The Commission recognises that meeting the investment objective over the short to medium term will be challenging and so remains flexible in its disbursement policy.

The annualised real return over the past ten years has been 5.9%. High inflation and disappointing equity returns in 2022 mean that the investment objective has not been met over shorter periods, however, the five year and three year real returns being 3.7% and 1.1% respectively.

Despite the volatile geopolitical environment and challenging economic environment, including the ongoing war in Ukraine, hostilities in the Middle East, persistent high inflation and elevated interest rates, equity and bond markets performed well in 2024 with the MSCI ACWI Index up 19.6% for the year and the Bloomberg Barclays Global Aggregate Index (GBP Hedged) up 3.0%. Against this backdrop the Commission achieved a total return net of fees of approximately 18.0% (2023: 13.6%). CPI + 4% was 6.5% (2023: 8.0%).



## *Asset Allocation*

During the year under review, the Committee amended the asset allocation from 80% equities, 15% property, 5% cash and bonds to 85% equities, 5% property (the South Kensington Estate), 10% cash and bonds, with ranges of plus or minus 5% in each case. The new allocation has been adopted in recognition of the more volatile investment environment, the improved returns from corporate bonds and a decision to exclude from the portfolio, for the purposes of setting a strategic asset allocation, some property holdings which are let on long leases for nominal rent and are not expected to generate market returns in the short to medium term (but which further the Commission's charitable objectives by providing accommodation to legacy institutions and are also held for their long-term potential).

In arriving at the new strategic asset allocation, and appointing investment managers to implement it, the Committee took advice from Stanhope Consulting, who modelled the expected risk and return profiles of various possible asset allocations and advised on which investment managers had investment styles that best fitted the Commission's investment objectives and best complemented each other.

The Finance Committee will revisit the strategic asset allocation at least every three years and consider the need for tactical deviations from it on at least an annual basis.

## *ESG considerations*

The Commission recognises that its investments have wider impacts and seeks to align its investment strategy with its aims, reflecting the views of its stakeholders and taking into account broader public benefit. The Commission expects its investment managers to integrate Environmental, Social and Governance (ESG) considerations into the normal investment process and to fulfil the requirements of the UK Stewardship Code, actively engaging with the companies in which they invest to promote best practice corporate behaviour and sustainable business practices. The Commission has one ethical exclusion which is tobacco.

The Commission recognises that climate change is a key challenge for the next decade and that limiting global temperature rises will require significant change in business, investment, technology development and fossil fuel use. The Commission monitors the carbon emissions of its equity portfolio and through its investment managers seeks to reduce these emissions over time.

## *Financial performance for the calendar year to 31 December 2024*

Over the 12-month period the investment assets (including directly held property not considered part of the strategic asset allocation and cash held outside the portfolio) generated income of £2,259,719 (2023: £2,559,838). When combined with capital gains of £23,017,136 (2023: capital gains of £16,630,182) this meant that, after grants and other expenditure, the total funds of the Commission increased from £143,838,891 to £162,548,711 as at 31 December 2024.

Expenditure on core Fellowships and Studentships increased from £3,963,890 to £4,224,615. A greater number of large Special Awards also meant that total expenditure on charitable activities increased from £4,957,163 to £5,983,370.

Expenditure on raising funds – which primarily comprises investment and property management fees – decreased from £766,633 in 2023 to £642,408 in 2024, the drop primarily reflecting decreased exposure to segregated funds and increased investment in pooled funds where fees have been deducted in calculating unit prices.

### *Going concern*

The Commissioners do not believe there are any material uncertainties that call into doubt the Commission's ability to continue and the accounts have therefore been prepared on a going concern basis.

The Commission, like every other organisation, has been impacted by the pandemic, Russia's invasion of Ukraine and the hostilities in the Middle East, which have resulted in ongoing supply chain disruption, persistent high inflation, increased interest rates and a cost-of-living crisis. Investment markets have been much more volatile, and the day-to-day value of the Commission's portfolio has inevitably reflected that. The Commission is a long-term investor, however, and Commissioners remain confident in the underlying strength of the portfolio; they see no evidence at this stage of any permanent loss of value – indeed, the portfolio has shown significant gains over the past year. Similarly, while the Commission has had to defer or write off a certain amount of rent, there is not considered to be any risk to the long-term value of the estate. The Commission has sufficient assets, and sufficient liquidity, to ride out the current market disruptions. The Commission's core grant-making activity has therefore continued largely as planned and Commissioners expect it to continue to do so.

### *Reserves Policy*

The Commission's funds originated from the surplus arising from the Great Exhibition of 1851 and have been enhanced by careful stewardship of the assets invested over many years. They are technically unrestricted, giving the Commissioners the ability to spend the funds as they wish in fulfilment of the charitable objectives of the Commission.

Given the Commission's flexibility to spend capital if required, the Commissioners do not consider that there is any merit in identifying an optimum level of free reserves that might be readily available if required but will respond appropriately to spending needs identified as and when circumstances arise.

### *The Commission's Auditor*

In 2008, Moore Kingston Smith LLP was appointed the Commission's auditor following a competitive tender. The audit partner meets with the Finance Committee at least once each year. In the interests of good governance, the audit manager changes at least every five years and the audit partner at least every ten years.

## Statement of Commissioners' Responsibilities

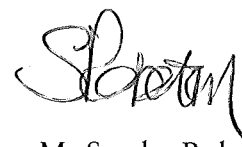
The Commissioners are responsible for preparing the Trustees' Report and the financial statements in accordance with applicable law and United Kingdom Accounting Standards (United Kingdom Generally Accepted Accounting Practice.)

The law applicable to charities in England and Wales requires the Commissioners to prepare financial statements for each financial year which give a true and fair view of the state of the affairs of the Commission and of the incoming resources and application of resources of the Commission for that period. In preparing these financial statements, the Commissioners are required to:

- select suitable accounting policies and then apply them consistently;
- observe the methods and principles in the Charities SORP;
- make judgements and estimates that are reasonable and prudent;
- state whether applicable accounting standards have been followed, subject to any material departures disclosed and explained in the financial statements;
- prepare the financial statements on the going concern basis unless it is inappropriate to presume that the Commission will continue in business.

The Commissioners are responsible for keeping proper accounting records that disclose with reasonable accuracy at any time the financial position of the Commission and enable them to ensure that the financial statements comply with the Charities Act 2011, the Charity (Accounts and Reports) Regulations 2008 and the provisions of the Royal Charter. They are also responsible for safeguarding the assets of the Commission and hence for taking reasonable steps for the prevention and detection of fraud and other irregularities.

The Annual Report on pages 2 to 58 and 63 to 90 was approved by the Commissioners on 9 July 2025.



Ms Sandra Robertson

# Independent Auditor's Report to the Commissioners of Royal Commission for the Exhibition of 1851

## *Opinion*

We have audited the financial statements of the Royal Commission for the Exhibition of 1851 for the year ended 31 December 2024 which comprise the Statement of Financial Activities, the Summary Income and Expenditure Account, the Balance Sheet, the Cash Flow Statement and notes to the financial statements, including a summary of significant accounting policies. The financial reporting framework that has been applied in their preparation is applicable law and United Kingdom Accounting Standards, including FRS 102 'The Financial Reporting Standard Applicable in the UK and Republic of Ireland' (United Kingdom Generally Accepted Accounting Practice).

In our opinion the financial statements:

- give a true and fair view of the state of the charity's affairs as at 31 December 2024, and of its incoming resources and application of resources, for the year then ended;
- have been properly prepared in accordance with United Kingdom Generally Accepted Accounting Practice; and
- have been prepared in accordance with the requirements of the Charities Act 2011.

## *Basis for opinion*

We conducted our audit in accordance with International Standards on Auditing (UK) (ISAs (UK)) and applicable law. Our responsibilities under those standards are further described in the *Auditor's responsibilities for the audit of the financial statements* section of our report. We are independent of the charity in accordance with the ethical requirements that are relevant to our audit of the financial statements in the UK, including the FRC's Ethical Standard, and we have fulfilled our other ethical responsibilities in accordance with these requirements. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion.

## *Conclusions relating to going concern*

In auditing the financial statements, we have concluded that the Commissioners' use of the going concern basis of accounting in the preparation of the financial statements is appropriate.

Based on the work we have performed, we have not identified any material uncertainties relating to events or conditions that, individually or collectively, may cast significant doubt on the charity's ability to continue as a going concern for a period of at least twelve months from when the financial statements are authorised for issue.

Our responsibilities and the responsibilities of the Commissioners with respect to going concern are described in the relevant sections of this report.

## *Other information*

The other information comprises the information included in the annual report, other than the financial statements and our auditor's report thereon. The Commissioners are responsible for the other information. Our opinion on the financial statements does not cover the other information and, except to the extent otherwise explicitly stated in our report, we do not express any form of assurance conclusion thereon.

In connection with our audit of the financial statements, our responsibility is to read the other information and, in doing so, consider whether the other information is materially inconsistent with the financial statements or our knowledge obtained in the audit or otherwise appears to be materially misstated. If we identify such material inconsistencies or apparent material misstatements, we are required to determine whether there is a material misstatement in the financial statements or a material misstatement of the other information. If, based on the work we have performed, we conclude that there is a material misstatement of this other information, we are required to report that fact.

We have nothing to report in this regard.

#### *Matters on which we are required to report by exception*

We have nothing to report in respect of the following matters where the Charities Act 2011 requires us to report to you if, in our opinion:

- the information given in the Commissioners' Annual Report is inconsistent in any material respect with the financial statements; or
- the charity has not kept adequate accounting records; or
- the financial statements are not in agreement with the accounting records and returns; or
- we have not received all the information and explanations we required for our audit.

#### *Responsibilities of Commissioners*

As explained more fully in the Commissioners' responsibilities statement set out on page 58, the Commissioners are responsible for the preparation of the financial statements and for being satisfied that they give a true and fair view, and for such internal control as the Commissioners determine is necessary to enable the preparation of financial statements that are free from material misstatement, whether due to fraud or error.

In preparing the financial statements, the Commissioners are responsible for assessing the charity's ability to continue as a going concern, disclosing, as applicable, matters related to going concern and using the going concern basis of accounting unless the Commissioners either intend to liquidate the charity or to cease operations, or have no realistic alternative but to do so.

#### *Auditor's responsibilities for the audit of the financial statements*

We have been appointed as auditor under section 144 of the Charities Act 2011 and report in accordance with regulations made under section 154 of that Act.

Our objectives are to obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is a high level of assurance but is not a guarantee that an audit conducted in accordance with ISAs (UK) will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements.

Irregularities, including fraud, are instances of non-compliance with laws and regulations. We design procedures in line with our responsibilities, outlined above, to detect material misstatements in respect of irregularities, including fraud. The extent to which our procedures are capable of detecting irregularities, including fraud is detailed below.

*Explanation as to what extent the audit was considered capable of detecting irregularities, including fraud*

The objectives of our audit in respect of fraud, are: to identify and assess the risks of material misstatement of the financial statements due to fraud; to obtain sufficient appropriate audit evidence regarding the assessed risks of material misstatement due to fraud, through designing and implementing appropriate responses to those assessed risks; and to respond appropriately to instances of fraud or suspected fraud identified during the audit. However, the primary responsibility for the prevention and detection of fraud rests with both management and those charged with governance of the charity.

Our approach was as follows:

- We obtained an understanding of the legal and regulatory requirements applicable to the charity and considered that the most significant are the Charities Act 2011, the Charity SORP, and UK financial reporting standards as issued by the Financial Reporting Council.
- We obtained an understanding of how the charity complies with these requirements by discussions with management.
- We assessed the risk of material misstatement of the financial statements, including the risk of material misstatement due to fraud and how it might occur, by holding discussions with management.
- We inquired of management and those charged with governance as to any known instances of non-compliance or suspected non-compliance with laws and regulations.
- Based on this understanding, we designed specific appropriate audit procedures to identify instances of non-compliance with laws and regulations. This included making enquiries of management and obtaining additional corroborative evidence as required.

As part of an audit in accordance with ISAs (UK) we exercise professional judgement and maintain professional scepticism throughout the audit. We also:

- Identify and assess the risks of material misstatement of the financial statements, whether due to fraud or error, design and perform audit procedures responsive to those risks, and obtain audit evidence that is sufficient and appropriate to provide a basis for our opinion. The risk of not detecting a material misstatement resulting from fraud is higher than for one resulting from error, as fraud may involve collusion, forgery, intentional omissions, misrepresentations, or the override of internal control.
- Obtain an understanding of internal control relevant to the audit in order to design audit procedures that are appropriate in the circumstances, but not for the purposes of expressing an opinion on the effectiveness of the charity's internal control.
- Evaluate the appropriateness of accounting policies used and the reasonableness of accounting estimates and related disclosures made by the Commissioners.

- Conclude on the appropriateness of the Commissioners' use of the going concern basis of accounting and, based on the audit evidence obtained, whether a material uncertainty exists related to events or conditions that may cast significant doubt on the charity's ability to continue as a going concern. If we conclude that a material uncertainty exists, we are required to draw attention in our auditor's report to the related disclosures in the financial statements or, if such disclosures are inadequate, to modify our opinion. Our conclusions are based on the audit evidence obtained up to the date of our auditor's report. However, future events or conditions may cause the charity to cease to continue as a going concern.
- Evaluate the overall presentation, structure and content of the financial statements, including the disclosures, and whether the financial statements represent the underlying transactions and events in a manner that achieves fair presentation.

We communicate with those charged with governance regarding, among other matters, the planned scope and timing of the audit and significant audit findings, including any significant deficiencies in internal control that we identify during our audit.

#### *Use of our report*

This report is made solely to the charity's Commissioners, as a body, in accordance with Chapter 3 of Part 8 of the Charities Act 2011. Our audit work has been undertaken so that we might state to the charity's Commissioners those matters we are required to state to them in an auditor's report and for no other purpose. To the fullest extent permitted by law, we do not accept or assume responsibility to any party other than the charity and charity's Commissioners as a body, for our audit work, for this report, or for the opinion we have formed.

Statutory auditor

Moore Kingston Smith LLP

2 Appold Street  
London

EC2A 2AP  
15/7/2025

Moore Kingston Smith LLP is eligible to act as auditor in terms of Section 1212 of the Companies Act 2006.

# Royal Commission for the Exhibition of 1851

## Statement of Financial Activities for the Year Ended 31 December 2024

|                                                               | Notes | Unrestricted<br>Funds<br>2024<br>£ | Unrestricted<br>Funds<br>2023<br>£ |
|---------------------------------------------------------------|-------|------------------------------------|------------------------------------|
| <b>Income from:</b>                                           |       |                                    |                                    |
| Donations                                                     | 4     | 2,000                              | 1,000                              |
| Investments                                                   | 5     | 2,259,719                          | 2,559,838                          |
| Other                                                         | 6     | 6,015                              | 5,103                              |
| <b>Total income</b>                                           |       | <u>2,267,734</u>                   | <u>2,565,941</u>                   |
| <b>Expenditure on:</b>                                        |       |                                    |                                    |
| Raising funds                                                 | 7     | 642,408                            | 766,633                            |
| Charitable activities                                         | 8     | 5,983,370                          | 4,957,163                          |
| <b>Total expenditure</b>                                      |       | <u>6,625,778</u>                   | <u>5,723,796</u>                   |
| <b>Net expenditure before gains and losses on investments</b> |       | (4,358,044)                        | (3,157,855)                        |
| <b>Net gains / (losses) on investments</b>                    |       |                                    |                                    |
| Gains / (losses) on property                                  |       | 154,478                            | (559,000)                          |
| Gains on investments                                          |       | 22,862,658                         | 17,189,182                         |
| <b>Total of net gains on investments</b>                      |       | <u>23,017,136</u>                  | <u>16,630,182</u>                  |
| <b>Net income</b>                                             |       | <u>18,659,092</u>                  | <u>13,472,327</u>                  |
| <b>Other recognised gains and losses</b>                      |       |                                    |                                    |
| Actuarial gains / (losses) on defined benefit pension scheme  | 14    | 50,728                             | (9,173)                            |
| <b>Net movement in funds</b>                                  |       | <u>18,709,820</u>                  | <u>13,463,154</u>                  |
| <b>Reconciliation of funds</b>                                |       |                                    |                                    |
| Total funds brought forward                                   |       | 143,838,891                        | 130,375,737                        |
| Net movement in funds                                         |       | 18,709,820                         | 13,463,154                         |
| <b>Total funds carried forward</b>                            |       | <u><u>162,548,711</u></u>          | <u><u>143,838,891</u></u>          |

The notes on pages 66 to 83 form part of these accounts. Notes 1-2 provide details of the Commission's objectives and accounting policies.



# Royal Commission for the Exhibition of 1851

## Balance Sheet as at 31 December 2024

|                                                         | Notes | Total<br>Funds<br>2024<br>£ | Total<br>Funds<br>2023<br>£ |
|---------------------------------------------------------|-------|-----------------------------|-----------------------------|
| <b>Fixed asset investments</b>                          |       |                             |                             |
| Investment properties                                   | 15    | 19,220,350                  | 19,595,350                  |
| Listed investments                                      | 16    | 149,969,167                 | 129,015,824                 |
| Cash held as part of the investment portfolio           |       | 165,408                     | 1,114,160                   |
|                                                         |       | <hr/>                       | <hr/>                       |
|                                                         |       | 169,354,925                 | 149,725,334                 |
| <b>Current assets</b>                                   |       |                             |                             |
| Debtors                                                 | 17    | 485,974                     | 318,915                     |
| Cash at bank and in hand                                |       | 1,267,369                   | 1,425,099                   |
|                                                         |       | <hr/>                       | <hr/>                       |
|                                                         |       | 1,753,343                   | 1,744,014                   |
| <b>Liabilities</b>                                      |       |                             |                             |
| Creditors: Amounts falling due within one year          | 18    | (4,640,555)                 | (4,078,902)                 |
|                                                         |       | <hr/>                       | <hr/>                       |
| <b>Net current liabilities</b>                          |       | (2,887,212)                 | (2,334,886)                 |
| <b>Total assets less current liabilities</b>            |       | <hr/>                       | <hr/>                       |
|                                                         |       | 166,467,713                 | 147,390,448                 |
| Creditors: Amounts falling due after more than one year | 18    | (3,645,002)                 | (3,206,557)                 |
|                                                         |       | <hr/>                       | <hr/>                       |
| <b>Net assets excluding pension liability</b>           |       | 162,822,711                 | 144,183,891                 |
| Defined benefit pension scheme liability                | 14    | (274,000)                   | (345,000)                   |
|                                                         |       | <hr/>                       | <hr/>                       |
| <b>Net assets</b>                                       |       | <hr/> <hr/>                 | <hr/> <hr/>                 |
|                                                         |       | 162,548,711                 | 143,838,891                 |
| <b>The funds of the Charity:</b>                        |       |                             |                             |
| <b>Capital Funds</b>                                    |       |                             |                             |
| Balance as at 1 January                                 |       | 143,838,891                 | 130,375,737                 |
| Movement in year                                        |       | 18,709,820                  | 13,463,154                  |
|                                                         |       | <hr/>                       | <hr/>                       |
| <b>Balance as at 31 December</b>                        |       | <hr/> <hr/>                 | <hr/> <hr/>                 |
|                                                         |       | 162,548,711                 | 143,838,891                 |

Approved by the Commissioners on 9 July 2025 and signed on their behalf by:



Ms Sandra Robertson  
Chairman, Finance Committee



Mr John Lavery  
Secretary

The notes on pages 66 to 83 form part of these accounts.

# Royal Commission for the Exhibition of 1851

## Statement of Cash Flows for the Year Ended 31 December 2024

|                                                                    | <b>Total<br/>Funds<br/>2024<br/>£</b> | <b>Total<br/>Funds<br/>2023<br/>£</b> |
|--------------------------------------------------------------------|---------------------------------------|---------------------------------------|
| <b>Cash flows from operating activities</b>                        |                                       |                                       |
| Donations received (excluding donations in kind)                   | 2,000                                 | 1,000                                 |
| Grants and award paid                                              | (4,146,875)                           | (4,691,655)                           |
| Payments to suppliers                                              | (1,099,846)                           | (1,115,782)                           |
| Payments in respect of employees                                   | (372,738)                             | (350,414)                             |
| Other payments                                                     | (35,968)                              | (32,029)                              |
| <b>Cash used in operating activities</b>                           | <b>(5,653,427)</b>                    | <b>(6,188,880)</b>                    |
| <b>Cash flows from investing activities</b>                        |                                       |                                       |
| Dividends, interest and rent from investments                      | 2,101,518                             | 2,648,366                             |
| Proceeds from sale of investments                                  | 119,813,534                           | 24,930,798                            |
| Purchase of investments                                            | (117,368,107)                         | (23,823,555)                          |
| <b>Net cash provided by investing activities</b>                   | <b>4,546,945</b>                      | <b>3,755,609</b>                      |
| <b>Change in cash and cash equivalents in the reporting period</b> | <b>(1,106,482)</b>                    | <b>(2,433,271)</b>                    |
| Cash and cash equivalents brought forward                          | 2,539,259                             | 4,972,530                             |
| <b>Cash and cash equivalents carried forward</b>                   | <b>1,432,777</b>                      | <b>2,539,259</b>                      |
| <b>Disclosed as:</b>                                               |                                       |                                       |
| Cash held as part of the investment portfolio                      | 165,408                               | 1,114,160                             |
| Cash at bank and in hand                                           | 1,267,369                             | 1,425,099                             |
|                                                                    | <b>1,432,777</b>                      | <b>2,539,259</b>                      |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2024

### 1. STATUS AND OBJECTIVES

The Commission for the Exhibition of 1851 was set up by Royal Charter in 1850 to plan and promote the Exhibition of Works of Industry of all Nations, which was to be held in London in 1851. When the affairs of the Great Exhibition had eventually been wound up, the Commissioners were appointed, under a Supplemental Charter, as a permanent body to administer the surplus funds at their disposal. These were to be applied in order to “increase the means of industrial education and extend the influence of science and art upon productive industry”.

### 2. ACCOUNTING POLICIES

The accounts are prepared under the historic cost convention, modified by the revaluation from time to time of certain fixed assets, and in accordance with the Financial Reporting Standard applicable in the UK and Republic of Ireland (effective January 2015) (FRS102), Accounting and Reporting by Charities: Statement of Recommended Practice applicable to charities preparing their accounts in accordance with the Financial Reporting Standard applicable in the UK and Republic of Ireland (effective January 2019) (SORP) and the Charities Act 2011.

In the estimation of the trustees (the Commissioners), there are no material uncertainties that call into doubt the Commission’s ability to continue and the accounts have therefore been prepared on a going concern basis.

The Commission, like every other organisation, has been impacted by the pandemic, Russia’s invasion of Ukraine and war in the Middle East, which have resulted in ongoing supply chain disruption, persistent high inflation, increased interest rates and a cost-of-living crisis. Investment markets have been much more volatile, and the day-to-day value of the Commission’s portfolio has inevitably reflected that. The Commission is a long-term investor, however, and Commissioners remain confident in the underlying strength of the portfolio; they see no evidence at this stage of any permanent loss of value. Similarly, while the Commission has had to defer or write off a certain amount of rent, there is not considered to be any risk to the long-term value of the estate. The Commission has sufficient assets, and sufficient liquidity, to ride out the current market disruptions. The Commission’s core grant-making activity has therefore continued largely as planned and Commissioners expect it to continue to do so.

The Commission meets the definition of a public benefit entity under FRS102.

The financial statements are presented in sterling which is the functional currency of the charity. Monetary amounts are rounded to the nearest pound.

#### (a) Investments

- (i) Are shown in the balance sheet at market value; any unrealised gain over original cost is shown in the statement of financial activities.
- (ii) Income on investments is included in the accounts when receivable.
- (iii) Cash held as part of the investment portfolio includes short-term deposits held temporarily with the company’s bankers pending re-investment.

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2024

### 2. ACCOUNTING POLICIES (Continued)

#### (b) Donations, legacies and similar income

Donations, legacies and similar income are included in the year in which they are receivable, that is, when the Commission becomes entitled to the income. Donations received for general purposes are included as unrestricted funds. Where the wishes of the donor are legally binding on Commissioners, donations are accounted for as Restricted Funds with their use limited to that defined by the donor.

#### (c) Fixed Assets and Depreciation

All purchases of capital items under £10,000 are written off in the year of purchase. Capital items over £10,000 are depreciated over their estimated useful economic lives. Currently no items are being depreciated.

#### (d) Investment Properties

All the Commission's properties are let to provide an income on a full repairing lease. All properties are inspected regularly by the Commission's Surveyors and revalued by them from time to time. The last full revaluation was undertaken at 31 December 2024 and was based on the existing use and occupation of the land, and the duration of leases at ground rents and rack rents. These valuations are reviewed and adjusted annually as described in note 15.

#### (e) Realised and Unrealised Gains and Losses on Investments

Gains and losses on investments and assets held for the Commission's use are treated in accordance with the Statement of Recommended Practice. They are recognised in the statement of financial activities for the year in which they occur.

#### (f) Cash and cash equivalents

Cash and cash equivalents include cash in hand, deposits held at call with banks, other short-term liquid investments with original maturities of three months or less, and bank overdrafts. Cash held on capital account pending investment by the charity's investment managers, together with cash for investment in transit between investment managers, is disclosed within fixed asset investments; all other cash and cash equivalents is disclosed within current asset investments.

#### (g) Lease premiums and licences

Premiums received for lease extensions are treated as capital receipts and included within gains / (losses) on property transactions. Certain other premiums received which do not materially affect the underlying value of the Commission's investment are treated as income receipts.

#### (h) Charitable activities

The primary charitable activity is the making of grants and awards. Grants and awards payable are accounted for on an accruals basis. Multi-year grants are accounted for in full in the year that the grant is awarded. The Commission recognises future liabilities discounted to their present value where material.

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2024

### 2. ACCOUNTING POLICIES (Continued)

#### (h) Charitable activities (continued)

The majority of grants and awards are made to individuals who have been granted Fellowships or Studentships by the Commission. A limited number of awards are made to Institutions in furtherance of their educational needs. Some support is also provided to the legacy institutions on the Commission's South Kensington estate and to organisations facilitating access to the Commission's archives. A full analysis is shown in note 9.

The Commission also undertakes some direct charitable activities, in particular networking and educational events organised for the Commission's Fellows, Students, Alumni and the general public. Further details are shown in note 10.

#### (i) Allocation of support costs

Support costs are allocated on the basis of board or staff time as appropriate.

#### (j) Financial instruments

The Commission has elected to apply the provisions of Section 11 *Basic Financial Instruments* and Section 12 *Other Financial Instruments Issues* of FRS 102 to all of its financial instruments.

Financial instruments are recognised in the Commission's balance sheet when the Commission becomes party to the contractual provisions of the instrument.

##### *Basic financial assets*

Basic financial assets, which include trade and other debtors and cash and bank balances, are initially measured at transaction price including transaction costs and are subsequently carried at amortised cost using the effective interest method unless the arrangement constitutes a financing transaction, where the transaction is measured at the present value of the future receipts discounted at a market rate of interest.

##### *Other financial assets*

Other financial assets, including investments in equity instruments which are not subsidiaries, associates or joint ventures, are initially measured at fair value, which is normally the transaction price. Such assets are subsequently carried at fair value and the changes in fair value are recognised in the statement of financial activities, except that investments in equity instruments that are not publicly traded and whose fair values cannot be measured reliably are measured at cost less impairment.

Trade debtors, loans and other debtors that have fixed or determinable payments that are not quoted in an active market are classified as 'loans and receivables'. Loans and receivables are measured at amortised cost using the effective interest method, less any impairment.

##### *Basic financial liabilities*

Basic financial liabilities, including trade and other creditors, are initially recognised at transaction price unless the arrangement constitutes a financing transaction, where the debt instrument is measured at the present value of the future payments discounted at a market rate of interest.

Debt instruments are subsequently carried at amortised cost, using the effective interest rate method.

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2024

### 2. ACCOUNTING POLICIES (Continued)

#### (j) Financial instruments (continued)

Trade creditors are obligations to pay for goods or services that have been acquired in the ordinary course of business from suppliers. Accounts payable are classified as current liabilities if payment is due within one year or less. If not, they are presented as non-current liabilities. Trade creditors are recognised initially at transaction price and subsequently measured at amortised cost using the effective interest method.

##### *Other financial liabilities*

Derivatives, including interest rate swaps and forward foreign exchange contracts, are not basic financial instruments. Derivatives are initially recognised at fair value on the date a derivative contract is entered into and are subsequently re-measured at their fair value. Changes in the fair value of derivatives are recognised in the statement of financial activities in finance costs or finance income as appropriate, unless they are included in a hedging arrangement.

#### (k) Retirement benefits

Payments to defined contribution retirement benefit schemes are charged as an expense as they fall due.

The cost of providing benefits under defined benefit plans is determined separately for each plan using the projected unit credit method and is based on actuarial advice.

The net interest element is determined by multiplying the net defined benefit liability by the discount rate, taking into account any changes in the net defined benefit liability during the period as a result of contribution and benefit payments. The net interest is recognised in the statement of financial activities.

Remeasurement changes comprise actuarial gains and losses and the return on the net defined benefit liability excluding amounts included in net interest. These are recognised immediately in the statement of financial activities in the period in which they occur.

The defined net benefit pension liability in the balance sheet comprises the total of the present value of the defined benefit obligation (using a discount rate based on high quality corporate bonds).

#### (l) Significant judgements and key sources of estimation uncertainty

In the application of the charity's accounting policies, Commissioners are required to make judgements, estimates and assumptions about the carrying value of assets and liabilities that are not readily apparent from other sources. The estimates are based on historical experience and other factors that are considered to be relevant. Actual results may differ from these estimates. The key sources of estimation uncertainty that have a significant effect on the amount recognised in the accounts are:

- the valuation of investment properties, which are stated at their estimated fair value based on professional valuations as disclosed in Note 15;
- the valuation of multi-year grant commitments, which take into account estimates of future inflation, early withdrawal rates, claim rates and other factors affecting the final amount payable; in this context, given other uncertainties, discounting for the time value of money is not considered material;

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2024

### 2. ACCOUNTING POLICIES (Continued)

#### (m) Significant judgements and key sources of estimation uncertainty (continued)

- the valuation of the defined benefit pension scheme liability, which is based on actuarial assumptions and a professional valuation as set out in Note 14;
- the valuation of future minimum lease payments under non-cancellable operating leases, which are discounted for inflation in accordance with Bank of England targets and ignore the potential effects of leasehold enfranchisements, as set out in Note 15.

### 3. FUNDS

All the Commission's income and capital is expendable at the discretion of the Commissioners and is therefore shown as a single unrestricted fund. The Commissioners had previously designated part of the unrestricted fund as a Special Projects Fund. However, during the year under review they decided that maintaining a separate fund for such projects was not helpful and the Special Projects Fund has been rolled back into the general unrestricted fund. Fund movements are disclosed in Note 20.

### 4. DONATIONS

The Commission received donations of £1,000 each from The Faculty of Royal Designers for Industry and The Royal Academy of Engineering. The donations were for the general charitable purposes of the Commission, but with an expressed wish that they be used to support the activities of the Sir Misha Black Awards Committee. The donations were therefore used to part fund the event at which the 2024 Medals and Award were presented. The Commissioners are very grateful to The Faculty of Royal Designers for Industry and The Royal Academy of Engineering for their support.

### 5. INVESTMENT INCOME

|                                  | 2024<br>£        | 2023<br>£        |
|----------------------------------|------------------|------------------|
| Rental income from UK properties | 670,741          | 776,165          |
| Income from managed investments  | 1,503,994        | 1,735,350        |
| Interest on cash deposits        | 84,984           | 48,323           |
|                                  | <u>2,259,719</u> | <u>2,559,838</u> |

### 6. OTHER INCOME

|                | 2024<br>£    | 2023<br>£    |
|----------------|--------------|--------------|
| Licence income | 6,015        | 5,103        |
|                | <u>6,015</u> | <u>5,103</u> |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2024

### 7. COST OF RAISING FUNDS

|                                   | 2024<br>£      | 2023<br>£      |
|-----------------------------------|----------------|----------------|
| Investment management fees        | 467,771        | 567,067        |
| Property management fees          | 113,643        | 120,068        |
| Legal fees                        | 2,430          | 27,094         |
| Allocated support costs (note 11) | 58,564         | 52,404         |
|                                   | <u>642,408</u> | <u>766,633</u> |

### 8. CHARITABLE ACTIVITIES

|                               | Grants<br>(note 9)<br>£ | Direct costs<br>(note 10)<br>£ | Allocated<br>support<br>costs<br>(note 11)<br>£ | 2024<br>£        | 2023<br>£        |
|-------------------------------|-------------------------|--------------------------------|-------------------------------------------------|------------------|------------------|
| Fellowships and studentships  | 3,887,351               | 162,094                        | 175,170                                         | 4,224,615        | 3,963,890        |
| STEM education and outreach   | 878,225                 | 151,147                        | 63,401                                          | 1,092,773        | 444,253          |
| Support for legacy estate     | 406,482                 | 35,182                         | 63,401                                          | 505,065          | 433,303          |
| Archives and alumni relations | -                       | 93,242                         | 67,675                                          | 160,917          | 115,717          |
|                               | <u>5,172,058</u>        | <u>441,665</u>                 | <u>369,647</u>                                  | <u>5,983,370</u> | <u>4,957,163</u> |

### 9. GRANTS AWARDED

#### a. Fellowships and studentships

|                                    | 2024<br>No. | 2024<br>£        | 2023<br>No. | 2023<br>£        |
|------------------------------------|-------------|------------------|-------------|------------------|
| Research Fellowships               | 10          | 2,005,165        | 10          | 1,692,455        |
| Industrial Fellowships             | 12          | 802,901          | 15          | 1,129,088        |
| Industrial Design Studentships     | 11          | 546,152          | 14          | 501,850          |
| Built Environment Fellowship       | -           | -                | 1           | 100,000          |
| Design Fellowship                  | 1           | 100,000          | -           | (37)             |
| Regenerative Design Fellowships    | -           | -                | -           | -                |
| Enterprise Fellowships             | 6           | 375,000          | 4           | 250,000          |
| Technical Teaching Fellowships     | 5           | 48,133           | -           | -                |
| Sir Misha Black Awards Bursaries   | 1           | 10,000           | -           | -                |
| Total fellowships and studentships | <u>46</u>   | <u>3,887,351</u> | <u>44</u>   | <u>3,673,356</u> |

All of the fellowships and studentships were awarded to individuals. The Annual Report includes more information on the awards granted, including where relevant details of each of the institutions at which individual recipients are carrying out their studies / research.



# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2024

### 9. GRANTS AWARDED (continued)

#### b. STEM education and outreach

|                                                                                        | 2024     | 2023     |
|----------------------------------------------------------------------------------------|----------|----------|
|                                                                                        | £        | £        |
| STEM Learning – Bespoke training for primary STEM teachers                             | 500,000  | -        |
| Royal Museums Greenwich – First Light gallery                                          | 100,000  | -        |
| Royal Designers for Industry – Summer schools                                          | 71,000   | -        |
| Institute of Physics – Mimi's Tiny Adventure                                           | 52,500   | -        |
| Royal Institution – Science in Schools                                                 | 50,000   | -        |
| National Science Centre – Outer Solar System gallery                                   | 40,000   | -        |
| Durham University – Celebrate Science 2024                                             | 15,000   | -        |
| Big Ideas – London Wonder                                                              | 14,400   | -        |
| Fun Kids Radio – War time inventions                                                   | 13,400   | -        |
| Number Champions – Numeracy in primary schools                                         | 12,000   | -        |
| Kids Invent Stuff – Exhibition / Inventors Club                                        | 10,000   | 10,000   |
| Somerscience Trust – Somerscience Festival 2024                                        | 5,000    | -        |
| British Science Association – Primary kit boxes                                        | 2,925    | 83,700   |
| Foundation for Science and Technology – Future Leaders Conference / Debate sponsorship | 2,500    | 9,500    |
| Imperial College Union Design Engineering Society - Hackathon                          | 2,000    | -        |
| Primary Engineer – Primary Engineer Curriculum                                         | -        | 45,000   |
| British School at Rome – Summer School placements                                      | -        | 19,500   |
| Education and Training Foundation – Technical Teaching Fellowships                     | -        | 15,000   |
| Oxford University Development Trust - OXbOXes                                          | -        | 15,000   |
| University of Hull – Humber Science Festival                                           | -        | 11,000   |
| All Party Parliamentary Engineering Group – Meeting sponsorship                        | -        | 10,000   |
| Royal Botanic Gardens Kew – Grow Wild                                                  | -        | 10,000   |
| Geological Society – Megalosaurus Month                                                | -        | 6,000    |
| J Mallinson and E Townsend – STEM materials                                            | -        | 750      |
| G Lamb – STEM outreach                                                                 | -        | 500      |
| MadeHereNow – Website development                                                      | -        | 2,000    |
| Smallpeice Trust – Arkwright Scholarships                                              | -        | 23,000   |
|                                                                                        | 890,725  | 260,950  |
| Less: Past awards written back where not utilised in full                              | (12,500) | (14,875) |
|                                                                                        | 878,225  | 246,075  |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2024

### 9. GRANTS AWARDED (continued)

All 15 of the STEM education and outreach grants in 2024 were awarded to institutions (2023: two of the STEM education and outreach grants were awarded to individuals with the remaining 13 awarded to institutions).

#### c. Support for legacy estate

|                                                                                 | 2024    | 2023    |
|---------------------------------------------------------------------------------|---------|---------|
|                                                                                 | £       | £       |
| Royal College of Art – Main entrance                                            | 250,000 | -       |
| Exhibition Road Cultural Group – SouthKenZEN+ Project work                      | 90,000  | 30,255  |
| Exhibition Road Cultural Group – SouthKenZEN+ Heat network                      | 70,000  | -       |
| Royal College of Music – Colin Lawson Fund                                      | 2,000   | -       |
| Imperial College London - Great Exhibition Road Festival 2025 and 2026          | -       | 200,000 |
| Science Museum – Power Hall refurbishment                                       | -       | 100,000 |
| Royal Society of Sculptors – Florilegium at Great Exhibition Road Festival 2023 | -       | 10,000  |
|                                                                                 | <hr/>   | <hr/>   |
|                                                                                 | 412,000 | 340,255 |
| Less: Past awards written back where not utilised in full                       | (5,518) | -       |
|                                                                                 | <hr/>   | <hr/>   |
|                                                                                 | 406,482 | 340,255 |
|                                                                                 | <hr/>   | <hr/>   |

All of the grants in support of the legacy estate in both 2024 and 2023 were awarded to institutions.

#### d. Archives and alumni relations

No awards were made in this category in 2024 or 2023.

In total, 19 grants were made to institutions and 46 to individuals (2023: 17 grants to institutions and 46 to individuals).

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2024

### 10. DIRECT COSTS

|                                         | Fellowships<br>and<br>studentships | STEM<br>education<br>outreach | Support for<br>legacy estate<br>and alumni<br>relations | Archives<br>and alumni<br>relations | 2024           | 2023           |
|-----------------------------------------|------------------------------------|-------------------------------|---------------------------------------------------------|-------------------------------------|----------------|----------------|
|                                         | £                                  | £                             | £                                                       | £                                   | £              | £              |
| Promotion and selection costs           | 97,786                             | -                             | -                                                       | -                                   | 97,786         | 76,708         |
| Networking and educational events       | 64,308                             | 151,147                       | 4,268                                                   | 18,169                              | 237,892        | 215,304        |
| Estate memberships, projects and advice | -                                  | -                             | 30,914                                                  | -                                   | 30,914         | 30,587         |
| Archive supplies and acquisitions       | -                                  | -                             | -                                                       | 66,709                              | 66,709         | 26,139         |
| Alumni website and expenses             | -                                  | -                             | -                                                       | 8,364                               | 8,364          | 7,088          |
|                                         | <u>162,094</u>                     | <u>151,147</u>                | <u>35,182</u>                                           | <u>93,242</u>                       | <u>441,665</u> | <u>355,826</u> |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2024

### 11. SUPPORT COSTS

|                             | Cost of raising funds | Fellowships and studentships | STEM education and outreach | Support for legacy estate | Archives and alumni relations | 2024           | 2023           | Basis of allocation |
|-----------------------------|-----------------------|------------------------------|-----------------------------|---------------------------|-------------------------------|----------------|----------------|---------------------|
|                             | £                     | £                            | £                           | £                         | £                             | £              | £              |                     |
| Governance costs (note 12)  | 9,439                 | 9,439                        | 7,551                       | 7,551                     | 3,776                         | 37,756         | 27,180         | Board time          |
| Staff costs (note 13)       | 41,523                | 140,085                      | 47,207                      | 47,207                    | 54,011                        | 330,033        | 294,495        | Staff time          |
| Retired staff pension costs | 1,854                 | 6,255                        | 2,108                       | 2,108                     | 2,412                         | 14,737         | 16,238         | Staff time          |
| Facility costs              | 1,097                 | 3,702                        | 1,248                       | 1,248                     | 1,427                         | 8,722          | 5,123          | Staff time          |
| Office costs                | 3,021                 | 10,191                       | 3,434                       | 3,434                     | 3,929                         | 24,009         | 35,471         | Staff time          |
| Legal and professional fees | 1,192                 | 4,020                        | 1,355                       | 1,355                     | 1,550                         | 9,472          | 7,891          | Staff time          |
| Travel and entertaining     | 438                   | 1,478                        | 498                         | 498                       | 570                           | 3,482          | 7,657          | Staff time          |
|                             | <u>58,564</u>         | <u>175,170</u>               | <u>63,401</u>               | <u>63,401</u>             | <u>67,675</u>                 | <u>428,211</u> | <u>394,055</u> |                     |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2024

### 12. GOVERNANCE COSTS

|                                     | 2024<br>£     | 2023<br>£     |
|-------------------------------------|---------------|---------------|
| Audit fees (including VAT)          |               |               |
| - Current year                      | 15,000        | 15,000        |
| - Prior year under / (over) accrual | (1,056)       | -             |
| Actuarial fees                      | 2,220         | 2,220         |
| Annual report                       | 17,548        | 4,994         |
| Meeting costs                       | 4,044         | 4,966         |
|                                     | <u>37,756</u> | <u>27,180</u> |

### 13. STAFF COSTS AND RELATED PARTY TRANSACTIONS

|                                       | 2024<br>£      | 2023<br>£      |
|---------------------------------------|----------------|----------------|
| Salaries (including benefits in kind) | 260,099        | 231,903        |
| Employers NI                          | 24,601         | 20,713         |
| Pension contributions                 | 43,834         | 40,954         |
| Training and development              | 1,499          | 925            |
|                                       | <u>330,033</u> | <u>294,495</u> |

The average number of employees during the year analysed by function was: -

|                            | 2024<br>No. | 2023<br>No. |
|----------------------------|-------------|-------------|
| Support and administration | 4.0         | 4.0         |
| Archive                    | 1.0         | 1.0         |
|                            | <u>5.0</u>  | <u>5.0</u>  |

The full-time equivalent number of employees during the year analysed by function was: -

|                            | 2024<br>No. | 2023<br>No. |
|----------------------------|-------------|-------------|
| Support and administration | 2.8         | 2.8         |
| Archive                    | 0.4         | 0.4         |
|                            | <u>3.2</u>  | <u>3.2</u>  |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2024

### 13. STAFF COSTS AND RELATED PARTY TRANSACTIONS (continued)

One employee earned between £60,000 and £70,000 and one employee earned between £90,000 and £100,000. Pension contributions of £9,636 and £13,545 respectively were paid in respect of these employees. (2023: one employee earned between £80,000 and £90,000; pension contributions of £12,600 were paid in respect of that employee)

Commissioners do not receive remuneration. During the year re-imbursements were made to three Commissioners in respect of travelling and other expenses totalling £1,442 (2023: to three Commissioners totalling £1,423). One Commissioner received an honorarium of £1,600 as a member of the Science and Engineering Fellowships Committee in recognition of specialist services provided in assessing potential candidates (2023: one Commissioner received £900).

The total amount paid in respect of key management personnel (i.e., the Secretary and Finance Director), including employer's national insurance and employer pension contributions, was £203,353 (2023: £180,997).

There were no other related party transactions during the year (2023: none).

### 14. PENSIONS AND OTHER LONG-TERM EMPLOYEE BENEFITS

All current and new members of staff are eligible to join a personal pension scheme of their choice with the Commission contributing 15% of salary (2023: 15% of salary). There is no requirement for employee contributions. Staff may opt to sacrifice some of their salary in return for an additional employer contribution. Employer contributions of £43,834 (2023: £40,954) were made in the year of which £952 (2023: £886) were outstanding at the year-end. There were no prepaid contributions at the year-end (2023: £nil).

All current and new members of staff also benefit from an unfunded / uninsured death in service scheme under which the Commissioners (at their absolute discretion) may pay a nominated beneficiary a lump sum equivalent to 18 months' salary if an employee dies while employed by the Commission. No liability for the scheme is recognised in the accounts as Commissioners do not believe there is any sensible way to estimate the liability. Actuarial calculations based on assumptions comparable to those used in valuing the defined benefit pension liability (see below) suggest that any liability in respect of the death in service scheme would in any case be immaterial.

All current and new members of staff also benefit from a Group Income Protection policy with Canada Life which covers basic salary and pension contributions for staff unable to work due to long term illness.

The Commission operates an unfunded pension scheme in the UK (the 'Scheme'). The Scheme is an unregistered, non-contributory defined benefit scheme. As the Scheme is unfunded, no contributions are paid by the Commission, other than to meet benefits as they fall due. As no triennial valuations are carried out, a valuation is carried out at the balance sheet date each year by an independent qualified actuary.

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2024

### 14. PENSIONS AND OTHER LONG-TERM EMPLOYEE BENEFITS (continued)

The Scheme was closed to new members on 14 July 2004. As at 31 December 2024, all four remaining members of the Scheme are receiving a pension and there is no further accrual of benefits. There is therefore no service cost for the year. The amount recognised in arriving at net expenditure for the year is an expense of £14,737 (2023: £16,238) which is fully in respect of net interest on the net liability. As regards the unfunded, defined benefit pension scheme:

*The principal assumptions used by the actuary were:*

|                                       | FRS102<br>Valuation<br>2024<br>(% p.a.) | FRS102<br>Valuation<br>2023<br>(% p.a.) |
|---------------------------------------|-----------------------------------------|-----------------------------------------|
| <i>Financial assumptions</i>          |                                         |                                         |
| Gross investment return               |                                         |                                         |
| In-service members                    |                                         |                                         |
| Pre-retirement                        | N/A                                     | N/A                                     |
| Post-retirement                       | N/A                                     | N/A                                     |
| Current pensioners                    | 4.8%                                    | 4.5%                                    |
| Pensionable earnings increases        | N/A                                     | N/A                                     |
| Price inflation                       | 3.7%                                    | 3.6%                                    |
| Pension increases                     | 3.7%                                    | 3.6%                                    |
| Allowance for administration expenses | 0.0%                                    | 0.0%                                    |
| <i>Demographic assumptions</i>        |                                         |                                         |
| Mortality                             |                                         |                                         |
| Pre-retirement                        | N/A                                     | N/A                                     |
| Post-retirement                       | 101%/104% S3PA<br>CMI 2023 1%           | 101%/104% S3PA<br>CMI 2022 1%           |
| Withdrawal allowance                  | No allowance                            | No allowance                            |
| Early retirement allowance            | No allowance                            | No allowance                            |
| Proportion married                    | 90%                                     | 90%                                     |
| Wife's age                            | 3 years younger<br>than husband         | 3 years younger<br>than husband         |

The assumptions used by the actuary are best estimates chosen from a range of possible actuarial assumptions which, due to the timescale covered, may not necessarily be borne out in practice.

#### *Value of Scheme assets and liabilities:*

|                                     | 2024<br>£ | 2023<br>£ |
|-------------------------------------|-----------|-----------|
| Market value of Scheme assets       | -         | -         |
| Present value of Scheme liabilities | (274,000) | (345,000) |
| Scheme deficit                      | (274,000) | (345,000) |
| Related deferred tax asset          | -         | -         |
| Net liability                       | (274,000) | (345,000) |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2024

### 14. PENSIONS AND OTHER LONG-TERM EMPLOYEE BENEFITS (continued)

| <i>Movements in the year:</i>          | 2024      | 2023      |
|----------------------------------------|-----------|-----------|
|                                        | £         | £         |
| Scheme deficit at beginning of year    | (345,000) | (357,000) |
| Current service cost                   | -         | -         |
| Interest on obligation                 | (14,737)  | (16,238)  |
| Actuarial gain / (loss) on liabilities | 50,728    | (9,173)   |
| Benefits paid directly by employer     | 35,009    | 37,411    |
|                                        | <hr/>     | <hr/>     |
| Scheme deficit at end of year          | (274,000) | (345,000) |
|                                        | <hr/>     | <hr/>     |

The interest on obligation of £14,737 (2023: £16,238) is disclosed within Support costs (note 11) while the actuarial gain on liabilities of £50,728 (2023: loss of £9,173) is disclosed within Other recognised gains and losses on the face of the SOFA.

### 15. INVESTMENT PROPERTIES AND OPERATING LEASES

|                                                        | 2024       | 2023       |
|--------------------------------------------------------|------------|------------|
|                                                        | £          | £          |
| <i>(a) Movements in value of investment properties</i> |            |            |
| Balance at 1 January                                   | 19,595,350 | 20,765,350 |
| Sales during the year                                  | (210,000)  | (365,000)  |
| Unrealised loss on year-end revaluation                | (165,000)  | (805,000)  |
|                                                        | <hr/>      | <hr/>      |
| Valuation at 31 December                               | 19,220,350 | 19,595,350 |
|                                                        | <hr/>      | <hr/>      |

The valuation as at 31 December 2024 shown above resulted from a full revaluation of the properties at 31 December 2024, undertaken by Daniel Watney LLP, Chartered Surveyors and Property Consultants. The valuation was carried out on an open market value basis in accordance with the RICS Appraisal and Valuation Manual and is based on existing usage and occupation of the land, and the duration of leases at ground and rack rents. All of the investment properties are located in the UK.



# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2024

### 15. INVESTMENT PROPERTIES AND OPERATING LEASES (continued)

#### (b) Operating leases – lessor

The Commission is entitled as landlord to income from investment properties under operating leases. Future minimum lease payments under non-cancellable operating leases, discounted for inflation, for each of the following periods are as follows:

|                                                   | 2024<br>£         | 2023<br>£         |
|---------------------------------------------------|-------------------|-------------------|
| Not later than one year                           | 77,750            | 94,538            |
| Later than one year and not later than five years | -                 | -                 |
| Later than five years                             | 11,054,796        | 10,903,421        |
|                                                   | <u>11,132,546</u> | <u>10,997,958</u> |

The Commission's investment properties are let for periods ranging up to 999 years. All leases are on full repairing and insuring terms. Leases of residential property are potentially subject to leasehold enfranchisement; this has been ignored in arriving at the above figures.

### 16. INVESTMENTS

|                                            | 2024<br>£          | 2023<br>£          |
|--------------------------------------------|--------------------|--------------------|
| (a) <i>Movements in listed investments</i> |                    |                    |
| Market value 1 January                     | 129,015,824        | 112,318,792        |
| Acquisitions at cost                       | 117,406,203        | 23,917,758         |
| Disposals at cost                          | (85,890,586)       | (20,252,654)       |
| Net gains / (losses) on revaluation        | (10,562,274)       | 13,031,928         |
|                                            | <u>149,969,167</u> | <u>129,015,824</u> |
| Market value 31 December                   | 149,969,167        | 129,015,824        |
|                                            | <u>128,360,319</u> | <u>96,844,702</u>  |

#### (b) Geographic breakdown

|                | 2024<br>£             | 2024<br>£      | 2023<br>£             | 2023<br>£        |
|----------------|-----------------------|----------------|-----------------------|------------------|
|                | Listed<br>investments | Cash           | Listed<br>investments | Cash             |
| In the UK      | 36,381,298            | 150,711        | 54,650,992            | 1,114,072        |
| Outside the UK | 113,587,869           | 14,697         | 74,364,832            | 88               |
|                | <u>149,969,167</u>    | <u>165,408</u> | <u>129,015,824</u>    | <u>1,114,160</u> |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2024

### 16. INVESTMENTS (continued)

All investments are listed on a recognised stock exchange.

There were no individual holdings the market value of which is considered to be material in the context of the portfolio as a whole.

### 17. DEBTORS

|                         | 2024<br>£     | 2023<br>£     |
|-------------------------|---------------|---------------|
| Rents receivable        |               |               |
| - in hands of surveyors | 277,856       | 132,886       |
| - in arrears            | 143,067       | 126,391       |
|                         | <hr/> 420,923 | <hr/> 259,277 |
| Other debtors           | 18,416        | 28,243        |
| Prepayments             | 46,635        | 31,395        |
|                         | <hr/> 485,974 | <hr/> 318,915 |
|                         | <hr/> <hr/>   | <hr/> <hr/>   |

### 18. CREDITORS

| Amounts falling due within one year | 2024<br>£       | 2023<br>£       |
|-------------------------------------|-----------------|-----------------|
| Grants payable                      | 4,497,521       | 3,866,077       |
| Other creditors                     | 143,034         | 212,825         |
|                                     | <hr/> 4,640,555 | <hr/> 4,078,902 |
|                                     | <hr/> <hr/>     | <hr/> <hr/>     |

|                                    | 2024<br>£     | 2023<br>£     |
|------------------------------------|---------------|---------------|
| <b>Analysis of other creditors</b> |               |               |
| Investment management fees         | 56,896        | 145,301       |
| Property management fees           | 30,043        | 24,398        |
| Audit fees                         | 15,000        | 15,000        |
| Other legal and professional fees  | 5,313         | 12,478        |
| Others                             | 35,782        | 15,648        |
|                                    | <hr/> 143,034 | <hr/> 212,825 |
|                                    | <hr/> <hr/>   | <hr/> <hr/>   |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2024

### 18. CREDITORS (continued)

| Amounts falling due after more than one year | 2024<br>£ | 2023<br>£ |
|----------------------------------------------|-----------|-----------|
| Grants payable                               | 3,645,002 | 3,206,557 |
| Due in one to two years                      | 2,298,118 | 2,195,140 |
| Due within two to five years                 | 1,346,884 | 1,011,417 |
|                                              | 3,645,002 | 3,206,557 |

The analysis of grants payable by award is as follows

| Award                             | Period of<br>commitment | 2024<br>£ | 2023<br>£ |
|-----------------------------------|-------------------------|-----------|-----------|
| Fellowships and studentships      |                         |           |           |
| - Research Fellowships            | 3 years                 | 3,604,299 | 3,321,439 |
| - Industrial Fellowships          | 3 years                 | 2,265,007 | 2,286,548 |
| - Industrial Design Studentships  | 2 years                 | 347,817   | 286,942   |
| - Built Environment Fellowships   | 2 years                 | 50,000    | 80,000    |
| - Design Fellowships              | 2 years                 | 110,000   | 55,000    |
| - Regenerative Design Fellowships | 2 years                 | 87,500    | 132,500   |
| - Enterprise Fellowships          | 1 year                  | 187,500   | 62,500    |
| - Sir Misha Black Award Bursaries | 1 year                  | 5,500     | 1,000     |
| STEM education and outreach       | 1 year                  | 909,900   | 196,250   |
| Support for legacy estate         | 3 years                 | 575,000   | 640,455   |
|                                   |                         | 8,142,523 | 7,072,634 |

### 19. FINANCIAL INSTRUMENTS

|                                                                             | 2024<br>£ | 2023<br>£ |
|-----------------------------------------------------------------------------|-----------|-----------|
| <b>Carrying amount of financial assets</b>                                  |           |           |
| Debt instruments measured at amortised cost (debtors excluding prepayments) | 439,339   | 287,520   |
|                                                                             | 439,339   | 287,520   |
| <b>Carrying amount of financial liabilities</b>                             |           |           |
| Measured at amortised cost                                                  | 8,285,557 | 7,285,459 |
|                                                                             | 8,285,557 | 7,285,459 |

# Royal Commission for the Exhibition of 1851

Notes to the Financial Statements  
for the Year Ended 31 December 2024

## 20. FUNDS

|                     | At 1<br>January<br>£ | Income<br>£      | Expenditure<br>£   | Gains /<br>(losses)<br>£ | Transfers<br>£ | At 31 December<br>£ |
|---------------------|----------------------|------------------|--------------------|--------------------------|----------------|---------------------|
| <b>Unrestricted</b> |                      |                  |                    |                          |                |                     |
| General             | 140,728,684          | 2,267,734        | (6,625,778)        | 23,067,864               | 3,110,207      | 162,548,711         |
| Designated          |                      |                  |                    |                          |                |                     |
| - Special Projects  | 3,110,207            | -                | -                  | -                        | (3,110,207)    | -                   |
|                     | <u>143,838,891</u>   | <u>2,267,734</u> | <u>(6,625,778)</u> | <u>23,067,864</u>        | <u>-</u>       | <u>162,548,711</u>  |

In 2021, the Commissioners set up a designated Special Projects Fund. However, during the year under review they decided that maintaining a separate fund for such projects was not helpful and the Special Projects Fund has been rolled back into the general unrestricted fund. The designated fund had comprised listed investments and was administered as part of the unrestricted fund.

## Administrative Information

### Structure, Governance and Management

The Commission is constituted as a limited company incorporated by Royal Charter. Its governing documents are the original Charter dated 3 January 1850 and a Supplemental Charter dated 2 December 1851.

The Commission may have up to twelve trustees, known as Royal Commissioners, at any one time, who together constitute the Board of Management, which meets formally twice a year. Commissioners are chosen to bring wide experience in areas relevant to the Commission's work – science, engineering, industry, design, architecture and finance. To maintain an appropriate balance of skills, Commissioners normally serve for 10 years, and Commissioners themselves identify possible successors, who may serve on a committee prior to election. Following election by the Board of Management, Commissioners are only appointed with the approval of the President.

All other committees are advisory in remit, are subordinate to the Board of Management and report to it, and all committee Chairmen are Commissioners. *Ad hoc* committees may be formed for limited periods and specific purposes. Any committee other than the Board of Management may have non-Commissioners as members subject to the wishes of the Chairman of that committee. All committees, except *ad hoc* committees, meet at least once annually. All committees are serviced by the Secretary and, where appropriate, by the Finance Director.

The Secretary also provides full briefing and induction programmes for all new Commissioners and committee members when appointed. As part of this introduction Commissioners are provided with a Governance Book containing full details of the Commission's history, role, strategy, procedures and Commissioners' responsibilities, as well as the relevant Charity Commission guidance for trustees. During their tenure, further opportunities for Commissioners to develop their knowledge of areas relevant to the Commission's activities are provided as appropriate.

Day to day running of the Commission is delegated to the Secretary, assisted by a small staff team. Matters of strategy, and all grants greater than £5,000, are decided by Commissioners.

Full details of Commissioners and Committee members in post during the year, as well as the small staff team, are provided on pages 86 to 88. Details of the Commission's professional advisers are provided on page 89.

### Remuneration

Commissioners are not remunerated in their role as trustees of the charity and do not receive benefits other than reimbursement of expenses incurred in attending meetings.

In order to maximise funds available for grant making, Commissioners are determined to keep staff numbers and associated office costs to a minimum. To attract and retain experienced staff of the right calibre, however, Commissioners recognise the need to set salaries in line with those for other grant-making charities in the London area, based on sector benchmarks and other publicly available data.

Salaries for all staff, including key management personnel, are reviewed annually by the Chairman of the Board and the Chairman of the Finance Committee as part of the performance appraisal process. Pay awards are dependent on performance and set based on increases in the cost of living and average salary increases for the sector. There are no automatic increments and no bonus scheme.

Commissioners recognise the importance of helping employees make adequate provision for retirement. All employees are therefore eligible to receive a 15% employer pension contribution to the pension scheme established for auto-enrolment purposes or a personal pension of their choice. All employees also benefit from a Group Income Protection policy that will cover basic salary and pension contributions if they are unable to work due to long-term illness. At their absolute discretion, Commissioners may pay a nominated beneficiary a lump sum equivalent to 18 months' salary if an employee dies while employed by the Commission. All employees are also entitled to an interest free season ticket loan. All of the above benefits are available to all employees, including key management personnel. Employees do not receive any other benefits.

## Risk Policy

In discharging their responsibilities for the management of risk, it is the policy of the Commissioners to identify, analyse and seek to manage any risks to the ability of the Commission to carry out its role effectively and meet the obligations of its Royal Charter.

To this effect the Commissioners have given consideration to the major risks to which the Commission is, or may be, exposed. A full risk register has been drawn up, which is reviewed regularly. Insurance brokers have been appointed to advise on areas where risk can be effectively mitigated through insurance. Compliance risks are mitigated through taking and following appropriate professional advice.

The main remaining areas of strategic and operational risk and the steps taken to address them are summarised below.

### *Investments: security, performance, liquidity*

The Commission has a diversified portfolio, both in terms of investments held and managers appointed. It has adopted investment and disbursement policies designed to maintain the real value of the portfolio over time and hence the support available to current and future beneficiaries. Sufficient liquidity is held outside the portfolio to meet short term commitments. Commissioners have delegated review of investment performance to a Finance Committee comprising individuals with relevant expertise.

### *Grant-making: applications, assessment, administration*

Commissioners have appointed specialist committees to review fellowship applications, work closely with other organisations active in the STEM arena to avoid unnecessary duplication or administrative effort and have appointed a communications company to assist with marketing of the awards to ensure they are brought to the attention of eligible recipients. Commissioners regularly seek feedback from potential applicants and other stakeholders to ensure the awards remain relevant.

### *Legacy estate: character, experience, relevance*

Commissioners take an active interest in the estate, seek to facilitate relevant initiatives across legacy institutions and provide financial support where possible to ensure the estate remains a beacon of excellence and inspiration in the worlds of science, engineering and design.

## Commissioners and Committee Members

### President

HRH The Princess Royal

### Commissioners (and Board of Management)

The Rt Hon Professor Lord Kakkar KG KBE PC FMedSci  
*Chairman, Board of Management*

Professor Jim Al-Khalili CBE FRS FInstP  
The Rt Hon Lord Burnett of Maldon PC DL  
Professor Dame Ann Dowling OM DBE FREng FRS  
Professor Sir Andrew Hopper CBE FRS FREng FIET  
Professor Sadie Morgan OBE HonFRAIA HonFRIBA HonFICE FRSA  
Dame Alison Nimmo DBE MRTPI FRICS HonFRIBA FICE  
Ms Sandra Robertson  
Professor Dame Carol Robinson DBE FRS FRSC FMedSci  
Professor Dame Sarah Springman DBE FREng  
Professor Eleanor Stride OBE FREng HonFIET  
Professor Chris Wise RDI FREng FICE MStructE HonFRIBA FRSA

Professor Dame Sarah Springman was appointed to the Board on 4 March 2024

Professor Sadie Morgan was appointed to the Board on 29 August 2024

Professor Lord Mair retired from the Board on 9 July 2024

Mr Jim Eyre retired from the Board on 11 December 2024

### Ex Officio Commissioners

The Lord President of the Council  
The First Lord of the Treasury  
The Chancellor of the Exchequer  
The Secretary of State for Science, Innovation and Technology  
The Secretary of State for Energy Security and Net Zero  
The Secretary of State for the Environment, Food and Rural Affairs  
The President of the Institution of Civil Engineers  
The President of the Geological Society

### Finance Committee

Ms Sandra Robertson *Chairman*  
Ms Sarah Arkle  
The Rt Hon Lord Burnett of Maldon PC DL  
Professor Sir Andrew Hopper CBE FRS FREng FIET  
Dame Alison Nimmo DBE MRTPI FRICS HonFRIBA FICE  
Mr Thomas Seaman  
Mr Fabian Thehos CFA

## Science and Engineering Fellowships Committee

Professor Dame Carol Robinson DBE FRS FRSC FMedSci *Chairman*  
Professor Jim Al-Khalili CBE FRS FInstP  
Professor Mike Benton FRS FRSE  
Professor Martin Bridson FRS  
Professor Andrew Briggs  
Professor Neil Champness FRSC FLSW  
Professor Martin Dawson FRS FRSE FIEEE FOSA FInstP  
Professor Anne Dell CBE FRS FMedSci  
Professor John Dewey FRS  
Professor Marian Holness FRS  
Professor Patrick Keogh FREng  
Dr Sandra Knapp OBE FRS  
Professor Rachel O'Reilly FRS FRSC  
Professor Rachel Oliver OBE FREng  
Professor Neil Ranson  
Professor Ann Rosser FRCP  
Dr Dame Frances Saunders DBE CB FREng FInstP  
Professor Christopher Tout  
Professor Dominic Vella  
Professor Stuart West  
Professor John Wood CBE FREng

Professor Martin Dawson was appointed to the Committee on 18 November 2024  
Professor Marian Holness was appointed to the Committee on 16 October 2024  
Professor Rachel Oliver was appointed to the Committee on 28 October 2024  
Professor Neil Ranson was appointed to the Committee on 13 November 2024  
Professor Ann Rosser was appointed to the Committee on 6 November 2024  
Professor Dominic Vella was appointed to the Committee on 21 October 2024  
Professor Gillian Bates retired from the Committee on 31 May 2024  
Professor Cyril Hilsum retired from the Committee on 31 May 2024  
Professor Sheena Radford retired from the Committee on 31 May 2024

## Brunel Fellowships Sub-Committee

Professor Dame Carol Robinson DBE FRS FRSC FMedSci *Chairman*  
Professor Dame Anne Dowling OM DBE FREng FRS  
Professor William Powrie FREng FICE  
Professor John Wood CBE FREng

## Industry and Engineering Committee

Professor Dame Ann Dowling OM DBE FRS FREng *Chairman*  
Professor Cees de Bont  
Mr Mike Carr OBE FREng HonDTech CEng FIET  
Professor John Clarkson FREng  
Dr Nicholas de León  
Professor Andrew Lewis FREng FRSC FAPS FIMMM CChem CSI  
Professor Ron Pethig  
Dr Malcolm Skingle CBE DSc  
Professor Dame Sarah Springman DBE FREng  
Professor Adam Stokes  
Professor Eleanor Stride OBE FREng



Mr Mike Carr was appointed to the Committee on 29 November 2024  
Professor Lord Mair retired from the Committee on 9 July 2024

## Built Environment and Design Fellowships Committee

Professor Chris Wise RDI FREng FICE MStructE HonFRIBA FRSA *Chairman*  
Professor Rachel Cooper OBE  
Professor Sadie Morgan OBE HonFRAIA HonFRIBA HonFICE FRSA  
Ms Kat Scott  
Dr Andrea Siodmok EMPP FRSA HonDCL

Professor Sadie Morgan was appointed to the Committee on 11 December 2024  
Mr Jim Eyre retired from the Committee on 11 December 2024

## Sir Misha Black Awards Committee

Professor Malcolm Garrett MBE RDI FISTD *Chairman*  
Professor Chris Wise RDI FREng FICE MStructE HonFRIBA FRSA  
Professor Peter Childs  
Dr Nicholas de León  
Professor Geoff Kirk RDI FREng

Ms Mary Mullin retired from the Committee on 4 March 2024

## Staff

Mr John Lavery MVO  
Mr Amahl Smith ACA  
Mrs Helen Harris  
Mrs Angela Kenny RMARA  
Ms Kat O'Dea

Secretary  
Finance Director  
Fellowship Programme Manager  
Archivist and Alumni Relations  
Office Manager / Executive Assistant

## Professional Advisers

### Bankers

The Royal Bank of Scotland plc  
London Drummonds (B) Branch  
49 Charing Cross  
London SW1A 2DX

### Surveyors

Daniel Watney LLP  
165 Fleet Street  
London EC4A 2DW

### Auditor

Moore Kingston Smith LLP  
9 Appold Street  
London EC2A 2AP

### Actuaries

XPS Pensions  
Albion  
Fishponds Road  
Wokingham RG41 2QE

### Legal Advisers

Lee Bolton Monier-Williams LLP  
1 The Sanctuary  
London SW1P 3JT

### Insurance Brokers

Howden  
3rd Floor  
Quadrant House  
Croydon Road  
Caterham CR3 6TR

### Investment Consultant

Stanhope Consulting  
35 Portman Square  
London W1H 6LR

### Investment Managers

Baillie Gifford & Co Limited  
Calton Square  
1 Greenside Row  
Edinburgh EH1 3AN

BlackRock Asset Management Ireland Limited  
2 Ballsbridge Park  
Ballsbridge  
Dublin 4  
Republic of Ireland

JP Morgan Asset Management (UK) Ltd  
60 Victoria Embankment  
London EC4Y 0JP

Osmosis Investment Management  
36-38 Botolph Lane  
London EC3R 8DE

Schroder & Co. Limited  
1 London Wall Place  
London  
EC2Y 5AU

The Children's Investment Fund  
TCI Fund Services (Ireland) Limited  
Ella House  
39-43 Merrion Square  
Dublin 2  
Republic of Ireland

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<http://alumni.royalcommission1851.org>  
LinkedIn: <https://linkedin.com/company/royalcom1851>  
instagram: <https://instagram.com/royalcom1851>  
Bluesky: <https://bsky.app/profile/royalcom1851.bsky.social>

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# Accounts

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# Royal Commission for the Exhibition of 1851

Annual Report and Accounts

For the year ended 31 December 2023



## The Aims of the Royal Commission

The 1851 Royal Commission's governing document is its Supplemental Charter of 1851, which requires the Commission to *"increase the means of industrial education and extend the influence of science and art upon productive industry"*.

This was originally interpreted as a requirement to create a centre of intellectual excellence, which resulted in the acquisition of the South Kensington estate and its subsequent development with museums, academic establishments and a Central Hall of Arts and Sciences (the Royal Albert Hall).

Later, in 1890, the emphasis was switched to the support of individuals, starting with the award of Science Research Scholarships from 1891.

Today the Commission runs its own schemes for:

- Research Fellowships
- Industrial Fellowships
- Industrial Design Studentships
- Built Environment Fellowships
- Fellowships in Design

In partnership with others it supports:

- Enterprise Fellowships
- Technical Teaching Fellowships

It also supports worthy individuals and appropriate organisations by Special Awards.

The total number of individuals being supported in 2023 was 140

Registered Charity No. 206123

## Contents

|                                                 |       |
|-------------------------------------------------|-------|
| Chairman's Report                               | 1-2   |
| Secretary's Report                              | 3     |
| The Work of the 1851 Royal Commission           | 4     |
| Public Benefit                                  | 4     |
| Grant-making Policies                           | 5-6   |
| Achievements in 2023                            | 7-10  |
| Future Plans                                    | 11    |
| Awards Granted in 2023                          | 12-21 |
| Awards Completed in 2023                        | 22-40 |
| Alumni Awards, Honours and Achievements         | 41-43 |
| Report by the Chairman of the Finance Committee | 44-47 |
| Statement of Commissioners' Responsibilities    | 48    |
| Independent Auditor's Report                    | 49-51 |
| Statement of Financial Activities               | 52    |
| Balance Sheet                                   | 53    |
| Cash Flow Statement                             | 54    |
| Notes to the Financial Statements               | 55-73 |
| Administrative Information                      | 74-75 |
| Commissioners, Committee Members and Staff      | 76-78 |
| Professional Advisers                           | 79    |

## Chairman's Report

I think it would be fair to observe that 2023 has been a period of resurgence and growth for the Royal Commission and its activities. The largest group of new Fellows joined our research, design and innovation programmes and our public events and engagements attracted larger audiences and visitor numbers than for many years. The charity has continued to increase its commitment to supporting STEM education and educators as well as contributing to several impressive, community-based projects. Committing just under £5 million in funding to our charitable outputs has meant it has been a year of endeavour and achievement and has established a strong foundation for the ambitious strategy we wish to deliver in the future.

All of this activity relies on the enthusiasm and dedication of the many volunteers that offer their support to our programmes, whether that be through serving on our various committees or overseeing the governance and strategic direction of the organisation itself right through to being a Royal Commissioner. All our Commissioners are figures of distinction; experts drawn from the worlds of academia, science and engineering, technology and design, finance and public service. All are lauded within their own disciplines as leaders and forward thinkers and who, each year, help the charity to provide substantial support to our extraordinary award recipients. Adding to their efforts, I also have the pleasure of welcoming Lord Burnett of Maldon, who joins us as the latest Royal Commissioner.

In 2023 we awarded 10 Research Fellowships, 15 Industrial Fellowships and 14 Industrial Design Studentships representing our most significant investment in young and emerging research talent within the UK to date. In addition, we funded six new entrepreneurs through the enterprise programme run by our partners at the Royal Academy of Engineering as well as awarding the bi-annual Built Environment Fellowship. We also welcomed the fifth cohort of participants onto our Technical Teaching Fellowship initiative. Across all our long-term education and research programmes, there was a gender balance in successful applicants, an outcome not deliberately sought but wholly commendable that hopefully will be a trend continued into the future.

Our external public engagements this year included the annual Great Exhibition Road Festival. This draws all the cultural and educational institutions and organisations based in South Kensington together over a weekend in June to share a street-based extravaganza of science, history and art. Once again the 1851-der tent was at the heart of the activity, with 15 volunteers from our current programmes and small executive team inviting members of the public to partake in experiments and demonstrations associated with elements of their research projects. It also provided an opportunity to explain the Commission's function and history to some of the 55,000 visitors that came to enjoy the experience.

This July saw the Royal Commission host the eighth recording of *The Engineers* with the BBC World Service. This time the subject for discussion was lunar exploration. The BBC presenter and regular host, Kevin Fong, encouraged engineers leading the renewed space programme to discuss humanity's return to the moon and all that entails, including a powerful rocket and capable spacecraft, a space station in lunar orbit and a permanent moon-base. Howard Hu, the Programme Manager of NASA's Orion Programme, Sara Pastor, the Project Leader for the development of the International Habitat module at the European Space Agency and Libby Jackson, the Head of Space Exploration from the UK Space Agency spent almost two hours discussing and answering questions before an audience of almost 700 at the Royal Geographical Society and radio listeners in their millions on this most ambitious of endeavours.

As part of our ongoing strategy to reinforce both STEM education in schools, and greater public awareness of the career opportunities in the science and technology arena, the Commission gave grants to projects being run by the British Science Association and Primary Engineer providing much needed resources to primary schools. Funds were also awarded to the Humber Science Festival. These allow for wider regional engagement in the STEM environment and enable communities to discover and celebrate local science and engineering-based industries and organisations.

Closer to home, we also acknowledged the achievements of our own community at our Alumni Science Evening and Fellows' Reception. With a revised and expanded format, the annual gathering for past and existing fellows at the Royal Society took place at the end of April. The audience of over 140 enjoyed listening to presentations from Research Fellows Dr Xianxin Guo (Optical Artificial Intelligence) and Dr Adam Smith (Understanding quantum matter using quantum computers) and Industrial Fellows Joseph Lawton (Remote plasma sputtering of thin film materials) and Poppy Oldroyd (Thin-film electrodes for chronic neuromodulation). The evening closed with an address from the distinguished alumna Professor Helen Fielding, who spoke about her achievements after completing her fellowship and described her current work as the Thomas Graham Professor of Chemistry at UCL. There was further sharing of knowledge and achievement at the Fellows' Reception, held at the Royal Geographical Society in the summer. 10 individuals from across all five of the Royal Commission's permanent programmes shared their work with our President, Her Royal Highness The Princess Royal, and current 1851 Fellows and committee members.

There has also been an opportunity to focus on more local matters. My fellow Royal Commissioners and I remain very cognisant of our stewardship responsibilities for the Albertopolis estate. We continue to actively champion the Exhibition Road Cultural Group's SouthKenZen+ project through both direct leadership and ongoing financial support. Creating a benchmark carbon zero and sustainability model for similar urban cultural districts across the world is one of the most important collaborations that the Commission has undertaken in its recent history and is a key focus for us and our colleagues within the 1851 group and the wider South Kensington district.

Since the receipt of its supplementary charter some 172 years ago the 1851 Royal Commission has been committed to the vision of Prince Albert. This remains crucially aligned to the aspirations of modern Britain and our traditional ambition to be one of the world's most innovative and productive economies. Our forebears drew inspiration from the example and ideas of our original President to power their endeavours, and we do the same today. The Princess Royal's support for our activities, as well as her wider public example, remains a source of great pride and encouragement to the Board of Management and all those involved with the Royal Commission. We are deeply honoured by Her Royal Highness's continued commitment to our purpose and people.

The Rt Hon Professor Lord Kakkar KBE PC FMedSci



## Secretary's Report

I can only echo the Chairman's comments - one of the constant joys of working for the Royal Commission is the individuals that one is fortunate to interact with on a daily basis. The award recipients are exceptional young scientists, designers and engineers pursuing a personal passion with energy and enthusiasm. Their talents will undoubtedly lead to ground-breaking discoveries, sometimes relatively quickly but in other cases they take what appears to be a very small step forward in research terms and it is only later that their work is credited with creating the paradigm shift in knowledge or process to make a crucial discovery or introduce an innovative product. Whatever the circumstances I am constantly inspired by their focus, knowledge and optimism. Equally I consider myself fortunate to work with the hugely capable and generous volunteers who make up our committees and Board of Management – all give their time, knowledge and commitment to ensure that the charity's various outputs remain true to the original vision of Prince Albert and the task he placed upon the Commission whilst also being relevant to the society of today's demands and expectations. Whilst behind the scenes all is overseen, organised, recorded and administered by a very small but dedicated and highly professional team who support all (including me) in an exemplary manner.

The problems and challenges of today and tomorrow seem more complex with each passing day yet the generation of problem solvers and innovators that the Royal Commission supports seem undaunted and relish the prospect of making an impact in their chosen work environment. Equally laudable are the efforts of the various organisations that are granted special awards by the Royal Commission. Powered by people who want to make a genuine difference, the programmes we support are a positive influence across the STEM environment – whether it be in the classroom or the community. This report captures only a small snapshot of what is being achieved across the broad spectrum of “1851” activity and I hope that the reader will be as enthused by the individual or organisation undertaking the research or programme, as by their achievements.

John Lavery MVO

## The Work of the 1851 Royal Commission

The Commission's aim is to 'make a difference' by providing educational fellowships and studentships to the very best early career scientists, engineers and designers. Success is hard to measure within the confines of a single year but looked at over the longer term the Commission's achievement is evident, with 13 Nobel Prize winners and over 150 Fellows of the Royal Society among its previous award winners. The case studies of completing fellows and summaries of alumni achievements later in this report also bear witness to the Commission's success.

In addition to its core fellowship schemes, the Commission also provides special awards to its legacy institutions, to other organisations working to encourage STEM (science, technology, engineering and mathematics) education and to organisations that can help facilitate access to its incredible archives. Details of some of these awards and the impact they have made can also be found later in this report.

As well as the grants that it makes, the Commission itself organises a number of educational and networking events for the benefit of its award holders, alumni, legacy institutions and the general public, which together make a significant contribution to STEM education.

The Commission was originally established by Royal Charter in 1850 under the Presidency of Prince Albert, to organise and stage the Great Exhibition. Held in the spectacular Crystal Palace, constructed in Hyde Park, it was the first ever World Fair, and the most successful. With over six million visitors, it also made a substantial profit.

Consolidated by Supplemental Charter, and enjoined to invest the surplus from the Great Exhibition *strictly in accordance with the ends of the Exhibition...[to] increase the means of industrial education and extend the influence of science and art upon productive industry* the Commission purchased 87 acres of land in South Kensington and helped establish its three great museums, the Royal Albert Hall and renowned institutions of learning, including Imperial College and the Royal Colleges of Art and Music.

When this huge undertaking was complete, there remained sufficient funds for the Commission to initiate, in 1891, a programme of fellowships and studentships to support pure research in science and engineering, applied research in industry, industrial design and other projects.

The Commission continues its work to this day, both managing its freehold estate and awarding almost £5m a year in research fellowships, design studentships and other grants. The provision of long leases to the legacy colleges and the Royal Albert Hall also makes a very substantial contribution to scientific, engineering and artistic education.

## Public Benefit

The Commission ensures that its work is for the public benefit and takes full account of the published Charity Commission guidance. The Commission's events and awards programmes and support of the legacy institutions represent identifiable benefits and are available to all eligible members of the public. They satisfy the primary charitable purpose of the advancement of education.

## Grant-making Policies

The Commission primarily pursues its charitable purposes through the award of grants to individuals and organisations. The Commission awards grants under a number of defined programmes. Full details of the terms and conditions for each programme, including application forms and deadlines where appropriate, are provided on the Commission's website. A brief summary of the major programmes which the Commission supports is provided below:

### **Schemes administered by the Commission:**

#### *Post-doctoral Research Fellowships in Science or Engineering*

These are intended to give early career scientists or engineers of exceptional promise the opportunity to conduct a research project of their own instigation; an ultimate objective is to contribute to the knowledge base required for a healthy and innovative national culture. Around eight to ten awards are made each year, including one or more Brunel Fellowships for engineering projects addressing the primary infrastructure needs of modern society. The awards are for up to three years, subject to annual review and encompass an annual stipend and some support for travel and other expenses.

#### *Industrial Fellowships*

These are intended to encourage profitable innovation and creativity in British industry. Projects in any science or engineering discipline will be considered. A variable number of awards – usually around ten to fifteen – is available each year depending on the financial value of individual awards granted. An ERA Foundation Fellowship for the electro-technology sector is awarded as part of the scheme. Fellowships are awarded to selected exceptional graduates with the potential to make an outstanding contribution to industry, for a programme of research, supported by their employing / sponsoring company, leading to a patent, product or process improvement in conjunction with a higher academic award. Awards are for up to three years, subject to annual review, and include a contribution towards living costs, a travel allowance, an honorarium for the host university and in appropriate cases a contribution towards university fees or towards the cost of enhancing the research project.

#### *Industrial Design Studentships*

These are intended to stimulate industrial design capability among the country's most able science and engineering graduates. A variable number of awards – usually around ten to fifteen – are offered each year for outstanding engineers or scientists who wish to develop their capabilities in industrial design by taking a recognised master's course and who aspire to become leading designers in British industry. The award is for up to two years and includes a stipend, materials allowance, travel allowance and contribution towards tuition fees.

#### *Fellowships in Design and the Built Environment*

Awarded in alternate years, these Fellowships each provide a stipend for up to two years to enable those at a more advanced stage in their career to explore important current issues, selected by the Commission.

### **Schemes administered by other organisations:**

#### *Enterprise Fellowships*

Awarded through the Royal Academy of Engineering (RAEng), these fellowships are open to outstanding UK-resident engineering graduates seeking entrepreneurial success. A package of tailored mentoring, training and grant funding will enable recipients to pursue commercialisation of their technological ideas. Originally three fellowships a year were available, but this has now been increased to six.

### *Technical Teaching Fellowships*

Awarded through the Education and Training Foundation (ETF), these fellowships are open to outstanding UK-resident Further Education practitioners who are recognised for their high impact teaching practice. Fellows are expected to share their expertise and learning across the sector as part of the award with the aim of supporting quality improvement in technical teaching and learning. Fellows will receive an award of £5,000 – £15,000 to support knowledge transfer activity and to ensure remission time is guaranteed. They will also be allocated a programme mentor to support them for the duration of the Fellowship and will attend developmental workshops.

### **Special Awards:**

Although the educational programmes described above represent the lion's share of its grant giving, the Commission also responds to all those requests for funding that commend themselves through the Special Awards procedure. Here the aim is to assist worthy individuals, organisations or projects whose aims in the broadest sense align to the Commission's, and all applications are carefully scrutinised at an appropriate level according to the amount of support requested. Grants range from a few hundred pounds to over a hundred thousand pounds. While Commissioners retain considerable flexibility in principle, in practice a majority of special awards are made either to institutions on the Commission's legacy estate or for educational outreach work by like-minded organisations seeking to draw the attention of the young to the opportunities presented by science, engineering and design. A small number of grants are also made to facilitate access to the Commission's archives.

In addition to the above schemes, the Commission also administers, in conjunction with the Sir Misha Black Awards Committee, two awards in the field of design education, for which nominations are sought each year. Full details are available on the Commission's website but in brief these are:

#### *Sir Misha Black Medal for Distinguished Services to Design Education*

Global in reach, the Medal acknowledges the important contribution of individuals to the teaching of design at all levels, from anywhere in the world – as designers, as champions, as mentors and as educators.

#### *Sir Misha Black Awards for Innovation in Design Education*

Salutes educators from across the United Kingdom and celebrates the innovative achievements of institutions and individuals. Recipients may receive a bursary of £10,000 to advance their work in innovative design education.

Together the Sir Misha Black Medal and Awards recognise those who by innovation, vision and contribution to theory or practice have measurably improved the education of designers and enhanced the profile of design education.

## Achievements in 2023

The core activity – and primary achievement – of the Commission is identifying early career science and engineering graduates of exceptional promise and supporting their work with its prestigious fellowships and studentships. Full details of the awards made during the year are given on pages 12 to 21.

The true impact of the Commission's award holders will only emerge over time, but some evidence of the success of the various programmes can be gleaned from the achievements of those Fellows who completed their awards during the year and the positions they go on to secure. A representative sample of case studies is provided on pages 22 to 40.

Many completing Fellows comment on the importance of their Fellowship to their success:

*It was an honour to be an 1851 Fellow. Its prestige and flexibility were invaluable to me and I'm in debt to the Commission for giving me the chance to pursue my dreams and ambition.*

Dr Farid Shahandeh, Research Fellow 2019

*The biggest benefit, personally, from the Royal Commission funding was the career progression that it has afforded me. A primary reason for applying for the Industrial Fellowship was future proofing my skillset and gaining access to experts in the area which I wanted to develop into. At the start of the Fellowship, I was a junior scientist, working in the area of practical marine biology, but with a desire to progress into digital applications and the interface between computational modelling and marine biology. Over the past 4 years my role has diversified to include management of data and databases, strategic planning for data governance and architecture, not only for Fouling Control but for the wider Marine, Protective and Yacht business. I have been promoted several times, most recently in the last few weeks, to now be the Digital Portfolio Leader – a position that neither existed, nor was envisioned at the start of my research, but one which has been realised as a result of the work I have done over the last 4 years.*

Marie Dale, Industrial Fellow 2019

*For me, having the opportunity to develop as a scientist through self-guided research whilst also maintaining my industrial career progression and employment was the ideal scenario. Without the support of the Commission, I would most definitely have had to sacrifice one of these. Being able to maintain both aspects has been a privilege which I could not place high enough value on, and speaking with colleagues and peers, many of whom have obtained advanced degrees in traditional settings, only solidifies this stance.*

Jack Kay, Industrial Fellow 2020

For some it is clear that without the award from the Commission their project would not have gone ahead or would have been much more limited in scope:

*Without the Industrial Fellowship award, this DPhil project would likely not have gone ahead, for it allowed me to pursue developing a novel technique that would have otherwise been out of my industrial sponsor's original interests, but through doing so, has now become a keen focus of the company.*

Thomas Waddell, Industrial Fellow 2020

Academic and Industrial Supervisors are also very complimentary about the Commission's Fellowships:

*We are grateful to the Royal Commission for the Exhibition of 1851 for awarding this fellowship as although we had interest in the area, the fellowship provided us with the means to dedicate resource to its study in a depth, breadth and speed that would otherwise not have been feasible. The results obtained during the course of this project have certainly justified this approach to industrial research enabling the combination of detailed and focussed research in an industrial setting. Furthermore, the opportunity that the fellowship has provided to the Fellow in her development of skills, capability and expertise in this area will provide the company with a long-lasting legacy.*

*Although the commercial value of this project has yet to be realised the research that the Fellow has undertaken has developed the technology to such a point where both proof of concept and feasibility*

*has been realised; patent filings are being discussed and drafted, and routes to commercial utilisation are being explored. The further development and scaling of this technology towards commercialisation is a clear next step and will actively be pursued beyond the completion of this project.*

Richard Ramsden, Industrial Supervisor

*This is our second Industrial Fellowship, and we strongly advocate in favour of the scheme. We believe that the unique manner in which industrial benefit/experience is put at the forefront of the Fellowship benefits all parties.*

Dr Scott Baxter, Industrial Supervisor

*I have not used the Industrial Fellowship previously, however found the scheme easy to navigate and think that it fills an important niche within the industrial-academic landscape, allowing novel collaborations to be formed and enabling talented researchers within companies to complete a PhD and take a more academic approach to progress industrial research. I have enjoyed the experience and will (and have already) recommended this scheme to colleagues within the appropriate academic areas. I think it is an excellent opportunity for either new or continuing industrial-academic research collaborations to be fostered with a talented researcher at the heart. I have noticed how it has importantly progressed the Fellow's career by providing him the opportunity to study for a PhD while remaining in the industrial setting and he has also used this opportunity to develop other skills (such as teaching, writing, project management and leadership). These have contributed to him receiving Chartered Chemist status recently and this is a big achievement for him.*

Dr Kimberley Roper, Academic Supervisor

*The ripple effects of this fellowship extend beyond its immediate scope. Several of my doctoral students, inspired by the collaboration and the fellow's work, sought guidance from the company's employees on navigating the intricacies of spinning out a company. From conceptualization to fundraising, their inquiries found a receptive audience within the company's network. Without the foundation laid by this fellowship, such avenues for mentorship and counsel on commercialisation matters would have remained elusive.*

*In essence, the Industrial Fellowship has catalysed a symbiotic relationship characterised by mutual learning and advancement. It has not only enriched our collective understanding of pressing medical issues but has also empowered us to explore avenues for translating research into tangible societal impact. Through this journey, the bonds forged with the company have evolved into a nexus of collaboration, innovation, and mentorship. I would highly recommend this scheme to other academic colleagues, particularly if they have an interest in commercialisation and/or translation of research ideas.*

Professor Ana Namburete, Academic Supervisor

*I have enthusiastically recommended the Industrial Fellowship scheme to colleagues (at Plymouth and elsewhere) and I will continue to do so – it is an excellent scheme. It is well resourced and extremely well managed. The Fellowship has helped contribute to the University of Plymouth's reputation for industrial collaboration and visibility in the sector through conference presentations and articles in industry magazines and other sources; such enterprise activities are very well regarded at the institution at the highest levels.*

Professor Mathew Upton, Academic Supervisor

A more complete picture of the impact of the Commission's awards comes from the honours and awards bestowed on more senior alumni – some highlights are given on pages 41 – 43.

Many of our alumni tell us that their Fellowship has made a decisive – and lasting – difference to their career:

*I was at Imperial College reading geology for my BSc and PhD in volcanology (1968-74). I received an 1851 Fellowship in 1974 hosted at Lancaster University. I had previously been unsuccessful at applying for a NERC fellowship so at the time whether I could continue in academia was in doubt. Receiving the 1851 Fellowship was a pivotal moment in my life and career and enabled me to work with Lionel Wilson at Lancaster to develop the first ever numerical models of volcanic explosions and bubble*

*formation in exploding volcanic magmas. I will always be hugely grateful to the 1851 Commission.*

Professor Sir Steve Sparks, Research Fellow 1974

*Without a doubt, my 1851 scholarship set me up for a wonderful science life journey. I couldn't have dreamed of a better start to my career, and I am forever grateful.*

Professor Jennifer Martin, Overseas Scholar 1986

*In reply to your question on how the 1851 Fellowship influenced my career, I can state, once one sees excellence, one doesn't forget it. The fellowship put me in contact with excellent colleagues. With the fellowship, I was able to undertake a PhD in biochemistry at the University of Cambridge with Sir Tim Hunt, who was awarded the Nobel prize in 2001. I was surrounded by intelligent and imaginative faculty/students who answered questions from which we are still benefiting today. I eventually returned to Canada (2 decades later) but always look to Europe for collaborations and teach Canadian students to think globally.*

Professor Roy Golsteyn, Overseas Scholar 1987

*I firmly believe that none of my achievements would have happened without the transformational benefits brought about by my Industrial Fellowship. In addition to allowing me to complete my PhD, it propelled me on an accelerated journey to leadership within my previous employer, Luxfer Group. The experiences gained in those roles in the US and Europe are still being put to good use today and are now being applied to some exciting new challenges.*

Professor Michael Clinch, Industrial Fellow 1996

*I founded Full Matrix Ltd ([www.fullmatrix.co.uk](http://www.fullmatrix.co.uk)) in the midst of the pandemic and shortly after that won a feasibility study with UKAEA looking at how the technology I developed in my Industrial Fellowship could be used to monitor the condition of fusion powerplant supply pipes. This has now developed into a much larger programme of work which we pitched for and won in late 2023. As a result, Full Matrix has now expanded to 6 people. We are currently making a prototype device for fusion powerplant and looking at how we can diversify to other industries too. It's all very exciting and has been made possible by the work I did under the Industrial Fellowship. I'm still incredibly grateful for the opportunity which not only allowed me to carry out the underpinning research but also greatly built my confidence in interacting with and presenting to high level audiences.*

Dr Ruth Sanderson, Industrial Fellow 2009

As well as becoming distinguished in their own fields, many of our alumni go on to make interesting contributions in other areas. To take one recent example:

*A few years ago, an interest in the traditional methods of celestial navigation lead me and collaborators to examine Captain Frank Worsley's original logbooks from the 1914 Imperial Trans-Antarctic Expedition under the command of Sir Ernest Shackleton. Our initial goal was to understand what methods Worsley had used to navigate the 800 nautical miles from Elephant Island to South Georgia in the 22½ foot vessel the James Caird seeking rescue. Our conclusions were published in the Records of the Canterbury Museum (New Zealand) where the logbooks are now housed.*

*When it was announced that a search was to be made for the wreck of Shackleton's ship, Endurance, we returned to the logs and were able make a prediction of the position at which the wreck would likely be found. We circulated our conclusions and published them in the Journal of Navigation. The story was picked up by a several media outlets including the BBC and London Times. Ultimately Endurance was found very close to where we had predicted. The full story is told in my YouTube video <https://www.youtube.com/watch?v=y3sMS5p8Pgk>.*

*In April of 2023 collaborators Lars Bergman, David Mearns and I were awarded a Certificate of Achievement by the Royal Institute of Navigation "In recognition of their pioneering data analysis and modelling leading to the successful location of the Endurance wreck".*

Professor Robin Stuart, Overseas Scholar 1981

As well as its core fellowships and studentships, the Commission also runs a very successful Special Awards programme, supporting individuals and institutions with similar aims to the Commission. As in previous years, many of the awards reflect the Commission's continuing commitment to raising the awareness of the young to the opportunities presented by science and engineering. As well as the awards to the British Science Association, Primary Engineer and Humber Science Festival mentioned in the Chairman's Report, these included awards to Kids Invent Stuff to support their Inventors' Club, the Royal Botanic Gardens Kew to support their Grow Wild initiative and The Geological Society to support their Megalosaurus Month.

The impact of such Special Awards may take some time to become apparent, but a brief look at some of the awards made in the last couple of year gives a flavour of what can be achieved.

The Humber Science Festival supported this year attracted 5,665 people over four days, over half of whom were schoolchildren. Participants could access over 30 events, including a Discovery Zone with over 35 hands on activities. 85% of attendees said the festival had increased their interest in STEM – a promising start for a new initiative.

Meanwhile the Mini YouTube engineering musical created by Kids Invent Stuff in 2022 and featuring a toilet-cleaning robot designed by six-year-old Erin has received over 4,000 views, over 16,000 Instagram mentions and over 54,000 Twitter impressions, with associated educational resources sent to over 250 primary schools.

Another Special Award in 2022 enabled the Smallpeice Trust to pilot nine Engineering Experience courses for Year 8 and 9 pupils and two General Engineering courses for Year 10 pupils. 562 students, over half of them female, attended the three-day residential courses with over 94% of participants saying the course had increased their interest in studying engineering.

As the examples above illustrate, the Commission funds a wide range of innovative STEM initiatives at varying scales, recognising that not all will achieve huge success, but in the hope that most will transform individual lives, and some will go on to have considerable reach. Needless to say, not all Special Awards proceed completely smoothly. Nevertheless, anecdotal evidence suggests that it is interventions such as these that can make all the difference in stimulating young people to become the scientists and engineers of tomorrow and the Commission remains committed to doing what it can.

As well as funding STEM outreach projects, the Commission also provides Special Awards to enhance its legacy estate in South Kensington and help the world leading institutions of Albertopolis to extend their reach. As explained in the Chairman's Report, the main award this year has been to support SouthKenZen+ - a collaborative initiative to accelerate the transition to zero emissions and support nature positive programmes.

These awards, often for major capital projects, can take many years to complete but also have significant impact. One recent award, for example, has enabled the Royal Albert Hall to enhance the public realm including widening footpaths to improve accessibility, providing safe queueing and waiting areas and upgrading security installations. A new pedestrian crossing is also in progress. The revitalised north-west quadrant outside the Hall has been renamed 1851 Place in recognition of the impact of the Commission's grant.



## Future Plans

2026 will mark the 175th Anniversary of the Great Exhibition. In preparation, the Commission is starting to plan a number of initiatives and events, including a new history of the Commission, research into the impact of the Commission's educational programmes, a public exhibition and a public lecture series.

The Commission already provides funding, through its Special Award programme, for a number of STEM initiatives. Over the coming year, the Commission will also be exploring whether there is scope for it to do more directly in support of one or two key priority areas, such as improving STEM education in primary schools and widening provision of STEM apprenticeships.

The Commission recognises that its various award programmes are not as well-known as they might be and will also be looking to improve communication with its various stakeholders, including a revamped website, a new annual review document and new marketing materials.

## Awards Granted in 2023

### Research Fellows

#### **Dr Emma Banks**

*Subject:* Illuminating the mechanistic basis of virus-like gene transfer between bacteria

*John Innes Centre*

The genes that confer resistance to antibiotics can be passed between bacteria through various horizontal gene transfer mechanisms. One involves a group of poorly understood virus-like gene transfer agents (GTAs). This project will systematically characterise GTA biology, with a view to harnessing GTAs as tools to tackle antibiotic resistance.

#### **Dr Alison Cribb**

*Subject:* Ecosystem engineers, resilience, and climate change through Earth history

*University of Southampton*

Ecosystem engineers are a type of keystone taxa that alter their environments to maintain resource availability and ecosystem habitability. This project will use the fossil record to understand the long-term effect of the survival and extinction of marine ecosystem engineers through ancient climate catastrophes on resilience and recovery of ocean ecosystems.

#### **Dr Larissa Gomes Franca**

*Subject:* Stimuli-responsive liquid crystal host materials for energy upconversion systems

*University of Cambridge*

This project aims to design and exploit smart materials that can convert light from low energy to high energy (upconversion) in response to an external stimulus (e.g., an electric field). These materials, based on liquid crystal hosts and molecular dopants, will be explored for applications including optical communication and sensing.

#### **Dr Freya Johnson**

*Subject:* Antiferromagnetic materials for fast and energy-efficient computing

*University of Cambridge*

This project uses a novel approach, exploiting an unconventional magnetic material that could speed up computers and make them more energy-efficient, reducing their environmental impact. Preliminary data, along with the Fellow's previously published work, promises large-scale low-cost computing technologies, potentially a thousand times faster than current technology.

#### **Dr Dean Lomax**

*Subject:* Novel imaging elucidates hunting behaviours of giant 'sea dragons' *University of Bristol*

Exceptional new discoveries of giant ichthyosaurs ('sea dragons'), including a practically complete skeleton, will be subjected to cutting-edge imaging technologies. Combined with analyses of specimens collected ~200 years ago, the results will feed directly into our understanding of the presumed unique hunting behaviours of these apex marine predators.

#### **Dr Giulia Rubino**

*Subject:* Undoing quantum operations using integrated photonics technologies

*University of Bristol*

Recent years have seen a breakthrough in the commercialisation of early prototypes of quantum computers, yet much work remains to be done to make quantum computers fault-tolerant and versatile. This project will tackle this challenge by providing the first experimental prototypes of quantum circuits able to undo unknown quantum operations.

**Dr Lucas Sá**

*Subject:* Order and chaos in dissipative quantum matter

*University of Cambridge*

This project involves a theoretical investigation of microscopic quantum systems coupled to an external environment. A central question is how interactions in such systems induce a transition from order to chaos. The expectation is that this work will have technological impact in the fabrication of complex quantum structures and, ultimately, quantum computers.

**Dr Benito Wainwright**

*Subject:* How does evolution break functional barriers to fine-tune adaptation?

*University of St Andrews*

How does nature overcome trade-offs in design to fine-tune adaptations to their environment? This project will use leaf mimicry in katydids as a unique way of understanding (a) how modularity between traits might break functional constraints during adaptive evolution and (b) the general engineering principles by which evolutionary trade-offs are resolved.

**Dr Daniel Wilson**

*Subject:* Transition-metal main-group cooperativity: A strategy for catalytic transformations with ammonia

*University College London*

Amines are one of the most widely used building blocks in the chemical industry. This project will explore the catalytic addition of the N-H bond of ammonia across a carbon-carbon multiple bond (hydroamination) and the coupling of amines to aromatic hydrocarbons (dehydrocoupling) using cooperative catalysts.

## Brunel Fellow

**Dr Yabin Liu**

*Subject:* Tidal turbine cavitation and gust control with micro jets

*University of Edinburgh*

This project aims to address two critical issues of tidal turbines, cavitation and unsteady loadings, with a new-concept passive technology with micro jets. By breaking the tip speed ratio limit and by reducing the maximum torque on the drivetrain, it will enable more efficient and reliable turbines at larger scales.

## Industrial Fellows

**Sara Abreu**

*Subject:* Investigation of factors affecting the downstream purification process of lentiviral vector manufacturing

*Sponsor:* Autolus

*University College London*

The aim of this project is to determine the impact of factor-interaction between unit operations involved in lentiviral vector manufacturing to have a simple, scalable, and cost-effective downstream processing that prioritizes high recovery with high purity, exploring different approaches for viral vector purification.

**Mark Bell**

*Subject:* Short range interferometric synthetic aperture radar (InSAR) for environmental modelling

*Sponsor:* Leonardo UK

*University of St Andrews*

Subsidence and landslips on rail and road infrastructure cause disruption, economic impact and pose a risk to life. This project aims to develop a novel radar-based mapping technology for routine monitoring of embankments and cuttings. This will enable the early detection of changes, reducing the risk of disruption or damage.

**Gillian Cameron**

*Subject:* The role of digital interventions in supporting workplace mental health and wellbeing

*Sponsor:* Inspire

*Ulster University*

The prevalence of mental health disorders and levels of help-seeking vary amongst employees within different occupational groups and industry sectors. This research will investigate if a personalised digital intervention, employed using a blended approach, could provide tailored support to address the varying challenges faced by organisations and employees.

**Peter Doggart**

*Subject:* Artificial Intelligence enhanced electrocardiography in emergency departments

*Sponsor:* PulseAI

*Ulster University*

Computer electrocardiogram interpretation algorithms were first introduced in the late 1950s and have since become widespread in clinical practice. However, currently available interpretation algorithms are limited in their diagnostic accuracy and can result in inappropriate treatment. This project aims to use Artificial Intelligence to address the shortcomings of existing systems.

**Marina Economidou**

*Subject:* Investigations into the ligand- and oxidation state-dependent extraction of residual palladium from pharmaceutically relevant molecules

*Sponsor:* GSK

*University of Strathclyde*

This project aims to delineate the factors influencing the extraction of palladium from pharmaceutically relevant reaction solutions. With current methods of palladium removal lacking generality, the goal is to generate an extraction workflow applicable to all systems, which would reduce the time and costs related to the pharmaceutical industry.

**Claudine Greenwood**

*Subject:* Identification of covalent tools for essential parasite proteins implicated in tropical diseases

*Sponsor:* GSK

*University of Strathclyde*

Antimicrobial resistance to tropical disease therapies is a global health threat; the identification of novel methods of treatment is urgently required. This project aims to identify covalent tools for essential parasite proteins implicated in visceral leishmaniasis and malaria, providing a novel mechanism to inhibit parasite growth.

**Ishbel Jamieson**

*Subject:* The quantification of elastance in digital tomosynthesis images of lungs

*Sponsor:* Adaptix

*University College London*

This project aims to develop a tool for producing 3D elasticity maps of the lungs using digital tomosynthesis images. With regions of anomalous lung elasticity strongly linked to areas of clinical interest a sensitive, low-dose, and low-cost technique suitable for image-based assessment of lung functionality is greatly needed.

**Aleksy Kwiatkowski**

*Subject:* Closing the loop: A computational-experimental feedback approach for predicting macrocycle closure

*Sponsor:* MSD

*University of Oxford*

The synthesis of ring-shaped molecules (macrocycles), a valuable class of medicines, is notoriously difficult. This project combines computation and experimentation to understand the factors influencing successful ring formation and hence will identify accessible macrocyclic scaffolds. The outcome will be user-friendly tools for designing and synthesising potentially life-changing macrocyclic therapeutics.

**Paul McHard**

*Subject:* Autonomous robotic detection and correction of surface defects in manufacturing

*Sponsor:* HAL Robotics

*University of Glasgow*

This project will develop an AI-based solution, HAL.AutoCorrect, to autonomously detect, characterise, and correct surface defects in manufactured parts during production. This new, innovative software will enable greater manufacturing efficiency, reducing costs, energy consumption, material waste, and productivity loss by utilising computer vision, deep learning and adaptive robotic programming.

**Anna Miller**

*Subject:* Feed the world: harnessing nature's molecules for maximising future food productivity

*Sponsor:* Syngenta

*University of Oxford*

Inhibition of nitrification is a powerful strategy to improve the efficiency and environmental impact of fertilisers. This is especially important in response to rapidly increasing global populations and climate change. To develop a novel agrochemical that inhibits nitrification, synthesis of natural products and analogues thereof is a crucial strategy.

**Sarah Oatway**

*Subject:* Investigation of a novel sensory discrimination training device for the management of phantom limb pain

*Sponsor:* 2PD

*Teesside University*

Phantom limb pain (PLP), defined as pain experienced in a limb which has been amputated, affects 76-87% of amputees. Preliminary evidence suggests that therapist delivered sensory discrimination training (SDT) can reduce PLP. This project will investigate the efficacy of a novel, software led, self-management medical device delivering SDT for PLP.

**Samantha Ree**

*Subject:* Separation techniques for the recovery of radionuclides suitable for cancer therapy from extant nuclear materials

*Sponsor:* National Nuclear Laboratory

*University of Manchester*

This research aims to explore the isolation and recovery of rare alpha-emitting radionuclides from the UK's stock of nuclear legacy materials. Development is required to efficiently produce these radionuclides at high purity. This would allow the radionuclides to be incorporated into a radiopharmaceutical for the treatment of oncological diseases.

**Matthew Southern**

*Subject:* Delivering novel 3D-rich building blocks for drug discovery

*Sponsor:* Sygnature Discovery

*University of Oxford*

This project will deliver methods for the array synthesis of 3D-rich building blocks featuring sulfonamides, sulfonimidamides, and sulfondiimidamides, which are all motifs in demand in drug discovery. The project will combine technology development and chemical innovation and exploits the complementary expertise of Sygnature Discovery and the Willis group.

**Fabian Spoendlin**

*Subject:* Advancing computational methods for the functional characterisation of antibodies using structural and flexibility data

*Sponsor:* F. Hoffman-La Roche

*University of Oxford*

This project aims to advance methods for the in-silico engineering of antibody therapeutics. Employing the latest developments in machine learning, it will attempt to use data on antibody structures and flexibility to predict their properties. Developed methods will be implemented to accelerate the antibody development of the pharmaceutical company Roche.

**Rebecca Stevens**

**Subject:** High-throughput chemical synthesis and biological testing of proteolysis targeting chimeras

**Sponsor:** GSK

*University of Strathclyde*

Proteolysis targeting chimeras (PROTACs) are incredibly interesting molecules for drug discovery; however, their optimisation is slow. This project focuses on developing a high-throughput platform to synthesise and test hundreds of structurally diverse PROTACs simultaneously, offering the potential to thoroughly analyse structure-activity relationships of a thousand PROTACs in a single experiment.

**Kate Turley**

**Subject:** Environmentally affective circadian lighting and IoT solution for healthy ageing

**Sponsor:** Chroma Lighting

*Ulster University*

The focus of this project is on creating personalised indoor lighting informed by data-driven insights on daily activity, in order to align the circadian rhythm and body clock of individuals with dementia, alleviate their symptoms of depression, poor sleep/restlessness, and improve their wellbeing.

## Enterprise Fellows

**Gregory Hargraves**

**Company:** Paige

Paige is the world's first affordable, multiline braille display. A novel design drastically reduces the cost per braille character. This enables Paige to create ten lines, each with 20 characters of braille. People will be able to use Paige for reading, writing and maths. Audio has greatly improved access for the blind. However, braille is crucial for spelling, grammar, punctuation, maths and for learning languages which are not phonetic - such as English. Paige can be used alongside a phone, tablet, and laptop in combination with a screen reader which enables sighted peers and parents to collaborate with users.

**James Eaton**

**Company:** IONETIC [Financially supported by the ERA Foundation]

IONETIC offers niche vehicle-makers and automotive OEMs an efficient blend of customisation and cost reduction through ARC, their battery design platform. ARC is a hardware and software innovation that allows IONETIC to quickly design and prototype optimised battery packs. Design and manufacture parameters are shared across the platform, meaning IONETIC can reduce cost and accelerate time to market for customers. IONETIC's UK manufacturing facility will allow their clients to further secure their supply chain while ensuring compliance with Rules of Origin.

**Idan Gal-Shohet**

**Company:** Fibe

Fibe is revolutionising the waste industry by utilising cutting-edge harmful-chemical-free technology to extract cellulosic fibres from potato harvest waste. This waste, which amounts to 250m tonnes annually, is currently pulverised or incinerated due to being inedible and unsafe to compost (due to risk of blight contamination). Fibe purchases this otherwise valueless waste from UK farmers, providing them with additional income and reducing their operating costs, and applies a series of biological and mechanical steps to extract fibres from the plant which are compatible with conventional textile weaving machinery. This allows Fibe to produce a product that requires no land, 99% less water and saves 82% carbon emissions compared to cotton. Additionally, Fibe's fibres have unique properties making them suitable for conventional apparel, including softness, washability, dyeability and biodegradability. Current waste streams have the potential to meet 160% of global non-synthetic clothing demand.

**Beren Kayali**

*Company:* Deploy Tech

Deploy Tech manufactures the first-ever flat-packed, inflatable, concrete water storage units, to empower the rural sector to meet their water needs. Deploy comes on a standard pallet with a built-in concrete slab which is an unforeseen in the infrastructure industry. The Deploy tank is air deployed, and once it reaches the final shape, it's hydrated to harden the material. It is then ready to use in just 24 hours. Deploy combines the best properties of concrete and plastic in one smart solution. Deploy fits in a pick-up truck and is half the price of conventional concrete. It's more durable than plastic and the best option for maintenance convenience. This novel material, combined with a thorough structural analysis, has enabled a typical 150mm wall thickness to be replaced with just 6 mm. This represents massive reductions in the generation of CO<sub>2</sub> and water usage.

**Douglas Brion**

*Company:* Matta-AI

Matta's operating system uniquely utilises cutting-edge AI, low-cost sensors, and a new data labelling approach, to enable the reliable and autonomous detection, correction, and prevention of errors across a wide variety of products, materials, and manufacturing approaches such as 3D printing. Matta trains deep neural networks to learn the fundamental physics of manufacturing processes and thus create AIs that are invariant across setups and can even explain to users why an error has occurred and how to fix it. This differs from competitors who just memorise how to manufacture a single part, from a single material, on a single setup. Matta is therefore the first system that could be applied industrially, and excitingly it opens the door to manufacturing platforms that can observe and learn together how to make things better, potentially enabling incredible advances across diverse industries.

**Sanzhar Taizhan**

*Company:* TaiSan Motors [Financially supported by the ERA Foundation]

TaiSan Motors has developed a novel battery format called "hexagonal" which increases structural integrity and boosts volume availability by 20%. The batteries have low internal resistance to enable fast charging and higher thermal conductivity to be effective in cooling/heating. The design limits cell-to-cell thermal propagation, absorbing and distributing crash load. The concept eliminates module-level components and reduces overall weight. TaiSan has customised the electrode design using a strategic partner's materials to make sodium-ion cells and eliminate lithium, cobalt and nickel. TaiSan also uses lightweight and fire-retardant thermoplastics for the battery housing to substitute bolting/fastening steps with customised next-gen structural adhesives. TaiSan's team implemented a physics-informed neural network to enable electrochemical models to fit automotive requirements. This allows the chemical reactions inside every battery to be tracked when the car is running, enabling accurate life cycle and thermal runaway prediction.

## Built Environment Fellow

**Dr Xiang Xie**

**Subject:** Integrating Self-programming Artificial General Intelligence in UK Clean Air Zones Using Large Language Models

**Mentor:** Professor Mohamad Kassem, Newcastle University

In the UK, poor air pollution stands out as a significant threat to public health, responsible for an estimated 29,000 to 43,000 deaths annually among other harmful health effects. This challenge is underscored by the United Nations' Sustainable Development Goal 11.6 'Reducing the Environmental Impact of Cities'. The introduction of Clean Air Zones (CAZs) across many UK cities aims to improve air quality and public health by discouraging the use of polluting vehicles or other policy interventions. Evaluating the effectiveness of various policies relies on AI-driven insights derived from data acquired through distributed air quality monitoring stations. However, due to the unique characteristics of urban areas, such as the type and percentage of different emission sources, the intellectual and cognitive capabilities need to be integrated to support the customisation of the Artificial General Intelligence (AGI) solution and the self-programming. Taking advantage of the impressive capabilities of humanlike understanding and reasoning, two large language models will be trained, namely the reasoning agent and coding agent. Through a conversational interface, the reasoning agent combines the complicated human intent with accumulated knowledge encoded, translated into the Chain-of-Thoughts (CoTs). CoTs, as intermediate reasoning steps, are sequentially delivered to realise the intervention assessment. Finally, the coding agent transforms CoTs into executable codes tailored to the CAZ's circumstances. Without the roles of data scientists and programmers, this transition towards self-programming AGI puts stakeholders in the driving seat, improving the transparency and explainability of the AI solution to CAZ stakeholders and the trustworthiness of the solution.



## Sir Misha Black Medal for Distinguished Services to Design Education

**Professor Marie Redmond**

*Università Ca' Foscari Venezia*

Professor Marie Redmond was born in Ireland and graduated from Trinity College, Dublin in 1972. She worked in the software industry in the UK and then in the USA for twelve years. While in the US, she spent time working in Cupertino at Apple Computer as part of a team building a network gateway between Digital Equipment Corporation's platform and Apple's software platform. Here she discovered the contribution and impact creative people could make to the overall design process for software.

Concurrently she taught at MIT (Massachusetts Institute of Technology), working in The Writing Program in collaboration with the Media Lab and again witnessed the impact of cross disciplinary thinking and practice.

In 1990 Professor Redmond returned to Trinity College, Dublin and was asked to set up a research group in Multimedia Systems (now called Interactive Digital Media). The first researchers she engaged were designers, video producers, musicians, writers and software engineers. A spin-off company was set up in 1994, called X Communications, as a campus company, which, under Professor Redmond's direction, created interactive installations in national cultural institutes.

In 2013 Professor Redmond designed and created a new MPhil course in Trinity College in partnership with the Institute of Creative and Cultural Entrepreneurship in Goldsmiths, University of London. The course was accredited by both Trinity College and Goldsmiths.

In 2015, Professor Redmond was invited by Ca'Foscari in Venice to develop a Masters' programme in Digital Humanities followed by a second Master's programme in Digital and Public Humanities, where she taught Design Thinking, Critical Theory and Creative and Cultural Entrepreneurship.

Professor Redmond has been a consultant with the European Commission on digital media and related sectors. She has curated shows on robotic art and been a board member of theatre companies and film festivals and arts organisations.

## Sir Misha Black Award for Innovation in Design Education

**Haleh Moravej**

*Manchester Metropolitan University*

Haleh Moravej is best known for the creation and establishment of her globally recognised, award-winning, student-led MetMUnch programme. In 2011 MetMUnch, brought Nutritional Science out of the lecture theatre and to the public. Its central premise was to demonstrate how design-led techniques, combined with the keen creative minds of students and graduates, could make healthy foods more appealing and accessible, first to students and then to the wider public. Sustainability is the underpinning ethos for every aspect of MetMUnch, working with diverse professionals nationally and internationally to design sustainable food systems, from food production, distribution and creating consumer awareness. Consumers are empowered to develop healthy eating habits through informative, fun packaging and labelling. What might be considered 'food waste' such as coffee grounds are used by students to grow mushrooms and food is preserved through fermenting.

## Industrial Design Students

|                    |                               |                                                  |
|--------------------|-------------------------------|--------------------------------------------------|
| Mohamed Azman      | Innovation Design Engineering | Royal College of Art and Imperial College London |
| Chris Bellamy      | BioDesign                     | University of the Arts London                    |
| Grace Broom        | Global Innovation Design      | Royal College of Art and Imperial College London |
| Ruta Czaplinska    | Innovation Design Engineering | Royal College of Art and Imperial College London |
| Joseph Jones       | Global Innovation Design      | Royal College of Art and Imperial College London |
| Tarika Kumar       | Global Innovation Design      | Royal College of Art and Imperial College London |
| Lucie Legrandois   | Innovation Design Engineering | Royal College of Art and Imperial College London |
| Julita Napieralska | Product Design Engineering    | Brunel University                                |
| Ori Nevares        | Global Innovation Design      | Royal College of Art and Imperial College London |
| Peter Neyra        | Design Products               | Royal College of Art and Imperial College London |
| Holly Souza-Newman | Global Innovation Design      | Royal College of Art and Imperial College London |
| Julia Szewczyk     | Integrated Industrial Design  | Loughborough University                          |
| Sabrina Tian       | Global Innovation Design      | Royal College of Art and Imperial College London |
| Guy Turner         | Innovation Design Engineering | Royal College of Art and Imperial College London |

## Technical Teaching Fellowships

|                                           |                                                               |
|-------------------------------------------|---------------------------------------------------------------|
| Paul Gartside                             | South Central Institute of Technology / Milton Keynes College |
| Amy Hollier                               | Heart of Worcestershire College                               |
| Bradley Collier<br>& Kumaran Rajarathinam | Blackburn College                                             |
| Kevin Pollard                             | MKC Training / Mid Kent College                               |

## Special Awards Granted

### *STEM education and outreach*

British Science Association – Primary kit boxes  
Primary Engineer – Primary Engineer Curriculum  
Smallpeice Trust – Arkwright scholarships  
British School at Rome – Summer School placements  
Education and Training Foundation – Technical Teaching Fellowships  
Oxford University Development Trust – OXbOXes  
University of Hull – Humber Science Festival  
Kids Invent Stuff – Inventors' Club  
Royal Botanic Gardens Kew – Grow Wild  
All Party Parliamentary Engineering Group – Event sponsorship  
Foundation for Science and Technology – Debate sponsorship  
Geological Society – Megalosaurus Month  
MadeHereNow – Website support  
J Mallinson & E Townsend – STEM materials  
G Lamb – STEM outreach

### *Support for legacy estate*

Imperial College London – Great Exhibition Road Festivals 2025 & 2026  
Science Museum Group – Power Hall refurbishment  
Exhibition Road Cultural Group – SouthKenZEN+  
Royal Society of Sculptors – Florilegium

## Awards completed in 2023

### Research Fellows

#### **Dr Keith Andrews**

*Project:* Addressing diabetes: glucose recognition with a bespoke molecular glove

*University of Oxford*

Keith describes the Fellowship as an overwhelming success. Although the science didn't always turn out as expected, looking back, the project has yielded more than he hoped for. The "molecular glove" that he set out to make (which he refers to as an organic cage) looks very different to the initial design. This is because he soon discovered that the field of supramolecular cages (i.e., the state of the art for synthesising large, robust, soluble cage-shaped molecules) was not as advanced as the literature suggested. This led him to design new chemistry protocols to access the molecules he required. This went spectacularly, and he published his new procedure in January 2023. Remarkably, this new type of cage has ground-breaking properties, and has led to three high-profile academic collaborations. The cage shows strong host-guest recognition (i.e., it is an excellent "glove" to detect molecules) and one collaboration is incorporating these cages into electronic sensors. Whilst studying the potential for this cage to recognise glucose, Keith discovered two surprising and high impact functions. First, the cage performs chemical catalysis just like an enzyme. This data, which will be published soon with the title "Enzyme-like acyl transfer catalysis in a bifunctional organic cage", is the first clear example of this sort of catalysis in synthetic enzyme mimics and has yielded a strong proposal for the other key goal of the Fellowship: to selectively modify glucose. Because glucose is complex and hard to modify, new reactions will enhance access to sugar polymers for biomedical research (such molecules are used in cell-signalling and for identifying bacteria). The second remarkable discovery was that, if polymers of glucose are threaded into the cage, it is possible to selectively break them down into glucose monomers. This has yielded further proposals to apply the cages as industrial catalysts for the conversion of waste biomass into glucose, which could be fermented to access biofuel. This Fellowship has therefore furthered the state of the art in supramolecular organic cage synthesis and initiated a new sub-field of supramolecular covalent organocatalysis.

Keith is now Assistant Professor of Organic Chemistry at Durham University where he hopes to translate the promising findings from his Fellowship into tools for studying enzymes and for biosustainable synthesis challenges.

#### **Dr Xianxin Guo**

*Project:* End to end optical training of neural networks

*University of Oxford*

In his Fellowship proposal for end-to-end optical training of neural networks, Xianxin set forth some rather ambitious objectives. At the end of his Fellowship, Xianxin is delighted to report that he has successfully accomplished all of these goals, and the results have surpassed his initial expectations.

Over the past three years, Xianxin carried out a series of experiments as outlined in the proposal. Working closely with his fellow group members, he built a large-scale programmable optical matrix multiplier, which can serve as the core of advanced optical processors. Subsequently he constructed a large-scale optical neural network based on that optical multiplier. Finally, he built an all-optical neural network and achieved the world's first end-to-end optical training of neural networks. Remarkably, all the crucial operations were executed optically following the innovative optical training method detailed in the Fellowship proposal.

The impact of this Fellowship project extends far beyond groundbreaking research. Xianxin founded a spin-out, Lumai Ltd. (originally known as OxONN Ltd.) to commercialise the optical computing technology. Lumai has secured venture capital investment to develop advanced optical processors for high performance computing.

Xianxin is now Head of Research at Lumai, and his goal is to deliver optical computing to power the next generation of machine learning.

### **Dr Thomas Macdonald**

*Project:* Exploring nanostructured light absorbers: from optoelectronics to innovative photovoltaics *Imperial College London / Queen Mary University of London*

In the first year of his Fellowship, Tom developed a robust platform to investigate emerging nanomaterials, particularly phosphorene nanoribbons, in the field of optoelectronics. Simultaneously, he mentored students in synthesizing and analysing alternative nanomaterials like nanocrystals, studying their interactions within solar cells.

In the second year, Tom successfully established a framework to understand the crucial roles played by phosphorene nanoribbons in optoelectronics. He also participated in projects focused on comprehending interfaces in third-generation solar cells. By the end of the second year, he had gained insights into defects at perovskite solar cell interfaces, employing advanced microscopy at the Henry Royce Institute.

During the third year, Tom published his findings on phosphorene nanoribbons in respected journals such as the Journal of the American Chemical Society and Joule. Overall, Tom's Fellowship yielded 40 papers in top-tier journals including Advanced Materials, Angewandte Chemie International Edition, and Nature Communications. Tom secured seven grants totalling over £1 million, along with a prestigious Royal Society University Research Fellowship, leading roles as a Senior Lecturer in Materials Science at Queen Mary University of London and subsequently Associate Professor at UCL, specializing in nanomaterials in renewable energy conversion.

### **Dr Farid Shahandeh**

*Project:* Constructing a unified resource-theoretic framework to characterise quantum computation processes *Swansea University / Royal Holloway, University of London*

This ambitious project aimed to establish a toolbox for identifying the physical resources required by quantum computers. During his Fellowship, Farid demonstrated that contextuality, a phenomenon arising from the limitation of classical physics in modelling data, is a geometric property of many theories, including quantum mechanics. Moreover, he showed that when suitably adapted to computational schemes, quantum contextuality is an essential resource for any meaningful advantage. Shortly after, colleagues from Poland and Canada developed a linear program to characterise the contextuality of data. Although this program alone cannot characterise resources in quantum computations, when combined with Farid's earlier findings, it paves the way to achieve the project's overarching goal in the near future. Consequently, Farid's project laid the foundations for understanding why quantum computers outperform classical computers in solving specific problems.

The Fellowship played a crucial role in fostering collaborations, leading to spin-off projects, such as partnerships with colleagues in Singapore, Spain, and Germany. It enabled Farid to effectively disseminate his results to the community and facilitated his organising the inaugural workshop Foundations of Quantum Computing (FQC2023) at RHUL, UK, on September 5-6, 2023. FQC2023 brought together experts and practitioners at the intersection of quantum computing and quantum foundations to exchange ideas, share insights, and cultivate collaborations on the fundamental aspects of quantum computing.

The Fellowship also facilitated support for Farid's PhD student, Mrs Zeynab Zolghadr. During her visit to the UK, she and Farid discovered that approximating quantum tomography, the most informative method for studying quantum systems, is impossible.

During the Fellowship, Farid secured a tenure-track lecturer position at Royal Holloway, University of London, ensuring the continuity of his research on this project.

### **Dr Benno Simmons**

*Project:* How invasive species transform a critical ecosystem function

*University of Exeter*

Benno is an ecologist and biodiversity conservationist. His Fellowship focused on understanding and mitigating the threat invasive species pose to pollination, a critical ecosystem service that supports crops and wild plant species globally. Previously, methodological limitations had prevented the effects of invasive species on pollination being detected. Benno therefore aimed to deploy novel, more sensitive, techniques to understand the current and future threat invasive species pose. He discovered a number of important results during his fellowship, with perhaps the most notable resulting in a joint-first author publication in PNAS. In this paper, they showed that very small amounts of field data could be scaled up to make big picture conclusions about the health of entire ecological communities subject to species invasions. This finding has significant implications for monitoring biodiversity, as it allows ecosystems to be monitored much more efficiently, with only tiny amounts of data required.

During his Fellowship, Benno was offered a permanent Lectureship in Ecological Data Science at the University of Exeter, which he started in October 2023. He is now a PI with a research group (simmons-lab.com), focused on using data science, AI and technology to help understand and reverse biodiversity loss. Notable projects running at the moment include using AI to identify species in camera trap images, working towards fully automated biodiversity monitoring.

### **Dr Adam Smith**

*Project:* Understanding strongly-correlated matter using quantum computers

*University of Nottingham*

The 1851 Research Fellowship allowed Adam to pursue research into the applications of quantum computers for studying the physics of strongly correlated materials. Quantum computers perform computations in a radically new way that makes them more naturally suited to certain types of problems. One such problem is the simulations of quantum mechanics, a famously complex field of physics, which currently available computers struggle with. During his Fellowship Adam introduced new algorithms for quantum computers for simulating dynamics of quantum systems. This is important for understanding experimental measurements of material properties and will ultimately guide the synthesis of new materials with desired properties.

After his first year, Adam was appointed Assistant Professor at the University of Nottingham and the remainder of his 1851 Fellowship was converted into a start-up grant. This allowed Adam to start his own research group by hiring a postdoctoral researcher, who has since been joined by a second postdoc and a PhD student. In 2023 Adam was awarded an ERC Starting Grant, with which he will extend the work started during his Fellowship and which will allow him to expand his research group further.

### **Dr Patrick Stowell**

*Project:* Cosmic ray neutron detectors for smart agriculture / civil engineering monitors

*Durham University / University of Sheffield*

The 1851 Fellowship allowed Patrick to drive forward his research into cosmic ray sensing, a technique that allows non-invasive soil moisture sensing over typical field scales. Patrick has shown that new boron sensors can be used to build cosmic ray sensors over twenty times cheaper than existing systems, making them viable for irrigation monitoring on farms. The Fellowship gave him the flexibility to set up partnerships between farms in the UK and abroad to test and optimise these systems. Partnering with Sao Paulo state's Lanapre Precision agriculture facility he developed hardware that allows cosmic ray sensors to be added to internet of things smart farm networks. Combined with COSMICSWAMP, a precision irrigation platform he developed, these sensors can be used to automatically perform studies of crop water stress and optimise irrigation in arid regions completely autonomously. COSMICSWAMP is now being tested at two pilot farm sites in South America with additional deployments expected in the coming year.

During the last few months of his Fellowship Patrick was offered a permanent lecturer position at the University of Sheffield, where he now works in both neutrino particle physics and applied neutron physics. He has taken over as the manager of the University of Sheffield neutron irradiation labs. Over the next few years, Patrick will be working to establish several dedicated neutron and gamma

test stands in these labs with a focus on soil characterisation and monitoring using radiological techniques in partnership with colleagues at Leeds University smart farm and Rothamsted Research.

## Brunel Fellow

**Dr Roy Bartle**

*Project:* Thermal desalination with renewable hydrogen energy

*University of the Highlands and Islands – Lews Castle College*

Roy's Fellowship has investigated the production of fresh potable water from seawater, mainly by thermal desalination, which uses heat to remove the salt content by evaporating out the water. His research suggests that the future of potable water production is in reverse osmosis (RO) desalination, which is a mechanical method of separating the water from the salt, rather than in thermal desalination systems, mainly because of the much superior economic case of RO systems. The exception is where a ready supply of low-grade waste heat is available from, for example, power stations or industrial manufacturing facilities, which give a heat supply for thermal desalination at minimal economic cost. These findings are currently being written-up for journal publication in 2024.

Following the Fellowship, Roy is maintaining an affiliation with the University of the Highlands and Islands for further energy engineering research as well as working to introduce renewable energy systems for irrigation and crop drying on his arable farm in Zambia. However, Roy's research interests are moving towards theology, including theology of the built environment, so his primary academic affiliation going forwards will be with Mukhanyo Theological College in South Africa, where he will be lecturing in ecclesiology and church history.

## Industrial Fellows

**Daniya Aynetdinova**

*Project:* Cationic cyclisation cascades mediated by carbon electrophiles for the formation of novel polycyclic products

*Sponsor:* Vertex Pharmaceuticals (Europe)

*University of Oxford*

During her Fellowship, Daniya successfully completed her aim to develop a robust polyene cyclisation methodology with the results published in the well-respected scientific journal: Chem. Eur. J. 2023, 29, e2022037 (doi: doi.org/10.1002/chem.202203732).

This project has paved the way for a new research direction in the field of polyene cyclisation. In an industrial setting at Vertex Pharmaceuticals, the successful completion of this project has introduced a novel methodology for the efficient stereoselective construction of complex 3D molecules, applicable to the synthesis of steroid analogues. To demonstrate this, a formal synthesis of rac-18-nor-estradiol has been achieved.

A further objective, which was to develop a diastereoselective cascade heterocyclisation methodology, has also been achieved, demonstrating the robustness of the carbocation-triggered cyclisation approach. Financial support from the Commission was critical in allowing Daniya to explore challenging enantioselective approaches to achieve carbo- and heterocyclisations.

Following her Fellowship, Daniya will be working at the University of Vienna as a postdoctoral researcher in the field of organic chemistry.

**Maral Bayaraa**

*Project:* Satellite-enabled early warning system for geotechnical structures

*Sponsor:* Satellite Applications Catapult

*University of Oxford*

Maral's Fellowship research combined InSAR monitoring, geotechnical modelling, and deep learning to create tailings dam failure early warning systems. The Fellowship has produced valuable research outcomes (including two high quality journal publications), has provided a real-world context and demonstrators for academic work in the field, and promises to deliver a commercially viable early warning solution.

Maral's project received the Prototypes for Humanity award at COP28 in Dubai, within the category of Data Science and AI. This generated considerable media exposure, including on BBC radio 4 and in videos from the ceremony with the Princess of Dubai. Maral was also awarded a Keeley senior scholarships prize from Wadham College, University of Oxford.

Maral has been able to engage with high level policymakers on the importance of her research, including engagement with the Deputy Prime Minister of Mongolia Mr. Amarsaikhan. Her research also led to a TV interview on Mongolian National Broadcasting MNB World and various podcasts.

Maral's research has already helped the Satellite Applications Catapult secure commercial mining projects. Her machine learning/AI expertise is opening up new opportunities, such as the development of an AI prototype within the Catapult's accelerator space commercialisation engine and the delivery of new sustainable finance interventions.

Maral remains with the Catapult, where she has been promoted to be a senior earth observation consultant.

**Sam Bourne**

*Project:* Characterising genetic variants associated with pain to improve the clinical translation of novel therapies

*Sponsor:* LifeArc

*University of Kent*

Pain is a serious unmet medical need globally, and a major barrier to addressing this is poor clinical translation. Indeed, other than reformulations of existing drugs, no novel disease-modifying pharmacological therapies have been approved over the past few decades. With pharmaceutical industries increasingly considering the disease area as high risk, innovative approaches are required to improve clinical success by selecting better prospective therapies and their appropriate patient population.

Sam's Fellowship undertook a large-scale approach to improve the clinical translation of novel pain therapies. This was done by examining human genetic biobanks that collectively comprise over 750,000 genomes to validate in-house pre-clinical analgesic drug targets and stratify complex patient populations. Over 135,000 mutations occurring in the general population were examined within 15 two-pore domain potassium channel (K2P) genes, which represent novel pain drug targets. Each of these was assessed for its ability to statistically influence an individual's susceptibility to 136 pain-related traits. In total, 18 mutations were discovered that significantly modulate a patient's likelihood of developing pain such as migraine, seeking clinical analgesic treatment or chronically using pain medications. Several mutations were shown for the first time to significantly alter the gene activity of ion-channels which prevent pain sensing signals from reaching the sensory cortices.

These efforts have provided novel translational validation of K2Ps as drug targets in large-scale patient populations for the first time, while pointing towards appropriately stratified patient populations for which specific drugs may be of most effect. This genetic approach has supported LifeArc's efforts by de-risking their pre-clinical development for K2Ps and by adding weight to growing consensus in the literature for developing novel K2P analgesics. This work has improved LifeArc's external reputation within industrial and academic fields, and particularly strengthened academic collaborations that will continue to be utilised in future projects.

Following the Fellowship, Sam will continue to take a leadership role as a drug discovery scientist at LifeArc. In particular, he will be applying the skills and knowledge he has gained to tackle new disease areas such as motor neuron disease.



### **Daniella Cheang**

*Project:* Can we keep borrowing from future generations? A green, biomimetic method for controlling chirality

*Sponsor:* AstraZeneca

*University of Oxford*

Forming carbon-carbon bonds is one of the most fundamental processes in organic chemistry and forms the basis of making materials for the pharmaceutical industry. Most biological molecules can exist in either a right-handed or left-handed form – a property known as chirality. These two forms are related by reflection in a mirror plane and are known as enantiomers. Nature has an innate ability to control chirality, and this can be seen in many natural materials. Chirality can have significant implication for drug candidates – one form may have therapeutic value, whereas the other may have reduced or even detrimental effects. Therefore, finding new ways to control chirality and form a molecule of single handedness are of high importance to the pharmaceutical industry. Daniella's project used hydrogen borrowing to mimic Nature's sophisticated enzymatic process. Hydrogen borrowing uses feedstock alcohols to elongate carbon chains in one step. During her Fellowship, Daniella developed different hydrogen borrowing methods for synthesising molecules of a single handedness, each with a different focus. In the first method,  $\beta$ -branched acyclic ketones were synthesised allowing formation of sterically hindered carbon-carbon bonds with high enantioselectivity. The second method focused on the synthesis of  $\gamma$ -branched cyclic ketones using a dynamic kinetic resolution strategy. Pharmaceutically relevant heteroatoms, such as nitrogen, were then incorporated to allow synthesis of enantioenriched gamma-aminobutyric acids from starting materials derived from simple racemic amino acids. These methods could be adapted to large scale setup and furthermore purification of the products by crystallisation was possible.

Following the Fellowship, Daniella will be taking up a research scientist position at Boehringer Ingelheim.

### **Marie Dale**

*Project:* Automated identification and predicted translocation of marine hull invasive species

*Sponsor:* AkzoNobel

*Durham University*

Shipping accounts for over 80% of global trade. In addition to transferring goods between ports, shipping can also result in the transfer of non-indigenous species. Biofouling is one of the main vectors for the spread of non-indigenous species, some of which may become invasive.

Invasive species are a major threat to the world's oceans as they cause biodiversity loss and damage to coastal industry and infrastructure. Up to 69% of known aquatic invasive species are introduced through transportation of biofouling; something which is only expected to worsen with the combination of increased trade and global climate change.

The global fleet is large, and resources are scarce – it is important these resources are deployed where invasive risk is greatest, to have the most impact. In her Fellowship research Marie has developed models to predict global species distribution and translocation potential through biofouling transportation on ship hulls, identifying viable translocation pathways both now and in the future (accounting for climate change). These viable pathways can help identify high-risk vessels which may require further scrutiny e.g. by in-water inspection. To make in-water inspections practicable and cost effective at the scale required, the second part of Marie's research has focussed on developing a route to automated image recognition of non-indigenous species.

Following on from the Fellowship, Marie will continue her research and explore opportunities to commercialise the output within AkzoNobel. This supports AkzoNobel's ambition to develop solutions to minimise the impact of invasive species, to support the wider shipping community and ultimately support the goal to reduce the environmental impact of shipping.

### **Jack Kay**

*Project:* Discovery of novel antimicrobial peptides to combat current and emerging superbugs

*Sponsor:* Ingenza

*University of Plymouth*

Jack's Fellowship focused on the identification of a significant number of potent, natural and engineered, antimicrobial candidates, which have promising application in the treatment of antimicrobial-resistant infections in both humans and animals. The discovery of these molecules represents a significant advancement in the field of bacteriocins research, with the number of known 4-helix bundle bacteriocins increasing by more than an order of magnitude, from fewer than 12 to over 200, directly from work carried out in the Fellowship.

Through this Fellowship, Jack has created a pipeline of lead molecules originating from a variety of microbial sources, which are diverse in amino acid sequence, and potency, with the full range of target specificity still to be tested. Promising candidate molecules will be exploited via partnership with Amprologix, which is a spin-out from the University of Plymouth leading the commercialisation of 4-helix bundle bacteriocins. Amprologix has already supported the leading 4-helix bundle bacteriocin Epidermicin through pre-clinical toxicology studies and is seeking further funding to advance to the lead compound Epidermicin NI01 for topical therapy of skin infection, and it is expected further funding will be obtained with the data generated during the Fellowship.

The Fellowship has also enabled Ingenza to keep up with current advancements in the field of biotechnology and become active contributors at the exciting interface with machine learning. Throughout the project, machine learning methodologies were applied in efforts to understand the complex relationship between amino acid sequence and observed activity of the 4-helix bundle bacteriocins. In doing so, the company has dramatically increased its in silico capabilities, as demonstrated by the development of a proprietary codon optimisation algorithm, a service it now offers as part of customer projects.

After completion of the Fellowship, Jack will continue working at Ingenza as a senior scientist in the Molecular Biology Department, further characterising the lead molecules identified and driving the development of Ingenza's in silico capabilities.

### **Joe Lawton**

*Project:* Remote plasma sputtering of high quality thermochromic thin films for energy conservation

*Sponsor:* Plasma Quest

*University of Surrey*

Joe's EngD project focussed on the investigation of Plasma Quest Limited's proprietary remote plasma sputtering technology in the production of important functional oxide thin film materials. Functional oxide thin films and coatings are key materials across many technological industries with demanding film structure and property requirements and the understanding of process parameter selection to produce the desired material is paramount to realising new products or devices.

The project investigated the process-structure-properties relationship of remote plasma sputtering processes and routes towards low-temperature deposition for two key functional oxide materials: thermochromic VO<sub>2</sub> and TiO<sub>2</sub>. The research was unfortunately unsuccessful in producing a low-temperature route to thermochromic VO<sub>2</sub>. However the project identified key process parameters for controlling the growth and properties of TiO<sub>2</sub> thin films. The study also expanded the process knowledge for the use of substrate biasing technology in conjunction with remote plasma sputtering as a means for low-temperature deposition of crystalline material onto a variety of different materials.

The work feeds into the wider knowledge of the unique processing landscape of the remote plasma sputtering technology at Plasma Quest Limited. The research helps to inform decisions with the development of new technological capabilities and processes for other materials of interest.

Joe is currently finishing writing up his thesis and applying for new jobs in London.

**Bojidar Rangelov**

*Project:* Discovering CT imaging biomarkers of exacerbations of COPD

*Sponsor:* GSK

*University College London*

During his Fellowship, Bojidar worked on developing machine learning and image analysis techniques applied to Chronic Obstructive Pulmonary Disease, and occasionally to other diseases. He advanced knowledge of the phenotypes and disease progression of COPD, identified imaging biomarker candidates of exacerbations of COPD and developed a comprehensive, machine learning powered suite of CT analysis algorithms, which can be used to extract and analyse these imaging biomarkers of COPD. The results of his research can contribute to the design of pharmaceutical trials by inspiring the study of lung anatomy which might have previously been overlooked. Furthermore, the disease progression techniques have been gaining traction in the field and are considered for patient stratification. Finally, the image analysis suite can be used to analyse further CT datasets and quantify imaging biomarkers in both stable COPD and during exacerbations of the disease, in addition to being applicable to other respiratory diseases.

While GSK does not intend to directly profit from the intellectual property of Bojidar's work, having access to the results of his research is expected to improve inefficiencies in data logistics and access, empower future image analysis studies and aid in patient stratification for clinical trials. Furthermore, the techniques Bojidar has developed should save costs on contracts with image analysis companies (which GSK has used in the past) by providing baseline results and endpoints which can be extracted in-house.

Following the Fellowship, Bojidar intends to continue developing in the machine vision and medical image analysis field by pursuing jobs in companies which focus on machine vision in the medical field. A great motivator is still the increased translation of engineering and AI to medicine and its impact on patient care. To this end, Bojidar is hopeful that in the future he will establish or find a role which would allow him to both spearhead research, collaborate with medical institutions, and translate technology into clinical practice.

**Andrei-Claudiu Roibu**

*Project:* Mapping brain network activity from structural connectivity using deep learning

*Sponsor:* F. Hoffman-LaRoche

*University of Oxford*

Andrei's Fellowship has helped him make significant advancements in the field of neuroimaging and brain age prediction, which further our understanding of factors which are linked to accelerated brain ageing (which could result in, or be precursors to neurodegenerative diseases), as well as those factors which are associated with resilience to ageing. His work has resulted in the creation of a set of predictive models using innovative AI methods, including convolutional and vision transformer networks, enhancing our capabilities to analyse brain aging with a high level of precision.

Andrei's work has also expanded the field of brain age prediction across 57 different MRI imaging modalities, with each modality capturing a different aspect of the ageing brain. These include aspects such as the brain's structure, connectivity, functional activity, microstructure, element deposition, etc. This research has also expanded the toolset available for analysing and understanding brain age predictions, allowing for a more detailed understanding of how it correlates with different lifestyle and environmental factors.

By identifying deviations from normal brain aging patterns, which could be linked to disease progression, his findings contribute substantially to early diagnostic processes, targeted therapeutic strategies, and clinical trials at Roche. While the project is in its nascent stages regarding commercialisation, it holds substantial potential for future applications in drug development and clinical trials.

Moreover, the Fellowship has strengthened the collaborative ties between Roche Pharma and Oxford University, enhancing Roche's research capabilities and expanding their academic network. This relationship has proven invaluable, fostering an exchange of ideas and methodologies that benefit both academic and industrial research spheres. The insights gained, and the methodologies developed during this Fellowship not only propel Roche Pharma's position in neuroscience research but also underscore the potential for significant future impacts on healthcare and treatment paradigms.

Following the Fellowship, Andrei is moving to a position with Synthara AG in Switzerland.

### **Thomas Waddell**

**Project:** Causal modelling of obesity and multi-organ dysfunction through magnetic resonance imaging; applying Bayesian networks

**Sponsor:** Perspectum

*University of Oxford*

Tom's DPhil project focused on the application of Bayesian networks in healthcare, specifically in Type 2 diabetes and long covid. The project has resulted in three journal publications (with an additional paper currently under review) and several conference publications. The work has greatly contributed to building Perspectum's multi-organ imaging offering and evidence base in the space of metabolic disease and COVID-19. The project has allowed Perspectum to showcase the true utility of multi-organ imaging, showing how (for example) the individual facets of body composition affect the development of non-alcoholic steatohepatitis, a severe form of liver disease which Perspectum's flagship product explores. Tom's work has been presented at multiple international conferences, allowing Perspectum to build their brand awareness and collaborate with several key opinion leaders to assist with industry positioning of Perspectum technology. Furthermore, Tom's Bayesian-network models have been used by Perspectum to illustrate the importance of stepping away from 'black box' AI approaches in healthcare.

Following the Fellowship, Tom will be continuing his employment at Perspectum within the BD Pharma department, in a role that combines his scientific knowledge and the dissemination/communications skills that were greatly improved through the Fellowship.

### **Declan Williams**

**Project:** Flow versus batch chemistry in the safe manufacture of explosives

**Sponsor:** QinetiQ

*University of Birmingham*

Declan's project focused on the use of microreactors for the manufacture of explosives and in particular whether less hazardous approaches can be used in place of current batch processes. As part of this research project the manufacture of conventional explosives (RDX and HMX) and energetic plasticisers (K10 and GlyN), have all been investigated in flow, significantly improving safety and reproducibility. The travel bursary provided as part of the Fellowship also enabled Declan to establish valuable networks within the flow chemistry community.

Declan's research has helped QinetiQ to further its expertise, but also given a large scope to innovate. By leveraging the outputs of this research project and expertise gained, QinetiQ now present a new offering to customers.

On completion of the project, Declan will return to being employed by QinetiQ full time and will continue to conduct research into the use of flow chemistry and microreactor technology in the exploration of novel explosives. He hopes to continue collaborating with Birmingham University, and other organisations within academia and the defence industry, to further develop approaches to the manufacture of explosives in flow, developing innovative, sustainable, and safe methods that are suitable for the large-scale manufacture of explosives.

Declan has recently been awarded the Frank Carver Bursary by the International Pyrotechnics Society.

## **Industrial Design Students**

### **Erin Carr**

**Course:** Earthquake Engineering and Infrastructure Resilience

*University of Bristol*

Completing a masters is the only way for civil engineers in the UK to become chartered. Without the support of the Royal Commission, Erin says, it simply would not have been possible for her to further her studies in this way. The opportunity to study this specialised masters at the University of Bristol has further solidified Erin's ambitions and career path in disaster relief while giving her real hands-on experience during the earthquake in Turkey. This opportunity provided her with the skills, knowledge and hands on experience to successfully join the Institution of Structural Engineers Emergency Engineering Field Investigation Team (EEFIT), who create teams of structural engineers to carry out emergency structural assessment and engineering in time of disasters.

Erin's masters thesis, *Parametric Finite Element Analysis of Concrete Beams Reinforced in Shear with Fibre Reinforced Polymers: Informing the National Annex to the new Eurocode for Design of Concrete Structures (EN1992)*, essentially looked at verifying experimental data of fibre reinforced concrete beams to inform the British National Annex of the Eurocodes, which is the set of building codes and standards civil engineers have to follow in order to build safe structures. This was the first time fibre reinforced concrete has been included into the codes signifying the research's importance, and it is hoped that the material's inclusion in the codes creates more confidence in construction in the UK for the future

Erin says: "I will forever be thankful for the opportunity and support the Royal Commission has given me to further my academic and professional ambitions which wouldn't have been possible otherwise. I thoroughly enjoyed this experience and am immensely proud to have been a part of the Royal Commission."

Erin is now working for Momentum Consulting Engineers in Bath and also continuing her nursing training.

### **Jahan Daya**

Course: Global Innovation Design

*Royal College of Art / Imperial College London*

With a background in Mechanical Engineering, Jahan joined the Global Innovation Design course seeking to combine technical and creative practices in a multidisciplinary and multicultural environment.

The course aims to immerse its students in changing cultural contexts and enabled Jahan to travel to Tokyo and New York where he focussed on honing his hands-on prototyping skills and learned a bit of Japanese. During the New York exchange at Pratt Institute, he worked on an experimental project to create biodegradable sunglasses frames from processed seafood waste (Chitosan). This project aimed to address the ever-increasing plastic waste issue in our oceans, generated from the production, sale, and loss of cheap sunglasses.

Upon returning to London, Jahan's final year solo project explored the problems surrounding shoulder injuries in swimming and water polo athletes and the complications arising when returning to their training. His project sought to give confidence and customised training benchmarks so that each athlete can monitor their rehabilitation and training progress while minimising the risk of re-injury. The outcome resulted in the development of a mobile app and wearable device fitted on both hands that tracks the athlete's motion to analyse their technique variations and muscular fatigue levels. By identifying the rate and volume of fatigue incidents, the system can estimate acute and chronic shoulder strain and subsequently evaluate how their training affects their rehabilitation and their risk of re-injury. Athletes can use this data to make informed decisions to tailor their training so they may safely and quickly return to sport.

Following the Studentship, Jahan has secured a six-month internship at Gurin Energy, a renewable energy developer based in Singapore. The company focuses on the development, ownership, and operation of wind, solar, and storage solutions in Asia.

### **Grace Duan**

Course: Innovation Design Engineering

*Royal College of Art / Imperial College London*

During her Studentship Grace explored the interdisciplinary intersection between design and technology, diversifying her skillset with various projects, including developing the *Leafeon System*, a circular system that has the potential to simultaneously bridge the nutrition gap and create more sustainable, organic agriculture by upcycling legume waste and surpluses into Leaf Protein Concentrate, a promising and innovative food source that is the cheapest, most abundant source of protein.

For the final major group project Grace looked at the growing problem of microplastics in our oceans and waterways. Current methods for detecting microplastics in water bodies are resource-intensive, requiring a great deal of expertise, expensive equipment, labour and time. *MicroSentry* is a low-cost and field-deployable in-situ sensor that can be attached to existing infrastructures such as data buoys, research vessels, and piers. It is designed to be used for continuous data collection,

providing real-time representative data that is relevant to scientific research and contamination monitoring for water companies. The sensor not only detects microplastics but also transmits the data to a data visualisation platform providing readable data for the public. This allows for easy access and understanding of the microplastic pollution levels in our water bodies. *MicroSentry* went on to be exhibited nationally and internationally, as well as making it to the finals of the Mayor's Entrepreneurship Competition 2023.

Following on from her studies, Grace is now an Associate Partner Manager at Amazon in London, working on the future of home devices.

### **Daniel Hale**

*Course:* Innovation Design Engineering

*Royal College of Art / Imperial College London*

In his first year, Daniel explored the future of distributed creation, geometric craft and circular manufacturing.

Daniel's second year group project, *Pleural*, aimed to create an autonomous device designed to help people with respiratory conditions combat mucus. Unlike anything else available, the innovative handheld device offers comprehensive guided chest physiotherapy to be carried out autonomously by patients at home. *Pleural* reached the finals of Imperial College's Venture Catalyst Challenge and the Mayor's Entrepreneur Competition and received a James Dyson Award and the Helen Hamlyn Award for Creativity.

For his solo project Daniel knew he wanted to work on something related to the environment and utilise principles of regenerative systems design. After becoming interested in the whales that drive the ocean nutrient cycle, he started looking into nutrient cycles at a domestic level and specifically addressing the mess that is the way we manage our biodegradable waste from the home. The final output from the project is a new kitchen sink appliance that processes all biodegradable waste into usable biogas and nutrient fertiliser for regrowth.

Daniel is now a Mechanical Design Engineer with Shellworks, a design-led company that creates compostable packaging solutions made from naturally-derived materials.

### **Eden Harrison**

*Course:* Innovation Design Engineering

*Royal College of Art / Imperial College London*

During his Industrial Design Studentship, Eden studied Innovation Design Engineering, transitioning from his prior work as a mechanical/structural engineer into the worlds of design and innovation. While in the first year of IDE, Eden worked on diverse projects, from vision-tracking and machine learning for gaze-prediction, to the computational modelling of flocking behaviour for sculpture. Eden's solo project during this year focused on the ability of phase-change materials to alleviate thermal stress in humanitarian camps.

During his second year, Eden worked with Liz Lee, Ori Blich and Juan Ignacio Rion to develop a novel biomaterial replacement for polystyrene that went on to place as a finalist in — amongst others — WE Innovate, the Mayor's Entrepreneur competition, and the Green Alley Award. It has also exhibited at major design festivals, from London to Dubai. This project has since flourished into a startup, Carbon Cell, winning a place on two competitive accelerator programmes and is currently based in Somerset House.

Eden's master's thesis, developed during the final six months of his second year, involved a novel post-humanist design approach to addressing underwater sound pollution. The result, *reef dB*, was a national runner up for the James Dyson Award, as well as winning the Innovation Design Engineering 'Outstanding Achievement Award'.

Since graduating Eden continues to work as CTO and co-founder for Carbon Cell, pushing the project towards a commercially successful future that can have a serious positive impact on our world.

**Samuel Jones**

Course: Design Products

*Royal College of Art*

During his Studentship, Sam evolved his design practice through impactful projects that have explored topics such as minimising furniture waste, exploring innovative alternatives to cars, and repairing electronic appliances. These have been great test beds for learning, alongside being formed around some of the world's most currently pressing topics.

In addition to the core course, Sam made sure to actively engage in additional projects such as OPPO X RCA and Design for Good, while also attending numerous training courses, talks, on-site visits, and exhibitions. What stood out most to him was the opportunity to consistently engage with some of the best people in industry and education. He has made contacts that he would never have been able to reach otherwise, with whom he looks forward to staying connected for many more years to come.

Sam's graduation project was a focused exploration of how we can apply the convenience of cars to the micromobility realm. Even though it was intended as a platform for learning, it gathered great interest, showing potential for real impact. It has now become a valuable asset, poised for further development and ultimately, market realisation.

Following his Studentship, Sam has set up his own consultancy, Jam Scones Design.

**Steph Jump**

Course: Innovation Design Engineering

*Royal College of Art / Imperial College London*

During her master's programme, Steph researched how spatial skills are vital for succeeding in STEM but are not taught in schools. These skills forecast future mathematics success, foretell which students will choose STEM careers, and even predict who will drive STEM innovation.

On average, girls have less spatial experience than boys, making them three times more likely than boys to struggle with this ability. Low-income students also lag significantly behind their wealthy peers. Steph's research suggests that spatial training can even out girls' abilities with boys', increase women's engineering retention by up to 30%, and improve students' STEM grades regardless of gender or income.

During her Studentship, Steph developed spatial skills training games. She received a scholarship from the Pokémon Company, was a finalist in the London Mayor's Entrepreneurial Prize and a competitor in Imperial's WE Innovate Programme.

Following her Studentship, Steph has become the founder and CEO of Alytica ([www.Alytica.studio](http://www.Alytica.studio)), a start-up driving equity in STEM education through spatial skill training games.

**Vedika Lall**

Course: Global Innovation Design

*Royal College of Art / Imperial College London*

Vedika's major project during her Studentship focused on uterine contraction monitoring. The experience of contractions preceding labour is truly unique, as each woman encounters them in her own distinct way. However, this crucial indicator of the mother's health is often overlooked and poorly communicated. Shockingly, over 40% of women struggle to discern whether they are in labour or not.

Uterine contraction monitoring is important because it is a critical biomarker of maternal health and a reliable indicator of labour progression to delivery. At present, uterine contractions are monitored using apps or manually, which is unreliable and frequently leads to women miscalculating.

*Bia* is an at-home uterine contraction monitoring system designed to seamlessly integrate into a mother's rest routine. Codesigned with recent mothers and clinicians from St. Mary's Hospital, London, *Bia* is intended to be comfortable and flexible; it incorporates a digital interface and novel sensing technology to listen, recognise and measure contraction activity reliably.

*Bia* is currently patent pending, and Vedika hopes to bring together a team to bring it to market. In the meantime, she is acting as a Design Mentor at the Srishti Manipal Institute of Art, Design and Technology.

### **Jasper Mallinson**

*Course:* Innovation Design Engineering

*Royal College of Art / Imperial College London*

Jasper came from a background in design engineering, with personal roots in ‘nuts and bolts making’ – working at a younger age in roles across metal fabrication and carpentry. In the years before joining the Innovation Design Engineering programme, he worked in the world of tech start-ups, developing drones for humanitarian landmine clearance and microfluidic blood testing devices.

During his Studentship, Jasper focused on regenerative design and digital fabrication, including using eco-acoustics to tackle agricultural soil degradation and modelling the natural shrinkage of fresh wood for use as a computational design tool.

His major project, *Mecha-morphis*, explores the concept of ‘augmented makers’ – the reimagining of digital fabrication technologies (technologies that control tools through computers) to augment, rather than replace, human making abilities, developing a wearable robotic device that gives humans the capabilities of digital fabrication machines.

Jasper is now a Product Design Engineer at AcoustoFab, which focuses on mid-air ultrasound manipulation.

### **Hunaid Nagaria**

*Course:* Innovation Design Engineering

*Royal College of Art / Imperial College London*

Hunaid entered the Innovation Design Engineering programme at Imperial and the RCA, wanting to build a practice around his interests in Industrial and Interaction Design. Receiving the Commission’s support made it possible for him to explore themes in accessibility and how to build technology for people living with varying abilities and circumstances.

During the programme, Hunaid’s solo pursuits focused on building technology that facilitated recreation, such as musical instruments for people living with dementia and a gaming controller for people living with Muscular Weakness, which turns anything you touch into a control interface. A key piece of work that lies outside these themes was the development of *Guerrilla*, a patent-pending device that tackles polluted road runoff as part of a group project. Hunaid’s work in the IDE programme culminated in a distinction and recognition from institutions such as the Mayor of London’s office and the Interaction Design Association.

Since graduating, Hunaid and his co-founders have transitioned *Guerrilla* from an academic project to an award-winning startup approaching real-world trials.

Following this, Hunaid has joined the design team at Nothing(R), a leading consumer electronics manufacturer. As a Creative Technologist, Hunaid will work with the team on research and development for new products and helping to realise an alternative, more ‘fun’ future for consumer electronics.

### **Fintan Pritchard**

*Course:* Integrated Industrial Design

*Loughborough University*

Fintan’s course and continued education have allowed him to make substantial progress with various advanced skills and software within design. Surface modelling in solidworks and Rhino alongside high-fidelity prototyping with CNC manufacture have equipped him to design and test complex and modern products with precision. Additionally, he pursued a good understanding of AI theory and product development, being one of only a few to successfully program a focused AI in TinyML, a new skill which is increasingly relevant and sought after.

Beyond these technical accomplishments, he enjoyed collaborating with designers with vastly different backgrounds and training, helping him develop his management and collaborative abilities. His business management project simulated a startup with the activity involving every aspect of running a business, from concept development and seeking investment to product distribution and everyday operation.

Following the course, Fintan has secured a role designing and marketing luxury audio equipment for EAR Yoshino, a high-end audio tech company.



### **Mia Shepherd**

*Course:* Product Design

*University of Strathclyde*

During her Studentship, Mia successfully navigated a variety of taught modules alongside an industrial group project and an individual endeavour, the latter of which was inspired by a personal passion for fibre arts (knitting, crochet, embroidery etc). Informed by her awareness of individuals within the crafting community who exclusively employ one hand for crocheting, she observed that remarkably, none of these crafters were utilising a commercially available assistive device. Furthermore, user-made solutions provided for their own specific needs, often lacking the versatility required to address all scenarios in which someone might exclusively use one hand. This could include relying on the arm's weight or clamping capability where only the hand dexterity is compromised compared to a complete upper limb amputation. Thus, Mia discerned a critical gap to design an inclusive assistive device for single handed crocheting.

In collaboration with a stakeholder, Mia developed a novel solution providing for a spectrum of crafters ranging from those devoid of manual dexterity in one hand to those with a single amputation extending from the shoulder. Mia's solution goes beyond the current market by providing on-the-go use and independence, removing the need for reliance on additional surfaces for mounting or stability.

Following the Studentship, Mia has accepted a position at the University of Strathclyde as a doctoral candidate under the title of Designing Cycling Health. She intends to blend her experiences in Sports Engineering and Product Design to craft insightful contributions aimed at engaging more people in Glasgow with sustainable infrastructure.

### **Annie Tang**

*Course:* Global Innovation Design

*Royal College of Art / Imperial College London*

During her Studentship, Annie embarked on a global journey from London to New York and Tokyo, delving into the intricacies of design on a worldwide scale.

One notable project involved developing a medical device tailored for individuals with Chronic Fatigue Syndrome (CFS) to better manage their symptoms. This endeavour led Annie to investigate ways to adapt 12-lead electrocardiograms (ECGs) for continuous commercial application, facilitating the collection of high-quality heart rate (HR) and heart rate variability (HRV) data for both patients and researchers. A novel solution emerged in the form of electrode 'tattoos'.

Another significant undertaking was a co-design initiative with residents of a social housing complex. Here, the focus was on addressing the challenges faced by older residents in navigating an increasingly digitized world. Annie's collaborative efforts resulted in the creation of a print logbook complemented by online resources, offering a bridge to essential services.

Lastly, Annie explored methods to enhance the relationship dynamics within familial care pairs dealing with chronic conditions, aiming to boost morale and overall quality of life. Through interactive activities featuring guided questions and prompts, she sought to foster understanding, joy, and moments of respite for these caregiving pairs.

Following the Studentship, Annie plans to continue to apply these insights and methodologies to tackle real-world challenges in the field of design, striving to make meaningful contributions to global communities.

## Eve Townsend

*Course:* Innovation Design Engineering

*Royal College of Art / Imperial College London*

Eve joined the Innovation Design Engineering program at Imperial College London and the Royal College of Art, focusing on combining technical innovation with human-centred design. With a background in physics, much of her work draws on the application of scientific knowledge to advance technologies that promise societal and environmental impact. Bridging industry and academia, she hopes to accelerate the transition of early-stage research into usable products, while designing new technologies, systems, and user experiences.

During her masters, Eve's research specialised in advanced human-computer interactions, developing *Loqui*: a wearable assistive device for people with Parkinson's disease. The device translated speech parameters into tactile biofeedback mitigating challenges associated with altered speech perception, volume and rate, thus enhancing users' quality of life by enabling autonomous engagement in real-life conversations.

In the environmental sciences, Eve worked on two main projects: *Biofonic* and *Xellyfish*. *Biofonic* is an eco-acoustic monitoring device that detects key soil health indicators and enabled agricultural researchers to quantify the impact of ecosystem-focused farming, accelerating progress towards Net Zero. *Xellyfish* is a bio-designed device that captured microplastics from water sources, earning finalist positions in the Terra Carta Design Lab, Mayors Entrepreneur Awards, and presentation at COP26.

This studentship has significantly helped Eve to further advance her career in research, design and engineering. Eve has now joined Riverlane, a company specialising in quantum error correction (QEC), where her focus on software decoding advances the pathway towards fault-tolerant quantum computing by turning unreliable physical qubits into reliable logical qubits.

## Enterprise Fellows

### Rowan Armstrong

*Company:* Bioliberty

Bioliberty is a robotics start-up that aims to empower every human, particularly those affected by stroke, to live a longer independent life through assistive and rehabilitative robotics.

In their recent report, 'Stroke rehabilitation in adults', the National Institute for Health and Care Excellence (NICE) suggested stroke survivors should get at least three hours a day, five days a week of rehabilitation. This will put considerable pressure on an already stretched NHS, so robotic solutions like theirs, which can be used without carer supervision, could be an extremely timely, cost-saving resource.

*Lifeglov* employs cutting-edge soft robotics technology for precise force generation and control, ensuring a tailored approach to rehabilitation. The device features adjustable force levels, allowing for personalised hand rehabilitation that promotes optimal recovery. When coupled with Bioliberty's virtual therapy environment, *Lifeglov* becomes a versatile tool for stroke survivors at every stage of their rehab journey.

Acting as both a passive and active device, it can either facilitate movement independently or provide assistance to complete specific motions. In its passive mode, *Lifeglov* does all the work to help mobilise movement, while in the active mode, it collaborates with the user to help them complete movements. Bioliberty's soft robotics can detect subtle movements, and, through trained AI algorithms, translate these intentions into actions.

In April 2023, Bioliberty secured £2.3m in funding from a consortium of investors, including Archangels, the business angel investment syndicate. This new funding will go towards developing the machine learning and data collection elements of the product. This is extremely important for therapists and other clinicians as it can help them monitor the progress of their patients as well as tailor their treatment.

Bioliberty has further exciting developments on the horizon, including the upcoming launch of *Lifeglov* in the US market.

In the meantime, they are conducting clinical investigations in collaboration with a leading rehabilitation hospital in the US. These research efforts aim to substantiate the effectiveness of Bioliberty's technology in aiding individuals to achieve a more optimal level of function post-stroke.

### **Joseph Bentley**

*Company:* ACT Medical

ACT Medical is a MedTech start-up looking to revolutionise the standard of care for penetrative trauma and reduce the mortality rates associated with violent crime.

In London, it takes 7 minutes for an ambulance to arrive, but only 5 minutes for a victim to bleed to death. Consequently, half of all violent trauma related deaths occur before the patient is able to reach definitive care. Providing first responders with a method of applying direct pressure to the wound site would drastically reduce the trauma mortality rate. This method needs to be intuitive, without knowledge of complex techniques such as wound packing, and easy to remove once the patient reaches surgery. ACT Medical are designing a device that directly addresses this need and aims to stem bleeding as quickly as current methods.

In July 2023, Joseph was awarded Entrepreneur of the Year and ACT Medical received the Innovation and Technology Award at the Generation Next Awards.

### **Fergal Mackie**

*Company:* Metacarpal

While foot and leg prosthetics have been incredibly successful at restoring the functional and psychological needs of amputees, the same cannot be said for hand devices. The NHS estimate 26-45% of upper-limb amputees wear no prosthetic at all! And some estimates are even higher. This problem is worsened when you consider that for those missing only one hand, this typically leads to overreliance on the sound side that can rapidly develop into arthritis or similar problems.

Centrally, the problem here is that these health problems are actually less of a sacrifice than current upper-limb prosthetics. No matter what, if any, device someone chooses - they must make a huge compromise to either their well-being, their function or their self-perception. Metacarpal is looking to make a product which does not compromise across any of these aspects.

Metacarpal aim to design a functional device, with accessible pricing, that's comfortable to wear all day long and looks so good that it makes the wearer feel good. They hope to achieve this with better materials and more advanced engineering than competitors.

In January 2023 Fergal was awarded a Young Innovators Award by Innovate UK and Metacarpal secured a Scottish Enterprise SMART grant to fund research and development.

## Built Environment Fellow

### **Dr Tijana Blanus**

*Subject:* Putting the 'Green' into Green Infrastructure

*Mentor:* Dr Ross Cameron

This project compared the performance of mixed hedge species with that of single species monocultures and examined their ecological benefits.

Hedges were chosen as the study focus due to their simplicity, space-saving nature, and cost-effectiveness, offering promising solutions to local environmental issues and the replacement of conventional urban barriers. The project's objectives included establishing and conducting outdoor growing experiments, as well as applied research in an urban school. This explored the opportunities associated with using hedges as a tool for environmental education, engaging the school pupils in novel research aiming to address challenges in planting implementation on school grounds.

Results revealed that mixed hedges, especially during autumn and winter, provided structural benefits for water retention. Moreover, the educational interventions positively influenced students' perceptions and appreciation of plants' environmental benefits, particularly in mitigating pollution and climate extremes.

Project outcomes will be showcased at the RHS Chelsea Flower Show in May 2024. Insights are already being incorporated into future planning of green interventions to support inclusion of planting into school grounds and its use as an educational resource, within the RHS's Campaign for School Gardening and the National Education Nature Park project. Looking further ahead, experiments will evaluate long-term hedge performance.

On a broader scale, these learnings contribute progress towards an overarching goal of creating green infrastructure that addresses the challenges posed by urbanisation and climate change, whilst championing more diverse, and more loved urban environments.

Tijana remains Principal Horticultural Scientist at the Royal Horticultural Society.

## Design Fellows

### **Aran Dasan**

*Subject:* Design for Resilience - Enki: Technologies for Resilient Biodiverse Oceans

*Mentor:* Professor Michel Kaiser, Heriot-Watt University

The ocean contains invisible underwater weather patterns. Temperature gradients, haloclines, cold water upwellings of nutrients, and climate-change induced warming waters.

These dynamic phenomena influence the presence of marine species who have preferred habitats. In terms of commercial fishing, this applies to target quota species as well as 'bycatch' species that fisheries do not wish to catch at all.

Aran and his colleagues proposed 'Enki': an internet-connected ocean sensor for fishing vessels, to observe these underwater patterns and correlate them with their fishing catch, in order to inform future fishing practices - to avoid bycatch and spend less fuel in achieving their mandated fishing quotas.

Enki sensors are attached to commercial fishing gears, which create measurement profiles of the water column during the fishing process. They measure key parameters such as temperature, salinity, depth, location, and turbidity. These measurement profiles are automatically uploaded to the cloud, where they can be viewed by skippers and other interested parties via a web application for analysis.

During this project, Aran and his colleagues took Enki from an early concept through to field-tested software and hardware prototypes. Their process involved human-centred design, design engineering and ecology. The prototypes were used by commercial crab fishing vessels in Orkney for a month. The results give an early indication of the usefulness of subsea measurements to inform responsible fishing practices.

During the project, a strong academic collaboration was created with Heriot-Watt University, who are continuing to deploy Enki in new fisheries around the UK to further prove the concept's value to sustainable fishing.

### **Professor Jacqui Cole**

*Subject:* Techno-push consumer-pull - Stimulating innovation of solar-powered windows for energy sustainable future cities: a user-centred approach

*Mentor:* Professor Peter Littlewood, Argonne National Laboratory

This project sought to understand the 'techno-push consumer-pull' of a next-generation photovoltaic device technology for use as solar-powered windows. These 'smart windows', which generate electricity from sunlight, could meet the entire energy demands of buildings for future cities, in a fully sustainable fashion. Achieving such a radical transformation requires driving 'smart windows' to innovation.

Jacqui is a research expert in this environmental technology. With this 'techno-push' in hand, she aimed to generate a concerted 'consumer-pull' on 'smart windows' by testing Rogers' five criteria for the successful diffusion of innovation: relative advantage, compatibility, complexity, trialability, observability. The project focused on testing the last two of these criteria: observability and trialability. These tests took the form of a 'pop up' exhibit that was showcased to 720 members of the public at the Visitors Centre of the Rutherford Appleton Laboratory (RAL) in August 2022, during two open days of the ISIS Neutron and Muon Source. This 'smart window' technology was showcased to promote public awareness, while soliciting questions from attendees to obtain feedback on this technology from a 'consumer-pull' perspective. The nature of the questions that were raised revealed that macroeconomic considerations about pricing and technical readiness of the 'smart window' technology predominated public thinking. These findings were checked via a subsequent event that focused on a different demographic: school children; whereby, this technology was presented as part of Protect the Planet Day 2022. The same macroeconomic notions about the technology prevailed in the line of questioning from this different demographic of the population. Thus, it was concluded that while Rogers' criterion, observability, is important in the form of gaining public awareness of this technology, Rogers' criterion of relative advantage is also at the front of everyone's minds. The recent rise in energy prices owing to the global energy crisis is likely to be a key influence in this regard. i.e. timeliness of this exhibit is also important. Therefore, the "Techno-push" needs to frame its findings more in terms of these macroeconomic concerns, rather than worry too much about the fineries of which chemical colour one should use for the light-harvesting part of the device technology, except on account of its financial viability. Nonetheless, the "Techno-push" part of this project generated 44 publications about these solar cell components that stand to be useful to the research scientist in this field.

## Sir Misha Black Award for Innovation in Design Education

### Judah Armani

*Subject:* Co-creating an innovative and pioneering approach to design education to empower young people, with neurodiversity, who find themselves in extreme poverty and/or profoundly challenging circumstances

Over the last year Judah has collaborated on new initiatives focused around place-based probation services and developing education in American youth prisons.

The following observations have been established:

1. Collaboration can lead to desistance from crime.
2. Collaboration increases communication - social capital.
3. Collaboration increases empathy - group accountability.
4. Collaboration increases the legitimacy of the initiative.
5. Collaboration fosters unity across a divided stakeholder group.

In addition, through observing place-based service delivery, Judah has shown that:

1. Place based services make the services more accessible.
2. Place based services improve the quality of services.
3. Place based services provide the scope for new emergent services.

These observations have led him to believe that through developing meaningful collaborations in prisons and place-based delivery of services across probation, the conditions for meaningful and genuine design education can take place in a profound and impactful manner. More so, the role of design within the development of the Criminal Justice System should be an imperative.

Judah was able to meaningfully journey with 50 men over the course of the year. In every location across Wales, England and America, profound development has taken place through impact measurement, full time employment and new education systems in place.

## Alumni Awards, Honours and Achievements

A selection of the alumni appointments, publications, honours and awards notified to the Commission. The Commission encourages all alumni to keep their alumni profiles up to date so that their successes can be celebrated.

### Overseas Scholars

Professor Jennifer Martin (1986)

- Awarded Ralph Slatyer Medal, Australian National University
- Chaired the worldwide Protein Data Bank Advisory Committee
- Appointed a Trustee of the Cambridge Crystallographic Data Centre
- Appointed a member of the Scientific Advisory Board of the Maurice Wilkins Centre, New Zealand
- Presented a Plenary Public Lecture for the International Union of Crystallography Congress in Melbourne
- Awarded an Undergraduate Certificate in Family History from the University of Tasmania

### Research Fellows

Professor Sinan Açıkgöz (2016)

- Awarded Manby Prize, Institution of Civil Engineers

Dr Jo Ashbourn (2002)

- Organised one-day conferences at the St Cross Centre for the History and Philosophy of Physics on: Physics Feuds Throughout History; Order and Chaos; and Polymaths Across the Eras

Dr Steven Beard (1983)

- Member of the MIRI development team awarded the Royal Astronomical Society Group Achievement Award in Astronomy for the James Webb Space Telescope

Professor Helen Coxall (2000)

- Participated in a research expedition on board the RS Joides Resolution as part of the International Ocean Drilling Program Expedition 400 which recovered deep sediment cores on the margins of Northern Greenland for deciphering the long-term history of the Greenland ice sheet

Professor David Cumming (1996)

- Awarded IET Achievement Medal in Electronics

Dr Barnali Ghosh (2003)

- Awarded John Mitchell Award, Institution of Civil Engineers

Professor Brianna Heazlewood (2012)

- Appointed Professor of Chemical Physics, University of Liverpool
- Awarded Philip Leverhulme Prize in Chemistry

Professor Adrian Horridge (1954)

- Published *How do Bees (And Humans) See Grey Levels?*

Dr Russell Low (1995)

- Appointed President and CEO of Axcelis Technologies

Professor Emilio Martínez-Pañeda (2018)

- Appointed Associate Professor of Engineering Science, University of Oxford
- Awarded ERC Starting Grant
- Awarded Young Investigator Medal, Spain's Royal Academy of Engineering

Professor Gavin Morley (2009)

- Appointed Professor, Department of Physics, University of Warwick
- Appointed lead PI for MAST-QG (Macroscopic superpositions towards witnessing the quantum nature of gravity) funded by the Sloan and Moore Foundations

Professor Sir Steve Sparks (1974)

- Awarded Imperial College 2023 Distinguished Alumni Award

Professor Ed Tate (1999)

- Appointed to the GSK Endowed Chair in Chemical Biology, Imperial College London

## Industrial Fellows

Professor Mike Clinch (1996)

- Elected Fellow of the Royal Academy of Engineering
- Appointed Director, Innoval Technology Ltd

Dr Mariastefania De Vido (2018)

- Selected to be included in the 100 Esperte, a high-profile Italian initiative to raise the profile of Italian female researchers and scholars available to communicate as experts in the media and with organisations such as schools and universities, to dispel stereotypes on female participation in male-dominated fields
- Technical lead for team that developed world record holding DiPOLE 10 J, 100Hz laser
- Awarded MBA, Heriot-Watt University

Professor Rob Deaves (1994)

- Awarded Honorary Professorship, School of Engineering, University of Birmingham
- Elected a Fellow of the Royal Academy of Engineering

## Enterprise Fellows

Ryan Beal (2022)

- SentientSports (data scientist in a box for sports) closed its pre-seed funding round and restructured its board. Since its inception, SentientSports has tested its models with more than 30 professional teams across Europe and the US as well as the English Premier League, the Football League, the Scottish Premiership and leading global sports agencies, who have all used its revolutionary AI technology to analyze data and recruit players

Natalie Kerres (2021)

- Awarded Innovation UK Women in Innovation Award

Harish Pesala (2021)

- Awarded Innovate UK Young Innovators Award

Varun Sarwal (2020)

- Hammer Missions (adaptive flight automation software for UAVs) increased revenues by 500% in 2023, received backing from Ordnance Survey and saw increased take-up by companies, charities and search and rescue organisations.

## Built Environment Fellows

David Rudlin (2019)

- Published (with Vicky Payne and Lucy Montague) *High Street: How our town centres can bounce back from the retail crisis*



## Rome Scholars

Susan Allix (1968)

- Published *On Books: The creative work of Susan Allix with a catalogue raisonné*
- Published *A Catalogue of Fine Press Artists Books from 1973 – 2023*

## Report by the Chairman of the Finance Committee

### *Introduction*

The Board of Management has appointed the Finance Committee as a sub-committee to supervise the Commission's finances and investments; this Committee meets at least twice a year. I would like to thank all members of the Committee for their ongoing valuable contribution in overseeing the Commission's finances.

During 2023 there were two formal meetings of the Committee. In the spring meeting we reviewed the annual accounts and met with the Commission's auditors. We also heard presentations from investment consultants. In the autumn meeting the Committee focused on reviews of the Commission's investment strategy and estate strategy.

### *Investment Policy*

Over the long term, the Commission aims to disburse 4% per annum of the trailing three-year average value of the portfolio. However, the Commission has few if any fixed liabilities and annual budgets include an allowance for Special Awards that can be adjusted without detriment to other programmes so this can vary from year to year depending on grant making opportunities and investment returns.

The investment objective is to generate a return of at least inflation plus 4% per annum over the long term, after expenses. This should allow the Commission to at least maintain and ideally grow the real value of the assets, whilst generating a stable and sustainable return to fund annual expenditure as set out above. The Finance Committee has determined that the inflation measure most relevant to the Commission's expenditure is the Consumer Price Index.

The Finance Committee is charged with agreeing a high-level asset allocation strategy with the investment managers, which is set so as to achieve the overall Commission investment objective. The Finance Committee is also responsible for identifying and monitoring investment managers and investment vehicles for the Commission. The Committee has appointed Stanhope Consulting to assist with monitoring and reporting of investment performance, and to advise on the most appropriate strategic asset allocation and the most suitable managers for the Commission's portfolio.

During the year under review, the neutral strategic asset allocation was 80% equities, 15% property (the South Kensington Estate), 5% cash and bonds. The Committee has reviewed the strategic asset allocation. Recognising the more volatile investment environment, and the improved returns from corporate bonds, it has decided that going forwards the strategic asset allocation should be 75% equities, 15% property (the South Kensington Estate), 10% cash and bonds, with ranges of plus or minus 5% in each case (outwith which a discussion as to whether rebalancing is required would automatically be triggered). The Committee is currently reviewing the investment performance of the legacy estate. As a result of this review, it is anticipated that certain properties may be excluded from the investment portfolio for the purposes of setting return and disbursement targets. If this proves to be the case, and the property component of the portfolio decreases substantially as a result, the strategic asset allocation will be reviewed again.

The Committee is also reviewing the balance of active and passive strategies within both the equity and bond components of the portfolio.

The Finance Committee will revisit the strategic asset allocation at least every three years and consider the need for tactical deviations from it on at least an annual basis.

The Commission adopts a total return approach to investment, generating the investment return from income and capital gains or losses. Recognising the likely volatility of the capital, the Commission will typically aim to generate an overall income return of between 2% and 3% per annum to reduce the risk that losses will need to be crystallised to fund commitments.

The Commission recognizes that long term investment is subject to market, political, economic, counterparty and other risks, with financial instability in particular being a key risk. The

Commission also recognizes inflation as a significant risk to the long-term sustainability of its activities and one that the investment policy should mitigate against.

The Commission's liabilities are primarily in sterling. However, the Committee does not require the equity portfolio to be hedged as it believes currency fluctuations should wash out over time, is confident the Commission can ride out short-term volatility and recognizes that in periods of market stress sterling investors tend to benefit from unhedged portfolios as their dollar assets generally appreciate - the dollar, unlike sterling, being a global reserve currency.

The Commission is able to tolerate volatility of the capital value of the portfolio, provided it is able to meet its short-term grant making commitments through either income or liquid capital assets. To allow for volatility of capital values, the trustees wish to maintain at least 5% of the portfolio in cash or lower risk fixed income investments hedged to sterling. Bearing in mind income generated by the portfolio and the flexibility to curtail Special Awards, this should allow three years' worth of Fellowships to be funded without needing to sell risk assets.

### *Ethical Investment Policy*

The Commission recognizes that its investments have wider impacts and seeks to align its investment strategy with its aims, reflecting the views of its stakeholders and taking into account broader public benefit. The Commission expects its investment managers to integrate Environmental, Social and Governance (ESG) considerations into the normal investment process and to fulfil the requirements of the UK Stewardship Code, actively engaging with the companies in which they invest to promote best practice corporate behaviour and sustainable business practices. Given its limited staff resources, it is not practical for the Commission to engage directly with individual companies, but it does expect its investment managers to report annually on their engagement activities and results.

The Commission expects its investment managers to apply ESG considerations to both segregated holdings and pooled holdings, taking account of the extent to which suitable alternative investment vehicles are available and bearing in mind de minimis considerations. The Commission will only appoint managers who are signatories to the UN Principles of Responsible Investment (UN PRI) and will take into account the ranking assigned to those managers by the UN PRI.

The Commission may exclude certain stocks or sectors where these are seen to be in direct conflict with its objects and activities. Equally, where consistent with the financial objectives, the Commission seeks to invest in areas with positive environmental and / or social impact, such as clean energy and various areas of new technology.

The Commission recognizes that climate change is a key challenge for the next decade and that limiting global temperature rises will require significant change in business, investment, technology development and fossil fuel use. The Commission monitors the carbon emissions of its main equity investment portfolio and through its investment managers seeks to reduce these emissions over time. The Commission is very aware, however, that certain companies and sectors that are critical to the transition to net zero are currently carbon intensive. The Commission does not exclude investment in such sectors but expects its investment managers to prioritise investment in companies that have a carbon reduction roadmap aligned with the goals of the Paris Agreement.

### *Investment Performance 2023*

Despite the volatile geopolitical environment and challenging economic environment, including the ongoing war in Ukraine, hostilities in the Middle East, persistent high inflation and elevated interest rates, equity and bond markets performed well in 2023 with the MSCI ACWI Index up 15.3% for the year and the Bloomberg Barclays Global Aggregate Index (GBP Hedged) up 6.2%. Against this backdrop the Commission achieved a total return net of fees of approximately 13.6% (2022: -8.9%). CPI + 4% was 8% (2022: 14.5%).

The Commission's portfolio is invested by three investment managers: Schroder & Co. Ltd; Charles Stanley & Co. Ltd and JP Morgan Asset Management (UK) Ltd. The Commission also has direct property holdings on its legacy estate in South Kensington. The asset allocation of the combined portfolio as at 31 December was 77.4% in global equities, 4.4% in listed alternative assets, 5.2%

in cash and bonds and 13.1% in the legacy estate (at the end of 2022 the proportions were 70.7%, 4.9%, 9.2% and 15.2% respectively).

Schroder & Co. Ltd and Charles Stanley invest globally, predominately in equities and returned 19.5% and 11.3% respectively (2022: -9.1% and -15.6% respectively). JP Morgan Asset Management (UK) Ltd manage a short duration bond account and returned 6.0% (2022: -2.6%). The directly held property returned 1.5% (2022: 0.9%) rental income of £776,165 (2022: £528,991) and realised gains on lease extensions of £246,000 (2022: £nil) compensating for unrealised losses on revaluation of £805,000 (2022: unrealised losses of £175,000), the latter reflecting the difficult small office market and the impact on investor sentiment of proposed leasehold reforms.

Managers are asked to measure the carbon emissions of their portfolios. As at the balance sheet date, companies comprising the segregated equity portfolio, managed by Schroder & Co, had a carbon footprint of 3,743 tonnes of CO<sub>2</sub> (2022: 3,866 tonnes) vs the MSCI AC World (TRI) USD of 9,493 tonnes of CO<sub>2</sub> (2022: 7,990 tonnes). Charles Stanley have estimated that the carbon intensity (T. CO<sub>2</sub>E/\$M Sales) of the companies in the underlying ETFs was 144.8 versus 124.4 for their index, the iShares MSCI World ACWI ETF (in 2022 the comparable figures were 131.5 versus an index of 148.2). While the carbon intensity of the Charles Stanley portfolio is higher than that of the index, this is primarily due to the high carbon intensity of holdings associated with the transition to decarbonisation, including the iShares Global Clean Energy ETF, Legal & General Battery Value ETF, and components of the Legal & General Global Infrastructure Index Fund.

#### *Long term performance vs investment objective*

The investment objective is to achieve at least a 4% real return over the long term. The annualised real return over the past ten years has been 4.9%. High inflation and disappointing equity returns in 2022 mean that the investment objective has not been met over shorter periods. The five year and three year real returns have been 3.3% and -2.5% respectively.

While inflation and interest rates are hopefully stabilising, tighter monetary policy, geopolitical uncertainty and market volatility are all set to continue, with the risk of a recession in some markets. The Commission recognises that meeting the investment objective over the short to medium term will be challenging and so remains flexible in its disbursement policy.

#### *Financial performance for the calendar year to 31 December 2023*

Over the 12-month period the investment portfolio generated income of £2,559,838 (2022: £2,386,031). When combined with capital gains of £16,630,182 (2022: capital losses of £15,790,681) this meant that, after grants and other expenditure, the total funds of the Commission increased from £130,375,737 to £143,838,891 as at 31 December 2023.

Expenditure on core Fellowships and Studentships increased from £3,671,284 to £3,963,890. However, fewer large Special Awards meant that total expenditure on charitable activities decreased from £5,470,448 to £4,957,163.

Expenditure on raising funds – which primarily comprises investment and property management fees – decreased from £799,328 in 2022 to £766,633 in 2023. The higher figure in 2022 primarily reflected the write off of rent relating to the lockdown period following an arbitration settlement.

#### *Going concern*

The Commissioners do not believe there are any material uncertainties that call into doubt the Commission's ability to continue and the accounts have therefore been prepared on a going concern basis.

The Commission, like every other organisation, has been impacted by the pandemic, Russia's invasion of Ukraine and the hostilities in the Middle East, which have resulted in ongoing supply chain disruption, persistent high inflation, increased interest rates and a cost-of-living crisis. Investment markets have been much more volatile, and the day-to-day value of the Commission's portfolio has inevitably reflected that. The Commission is a long-term investor, however, and Commissioners remain confident in the underlying strength of the portfolio; they see no evidence

at this stage of any permanent loss of value – indeed, the portfolio has shown significant gains over the past year. Similarly, while the Commission has had to defer or write off a certain amount of rent, there is not considered to be any risk to the long-term value of the estate. The Commission has sufficient assets, and sufficient liquidity, to ride out the current market disruptions. The Commission's core grant-making activity has therefore continued largely as planned and Commissioners expect it to continue to do so.

#### *Reserves Policy*

The Commission's funds originated from the surplus arising from the Great Exhibition of 1851 and have been enhanced by careful stewardship of the assets invested over many years. They are technically unrestricted, giving the Commissioners the ability to spend the funds as they wish in fulfilment of the charitable objectives of the Commission. None of the funds are in assets that cannot readily be realised.

In order to balance the needs of current and potential future beneficiaries of the charity, the Commissioners recognise the need to maintain a strong capital base so as to deliver an appropriate level of return to enable the Commission to continue to fulfil its charitable objectives on a long-term basis. Accordingly, all of the Commission's funds are invested in line with the investment policy described above and normal expenditure commitments are set to match the assumed average return above inflation delivered by the portfolio.

Given the Commission's flexibility to spend capital if required, the Commissioners do not consider that there is any merit in identifying an optimum level of free reserves that might be readily available if required but will respond appropriately to spending needs identified as and when circumstances arise.

#### *The Commission's Auditor*

In 2008, Moore Kingston Smith LLP was appointed the Commission's auditor following a competitive tender. The audit partner meets with the Finance Committee at least once each year. In the interests of good governance, the audit manager changes at least every five years and the audit partner at least every ten years.

## Statement of Commissioners' Responsibilities

The Commissioners are responsible for preparing the Trustees' Report and the financial statements in accordance with applicable law and United Kingdom Accounting Standards (United Kingdom Generally Accepted Accounting Practice.)

The law applicable to charities in England and Wales requires the Commissioners to prepare financial statements for each financial year which give a true and fair view of the state of the affairs of the Commission and of the incoming resources and application of resources of the Commission for that period. In preparing these financial statements, the Commissioners are required to:

- select suitable accounting policies and then apply them consistently;
- observe the methods and principles in the Charities SORP;
- make judgements and estimates that are reasonable and prudent;
- state whether applicable accounting standards have been followed, subject to any material departures disclosed and explained in the financial statements;
- prepare the financial statements on the going concern basis unless it is inappropriate to presume that the Commission will continue in business.

The Commissioners are responsible for keeping proper accounting records that disclose with reasonable accuracy at any time the financial position of the Commission and enable them to ensure that the financial statements comply with the Charities Act 2011, the Charity (Accounts and Reports) Regulations 2008 and the provisions of the Royal Charter. They are also responsible for safeguarding the assets of the Commission and hence for taking reasonable steps for the prevention and detection of fraud and other irregularities.

The Annual Report on pages 1 to 48 and 52 to 79 was approved by the Commissioners on 9 July 2024.

Ms Sandra Robertson



# Independent Auditor's Report to the Commissioners of Royal Commission for the Exhibition of 1851

## *Opinion*

We have audited the financial statements of the Royal Commission for the Exhibition of 1851 for the year ended 31 December 2023 which comprise the Statement of Financial Activities, the Summary Income and Expenditure Account, the Balance Sheet, the Cash Flow Statement and notes to the financial statements, including a summary of significant accounting policies. The financial reporting framework that has been applied in their preparation is applicable law and United Kingdom Accounting Standards, including FRS 102 'The Financial Reporting Standard Applicable in the UK and Republic of Ireland' (United Kingdom Generally Accepted Accounting Practice).

In our opinion the financial statements:

- give a true and fair view of the state of the charity's affairs as at 31 December 2023, and of its incoming resources and application of resources, for the year then ended;
- have been properly prepared in accordance with United Kingdom Generally Accepted Accounting Practice; and
- have been prepared in accordance with the requirements of the Charities Act 2011.

## *Basis for opinion*

We conducted our audit in accordance with International Standards on Auditing (UK) (ISAs (UK)) and applicable law. Our responsibilities under those standards are further described in the *Auditor's responsibilities for the audit of the financial statements* section of our report. We are independent of the charity in accordance with the ethical requirements that are relevant to our audit of the financial statements in the UK, including the FRC's Ethical Standard, and we have fulfilled our other ethical responsibilities in accordance with these requirements. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion.

## *Conclusions relating to going concern*

In auditing the financial statements, we have concluded that the Commissioners' use of the going concern basis of accounting in the preparation of the financial statements is appropriate.

Based on the work we have performed, we have not identified any material uncertainties relating to events or conditions that, individually or collectively, may cast significant doubt on the charity's ability to continue as a going concern for a period of at least twelve months from when the financial statements are authorised for issue.

Our responsibilities and the responsibilities of the Commissioners with respect to going concern are described in the relevant sections of this report.

## *Other information*

The other information comprises the information included in the annual report, other than the financial statements and our auditor's report thereon. The Commissioners are responsible for the other information. Our opinion on the financial statements does not cover the other information and, except to the extent otherwise explicitly stated in our report, we do not express any form of assurance conclusion thereon.

In connection with our audit of the financial statements, our responsibility is to read the other information and, in doing so, consider whether the other information is materially inconsistent with the financial statements or our knowledge obtained in the audit or otherwise appears to be materially misstated. If we identify such material inconsistencies or apparent material misstatements, we are required to determine whether there is a material misstatement in the financial statements or a material misstatement of the other information. If, based on the work we have performed, we conclude that there is a material misstatement of this other information, we are required to report that fact.

We have nothing to report in this regard.

*Matters on which we are required to report by exception*

We have nothing to report in respect of the following matters where the Charities Act 2011 requires us to report to you if, in our opinion:

- the information given in the Commissioners' Annual Report is inconsistent in any material respect with the financial statements; or
- the charity has not kept adequate accounting records; or
- the financial statements are not in agreement with the accounting records and returns; or
- we have not received all the information and explanations we required for our audit.

*Responsibilities of Commissioners*

As explained more fully in the Commissioners' responsibilities statement set out on page 48, the Commissioners are responsible for the preparation of the financial statements and for being satisfied that they give a true and fair view, and for such internal control as the Commissioners determine is necessary to enable the preparation of financial statements that are free from material misstatement, whether due to fraud or error.

In preparing the financial statements, the Commissioners are responsible for assessing the charity's ability to continue as a going concern, disclosing, as applicable, matters related to going concern and using the going concern basis of accounting unless the Commissioners either intend to liquidate the charity or to cease operations, or have no realistic alternative but to do so.

*Auditor's responsibilities for the audit of the financial statements*

We have been appointed as auditor under section 144 of the Charities Act 2011 and report in accordance with regulations made under section 154 of that Act.

Our objectives are to obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is a high level of assurance but is not a guarantee that an audit conducted in accordance with ISAs (UK) will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements.

Irregularities, including fraud, are instances of non-compliance with laws and regulations. We design procedures in line with our responsibilities, outlined above, to detect material misstatements in respect of irregularities, including fraud. The extent to which our procedures are capable of detecting irregularities, including fraud is detailed below.

*Explanation as to what extent the audit was considered capable of detecting irregularities, including fraud*

The objectives of our audit in respect of fraud, are: to identify and assess the risks of material misstatement of the financial statements due to fraud; to obtain sufficient appropriate audit evidence regarding the assessed risks of material misstatement due to fraud, through designing and implementing appropriate responses to those assessed risks; and to respond appropriately to instances of fraud or suspected fraud identified during the audit. However, the primary responsibility for the prevention and detection of fraud rests with both management and those charged with governance of the charity.

Our approach was as follows:

- We obtained an understanding of the legal and regulatory requirements applicable to the charity and considered that the most significant are the Charities Act 2011, the Charity SORP, and UK financial reporting standards as issued by the Financial Reporting Council.



- We obtained an understanding of how the charity complies with these requirements by discussions with management.
- We assessed the risk of material misstatement of the financial statements, including the risk of material misstatement due to fraud and how it might occur, by holding discussions with management.
- We inquired of management and those charged with governance as to any known instances of non-compliance or suspected non-compliance with laws and regulations.
- Based on this understanding, we designed specific appropriate audit procedures to identify instances of non-compliance with laws and regulations. This included making enquiries of management and obtaining additional corroborative evidence as required.

As part of an audit in accordance with ISAs (UK) we exercise professional judgement and maintain professional scepticism throughout the audit. We also:

- Identify and assess the risks of material misstatement of the financial statements, whether due to fraud or error, design and perform audit procedures responsive to those risks, and obtain audit evidence that is sufficient and appropriate to provide a basis for our opinion. The risk of not detecting a material misstatement resulting from fraud is higher than for one resulting from error, as fraud may involve collusion, forgery, intentional omissions, misrepresentations, or the override of internal control.
- Obtain an understanding of internal control relevant to the audit in order to design audit procedures that are appropriate in the circumstances, but not for the purposes of expressing an opinion on the effectiveness of the charity's internal control.
- Evaluate the appropriateness of accounting policies used and the reasonableness of accounting estimates and related disclosures made by the Commissioners.
- Conclude on the appropriateness of the Commissioners' use of the going concern basis of accounting and, based on the audit evidence obtained, whether a material uncertainty exists related to events or conditions that may cast significant doubt on the charity's ability to continue as a going concern. If we conclude that a material uncertainty exists, we are required to draw attention in our auditor's report to the related disclosures in the financial statements or, if such disclosures are inadequate, to modify our opinion. Our conclusions are based on the audit evidence obtained up to the date of our auditor's report. However, future events or conditions may cause the charity to cease to continue as a going concern.
- Evaluate the overall presentation, structure and content of the financial statements, including the disclosures, and whether the financial statements represent the underlying transactions and events in a manner that achieves fair presentation.

We communicate with those charged with governance regarding, among other matters, the planned scope and timing of the audit and significant audit findings, including any significant deficiencies in internal control that we identify during our audit.

#### *Use of our report*

This report is made solely to the charity's Commissioners, as a body, in accordance with Chapter 3 of Part 8 of the Charities Act 2011. Our audit work has been undertaken so that we might state to the charity's Commissioners those matters we are required to state to them in an auditor's report and for no other purpose. To the fullest extent permitted by law, we do not accept or assume responsibility to any party other than the charity and charity's Commissioners as a body, for our audit work, for this report, or for the opinion we have formed.

Statutory auditor

*Moore Kingston Smith LLP*

2 Appold Street  
London  
EC2A 2AP

*17/7/2024*

Moore Kingston Smith LLP is eligible to act as auditor in terms of Section 1212 of the Companies Act 2006.

# Royal Commission for the Exhibition of 1851

## Statement of Financial Activities for the Year Ended 31 December 2023

|                                                               | Notes | Unrestricted<br>Funds<br>2023<br>£ | Unrestricted<br>Funds<br>2022<br>£ |
|---------------------------------------------------------------|-------|------------------------------------|------------------------------------|
| <b>Income from:</b>                                           |       |                                    |                                    |
| Donations                                                     | 4     | 1,000                              | 3,300                              |
| Investments                                                   | 5     | 2,559,838                          | 2,386,031                          |
| Other                                                         | 6     | 5,103                              | 4,217                              |
| <b>Total income</b>                                           |       | <b>2,565,941</b>                   | <b>2,393,548</b>                   |
| <b>Expenditure on:</b>                                        |       |                                    |                                    |
| Generating funds                                              | 7     | 766,633                            | 799,328                            |
| Charitable activities                                         | 8     | 4,957,163                          | 5,470,448                          |
| <b>Total expenditure</b>                                      |       | <b>5,723,796</b>                   | <b>6,269,776</b>                   |
| <b>Net expenditure before gains and losses on investments</b> |       | <b>(3,157,855)</b>                 | <b>(3,876,228)</b>                 |
| <b>Net gains / (losses) on investments</b>                    |       |                                    |                                    |
| Losses on property                                            |       | (559,000)                          | (170,900)                          |
| Gains / (losses) on investments                               |       | 17,189,182                         | (15,619,781)                       |
| <b>Total of net gains / (losses) on investments</b>           |       | <b>16,630,182</b>                  | <b>(15,790,681)</b>                |
| <b>Net income / (expenditure)</b>                             |       | <b>13,472,327</b>                  | <b>(19,666,909)</b>                |
| <b>Other recognised gains and losses</b>                      |       |                                    |                                    |
| Actuarial gains / (losses) on defined benefit pension scheme  | 14    | (9,173)                            | 13,087                             |
| <b>Net movement in funds</b>                                  |       | <b>13,463,154</b>                  | <b>(19,653,822)</b>                |
| <b>Reconciliation of funds</b>                                |       |                                    |                                    |
| Total funds brought forward                                   |       | 130,375,737                        | 150,029,559                        |
| Net movement in funds                                         |       | 13,463,154                         | (19,653,822)                       |
| <b>Total funds carried forward</b>                            |       | <b>143,838,891</b>                 | <b>130,375,737</b>                 |

The notes on pages 55 to 73 form part of these accounts. Notes 1-2 provide details of the Commission's objectives and accounting policies.

# Royal Commission for the Exhibition of 1851

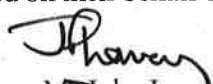
## Balance Sheet as at 31 December 2023

|                                                         | Notes | Total<br>Funds<br>2023<br>£ | Total<br>Funds<br>2022<br>£ |
|---------------------------------------------------------|-------|-----------------------------|-----------------------------|
| <b>Fixed asset investments</b>                          |       |                             |                             |
| Investment properties                                   | 15    | 19,595,350                  | 20,765,350                  |
| Listed investments                                      | 16    | 129,015,825                 | 112,318,792                 |
| Cash held as part of the investment portfolio           |       | 1,114,160                   | 3,672,152                   |
|                                                         |       | <u>149,725,335</u>          | <u>136,756,294</u>          |
| <b>Current assets</b>                                   |       |                             |                             |
| Debtors                                                 | 17    | 318,916                     | 377,919                     |
| Cash at bank and in hand                                |       | 1,425,099                   | 1,300,378                   |
|                                                         |       | <u>1,744,015</u>            | <u>1,678,297</u>            |
| <b>Liabilities</b>                                      |       |                             |                             |
| Creditors: Amounts falling due within one year          | 18    | (4,078,902)                 | (4,595,362)                 |
| <b>Net current liabilities</b>                          |       | <u>(2,334,887)</u>          | <u>(2,917,065)</u>          |
| <b>Total assets less current liabilities</b>            |       | 147,390,448                 | 133,839,229                 |
| Creditors: Amounts falling due after more than one year | 18    | (3,206,557)                 | (3,106,492)                 |
| <b>Net assets excluding pension liability</b>           |       | <u>144,183,891</u>          | <u>130,732,737</u>          |
| Defined benefit pension scheme liability                | 14    | (345,000)                   | (357,000)                   |
| <b>Net assets</b>                                       |       | <u><u>143,838,891</u></u>   | <u><u>130,375,737</u></u>   |
| <b>The funds of the Charity:</b>                        |       |                             |                             |
| <b>Capital Funds</b>                                    |       |                             |                             |
| Balance as at 1 January                                 |       | 130,375,737                 | 150,029,559                 |
| Movement in year                                        |       | 13,463,154                  | (19,653,822)                |
| <b>Balance as at 31 December</b>                        |       | <u><u>143,838,891</u></u>   | <u><u>130,375,737</u></u>   |

Approved by the Commissioners on 9 July 2024 and signed on their behalf by:



Ms Sandra Robertson  
Chairman, Finance Committee



Mr John Lavery  
Secretary

The notes on pages 55 to 73 form part of these accounts.

# Royal Commission for the Exhibition of 1851

## Statement of Cash Flows for the Year Ended 31 December 2023

|                                                                    | Total<br>Funds<br>2023<br>£ | Total<br>Funds<br>2022<br>£ |
|--------------------------------------------------------------------|-----------------------------|-----------------------------|
| <b>Cash flows from operating activities</b>                        |                             |                             |
| Donations received (excluding donations in kind)                   | 1,000                       | 3,300                       |
| Grants and awards paid                                             | (4,691,655)                 | (4,093,117)                 |
| Payments to suppliers                                              | (1,115,782)                 | (1,033,626)                 |
| Payments in respect of employees                                   | (350,414)                   | (346,594)                   |
| Other payments                                                     | (32,029)                    | (24,638)                    |
| <b>Cash used in operating activities</b>                           | <b>(6,188,880)</b>          | <b>(5,494,675)</b>          |
| <b>Cash flows from investing activities</b>                        |                             |                             |
| Dividends, interest and rent from investments                      | 2,648,366                   | 2,299,721                   |
| Proceeds from sale of investments                                  | 24,930,748                  | 20,366,979                  |
| Purchase of investments                                            | (23,823,555)                | (15,278,465)                |
| <b>Net cash provided by investing activities</b>                   | <b>3,755,559</b>            | <b>7,388,235</b>            |
| <b>Change in cash and cash equivalents in the reporting period</b> | <b>(2,433,321)</b>          | <b>1,893,560</b>            |
| Cash and cash equivalents brought forward                          | 4,972,530                   | 3,078,970                   |
| <b>Cash and cash equivalents carried forward</b>                   | <b>2,539,209</b>            | <b>4,972,530</b>            |
| <b>Disclosed as:</b>                                               |                             |                             |
| Cash held as part of the investment portfolio                      | 1,114,110                   | 3,672,152                   |
| Cash at bank and in hand                                           | 1,425,099                   | 1,300,378                   |
|                                                                    | <b>2,539,209</b>            | <b>4,972,530</b>            |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2023

### 1. STATUS AND OBJECTIVES

The Commission for the Exhibition of 1851 was set up by Royal Charter in 1850 to plan and promote the Exhibition of Works of Industry of all Nations, which was to be held in London in 1851. When the affairs of the Great Exhibition had eventually been wound up, the Commissioners were appointed, under a Supplemental Charter, as a permanent body to administer the surplus funds at their disposal. These were to be applied in order to “increase the means of industrial education and extend the influence of science and art upon productive industry”.

### 2. ACCOUNTING POLICIES

The accounts are prepared under the historic cost convention, modified by the revaluation from time to time of certain fixed assets, and in accordance with the Financial Reporting Standard applicable in the UK and Republic of Ireland (effective January 2015) (FRS102), Accounting and Reporting by Charities: Statement of Recommended Practice applicable to charities preparing their accounts in accordance with the Financial Reporting Standard applicable in the UK and Republic of Ireland (effective January 2019) (SORP) and the Charities Act 2011.

In the estimation of the trustees (the Commissioners), there are no material uncertainties that call into doubt the Commission’s ability to continue and the accounts have therefore been prepared on a going concern basis.

The Commission, like every other organisation, has been impacted by the pandemic, Russia’s invasion of Ukraine and war in the Middle East, which have resulted in ongoing supply chain disruption, persistent high inflation, increased interest rates and a cost-of-living crisis. Investment markets have been much more volatile, and the day-to-day value of the Commission’s portfolio has inevitably reflected that. The Commission is a long-term investor, however, and Commissioners remain confident in the underlying strength of the portfolio; they see no evidence at this stage of any permanent loss of value. Similarly, while the Commission has had to defer or write off a certain amount of rent, there is not considered to be any risk to the long-term value of the estate. The Commission has sufficient assets, and sufficient liquidity, to ride out the current market disruptions. The Commission’s core grant-making activity has therefore continued largely as planned and Commissioners expect it to continue to do so.

The Commission meets the definition of a public benefit entity under FRS102.

The financial statements are presented in sterling which is the functional currency of the charity. Monetary amounts are rounded to the nearest pound.

#### (a) Investments

- (i) Are shown in the balance sheet at market value; any unrealised gain over original cost is shown in the statement of financial activities.
- (ii) Income on investments is included in the accounts when receivable.
- (iii) Cash held as part of the investment portfolio includes short-term deposits held temporarily with the company’s bankers pending re-investment.

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2023

### 2. ACCOUNTING POLICIES (continued)

#### (b) Donations, legacies and similar income

Donations, legacies and similar income are included in the year in which they are receivable, that is, when the Commission becomes entitled to the income. Donations received for general purposes are included as unrestricted funds. Where the wishes of the donor are legally binding on Commissioners, donations are accounted for as Restricted Funds with their use limited to that defined by the donor.

#### (c) Fixed Assets and Depreciation

All purchases of capital items under £10,000 are written off in the year of purchase. Capital items over £10,000 are depreciated over their estimated useful economic lives. Currently no items are being depreciated.

#### (d) Investment Properties

All the Commission's properties are let to provide an income on a full repairing lease. All properties are inspected regularly by the Commission's Surveyors and revalued by them from time to time. The last full revaluation was undertaken at 31 December 2019 and was based on the existing use and occupation of the land, and the duration of leases at ground rents and rack rents. These valuations are reviewed and adjusted annually as described in note 15.

#### (e) Realised and Unrealised Gains on Investments

Gains and losses on investments and assets held for the Commission's use are treated in accordance with the Statement of Recommended Practice. They are recognised in the statement of financial activities for the year in which they occur.

#### (f) Cash and cash equivalents

Cash and cash equivalents include cash in hand, deposits held at call with banks, other short-term liquid investments with original maturities of three months or less, and bank overdrafts. Cash held on capital account pending investment by the charity's investment managers, together with cash for investment in transit between investment managers, is disclosed within fixed asset investments; all other cash and cash equivalents is disclosed within current asset investments.

#### (g) Lease premiums and licences

Premiums received for lease extensions are treated as capital receipts and included within gains / (losses) on property transactions. Certain other premiums received which do not materially affect the underlying value of the Commission's investment are treated as income receipts.

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2023

### 2. ACCOUNTING POLICIES (continued)

#### (h) Charitable activities

The primary charitable activity is the making of grants and awards. Grants and awards payable are accounted for on an accruals basis. Multi-year grants are accounted for in full in the year that the grant is awarded. The Commission recognises future liabilities discounted to their present value where material.

The majority of grants and awards are made to individuals who have been granted Fellowships or Studentships by the Commission. A limited number of awards are made to Institutions in furtherance of their educational needs. Some support is also provided to the legacy institutions on the Commission's South Kensington estate and to organisations facilitating access to the Commission's archives. A full analysis is shown in note 9.

The Commission also undertakes some direct charitable activities, in particular networking and educational events organised for the Commission's Fellows, Students, Alumni and the general public. Further details are shown in note 10.

#### (i) Allocation of support costs

Support costs are allocated on the basis of board or staff time as appropriate.

#### (j) Financial instruments

The Commission has elected to apply the provisions of Section 11 *Basic Financial Instruments* and Section 12 *Other Financial Instruments Issues* of FRS 102 to all of its financial instruments.

Financial instruments are recognised in the Commission's balance sheet when the Commission becomes party to the contractual provisions of the instrument.

##### *Basic financial assets*

Basic financial assets, which include trade and other debtors and cash and bank balances, are initially measured at transaction price including transaction costs and are subsequently carried at amortised cost using the effective interest method unless the arrangement constitutes a financing transaction, where the transaction is measured at the present value of the future receipts discounted at a market rate of interest.

##### *Other financial assets*

Other financial assets, including investments in equity instruments which are not subsidiaries, associates or joint ventures, are initially measured at fair value, which is normally the transaction price. Such assets are subsequently carried at fair value and the changes in fair value are recognised in the statement of financial activities, except that investments in equity instruments that are not publicly traded and whose fair values cannot be measured reliably are measured at cost less impairment.

Trade debtors, loans and other debtors that have fixed or determinable payments that are not quoted in an active market are classified as 'loans and receivables'. Loans and receivables are measured at amortised cost using the effective interest method, less any impairment.

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2023

### 2. ACCOUNTING POLICIES (continued)

#### (j) Financial instruments (continued)

##### *Basic financial liabilities*

Basic financial liabilities, including trade and other creditors, are initially recognised at transaction price unless the arrangement constitutes a financing transaction, where the debt instrument is measured at the present value of the future payments discounted at a market rate of interest.

Debt instruments are subsequently carried at amortised cost, using the effective interest rate method.

Trade creditors are obligations to pay for goods or services that have been acquired in the ordinary course of business from suppliers. Accounts payable are classified as current liabilities if payment is due within one year or less. If not, they are presented as non-current liabilities. Trade creditors are recognised initially at transaction price and subsequently measured at amortised cost using the effective interest method.

##### *Other financial liabilities*

Derivatives, including interest rate swaps and forward foreign exchange contracts, are not basic financial instruments. Derivatives are initially recognised at fair value on the date a derivative contract is entered into and are subsequently re-measured at their fair value. Changes in the fair value of derivatives are recognised in the statement of financial activities in finance costs or finance income as appropriate, unless they are included in a hedging arrangement.

#### (k) Retirement benefits

Payments to defined contribution retirement benefit schemes are charged as an expense as they fall due.

The cost of providing benefits under defined benefit plans is determined separately for each plan using the projected unit credit method and is based on actuarial advice.

The net interest element is determined by multiplying the net defined benefit liability by the discount rate, taking into account any changes in the net defined benefit liability during the period as a result of contribution and benefit payments. The net interest is recognised in the statement of financial activities.

Remeasurement changes comprise actuarial gains and losses and the return on the net defined benefit liability excluding amounts included in net interest. These are recognised immediately in the statement of financial activities in the period in which they occur.

The defined net benefit pension liability in the balance sheet comprises the total of the present value of the defined benefit obligation (using a discount rate based on high quality corporate bonds).



# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2023

### 2. ACCOUNTING POLICIES (continued)

#### (1) Significant judgements and key sources of estimation uncertainty

In the application of the charity's accounting policies, Commissioners are required to make judgements, estimates and assumptions about the carrying value of assets and liabilities that are not readily apparent from other sources. The estimates are based on historical experience and other factors that are considered to be relevant. Actual results may differ from these estimates. The key sources of estimation uncertainty that have a significant effect on the amount recognised in the accounts are:

- the valuation of investment properties, which are stated at their estimated fair value based on professional valuations as disclosed in Note 15;
- the valuation of multi-year grant commitments, which take into account estimates of future inflation, early withdrawal rates, claim rates and other factors affecting the final amount payable; in this context, given other uncertainties, discounting for the time value of money is not considered material;
- the valuation of the defined benefit pension scheme liability, which is based on actuarial assumptions and a professional valuation as set out in Note 14;
- the valuation of future minimum lease payments under non-cancellable operating leases, which are discounted for inflation in accordance with Bank of England targets and ignore the potential effects of leasehold enfranchisements, as set out in Note 15.

### 3. FUNDS

All the Commission's income and capital is expendable at the discretion of the Commissioners and is therefore shown as a single unrestricted fund. The Commissioners have designated part of the unrestricted fund as a Special Projects Fund. It is anticipated this will primarily be used to fund activities in connection with the 175th Anniversary of the Great Exhibition in 2026 and the transition to net zero. Movements on the designated fund are disclosed in Note 20.

### 4. DONATIONS

The Commission received a donation of £1,000 from The Faculty of Royal Designers for Industry. The donation is for the general charitable purposes of the Commission, but with an expressed wish that it be used to support the activities of the Sir Misha Black Awards Committee. The donation was therefore used to part fund the ceremony held on 16 November 2023 at which the 2023 Medal and Award were presented. The Commissioners are very grateful to The Faculty of Royal Designers for Industry for their support.

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2023

### 5. INVESTMENT INCOME

|                                  | 2023<br>£        | 2022<br>£        |
|----------------------------------|------------------|------------------|
| Rental income from UK properties | 776,165          | 528,991          |
| Income from managed investments  | 1,735,350        | 1,847,680        |
| Interest on cash deposits        | 48,323           | 9,360            |
|                                  | <u>2,559,838</u> | <u>2,386,031</u> |

### 6. OTHER INCOME

|                | 2023<br>£    | 2022<br>£    |
|----------------|--------------|--------------|
| Licence income | 5,103        | 4,217        |
|                | <u>5,103</u> | <u>4,217</u> |

### 7. COST OF GENERATING FUNDS

|                                   | 2023<br>£      | 2022<br>£      |
|-----------------------------------|----------------|----------------|
| Investment management fees        | 567,067        | 542,701        |
| Property management fees          | 120,068        | 61,185         |
| Legal fees                        | 27,094         | 32,438         |
| Write offs                        | -              | 104,183        |
| Allocated support costs (note 11) | 52,404         | 58,821         |
|                                   | <u>766,633</u> | <u>799,328</u> |

### 8. CHARITABLE ACTIVITIES

|                               | Grants<br>(note 9)<br>£ | Direct<br>costs<br>(note 10)<br>£ | Allocated<br>support<br>costs<br>(note 11)<br>£ | 2023<br>£        | 2022<br>£        |
|-------------------------------|-------------------------|-----------------------------------|-------------------------------------------------|------------------|------------------|
| Fellowships and studentships  | 3,673,356               | 126,125                           | 164,409                                         | 3,963,890        | 3,671,284        |
| STEM education and outreach   | 246,075                 | 141,420                           | 56,758                                          | 444,253          | 416,247          |
| Support for legacy estate     | 340,255                 | 36,290                            | 56,758                                          | 433,303          | 1,299,392        |
| Archives and alumni relations | -                       | 51,991                            | 63,726                                          | 115,717          | 83,525           |
|                               | <u>4,259,686</u>        | <u>355,826</u>                    | <u>341,651</u>                                  | <u>4,957,163</u> | <u>5,470,448</u> |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2023

### 9. GRANTS AWARDED

#### (a) *Fellowships and studentships*

|                                    | 2023<br>No. | 2023<br>£ | 2022<br>No. | 2022<br>£ |
|------------------------------------|-------------|-----------|-------------|-----------|
| Research Fellowships               | 10          | 1,692,455 | 9           | 1,027,845 |
| Industrial Fellowships             | 15          | 1,129,088 | 10          | 1,312,595 |
| Industrial Design Studentships     | 14          | 501,850   | 13          | 437,789   |
| Built Environment Fellowship       | 1           | 100,000   | -           | 21,598    |
| Design Fellowship                  | -           | (37)      | 1           | 100,000   |
| Regenerative Design Fellowships    | -           | -         | 2           | 200,000   |
| Enterprise Fellowships             | 4           | 250,000   | 5           | 250,000   |
| Sir Misha Black Awards Bursaries   | -           | -         | 1           | 4,500     |
| Total fellowships and studentships | 44          | 3,673,356 | 41          | 3,354,327 |

All of the fellowships and studentships were awarded to individuals. The Annual Report includes more information on the awards granted, including where relevant details of each of the institutions at which individual recipients are carrying out their studies / research.

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2023

### 9. GRANTS AWARDED (continued)

#### (b) STEM education and outreach

|                                                                        | 2023<br>£ | 2022<br>£ |
|------------------------------------------------------------------------|-----------|-----------|
| British Science Association – Primary kit boxes                        | 83,700    | -         |
| Primary Engineer – Primary Engineer Curriculum                         | 45,000    | -         |
| British School at Rome – Summer School placements                      | 19,500    | -         |
| Education and Training Foundation – Technical Teaching Fellowships     | 15,000    | -         |
| Oxford University Development Trust – OXbOXes                          | 15,000    | -         |
| University of Hull – Humber Science Festival                           | 11,000    | -         |
| Kids Invent Stuff – Inventors Club                                     | 10,000    | -         |
| All Party Parliamentary Engineering Group – Meeting sponsorship        | 10,000    | -         |
| Royal Botanic Gardens Kew – Grow Wild                                  | 10,000    | -         |
| Foundation for Science and Technology – Debate sponsorship             | 9,500     | -         |
| Geological Society – Megalosaurus Month                                | 6,000     | -         |
| J Mallinson and E Townsend – STEM materials                            | 750       | -         |
| G Lamb – STEM outreach                                                 | 500       | -         |
| MadeHereNow – Website development                                      | 2,000     | 2,000     |
| Smallpeice Trust – Arkwright Scholarships / General Engineering course | 23,000    | 10,000    |
| Well North Enterprises – STEM development in Rotherham and Liverpool   | -         | 75,000    |
| Somerscience Trust – Somerscience Festival                             | -         | 15,000    |
| WoMars – STEM outreach                                                 | -         | 1,000     |
| Royal Designers for Industry – Summer Schools                          | -         | 92,500    |
| EDT – Routes into STEM                                                 | -         | 14,060    |
|                                                                        | <hr/>     | <hr/>     |
|                                                                        | 260,950   | 209,560   |
| Less: Past awards written back where not utilised in full              | (14,875)  | (20,500)  |
|                                                                        | <hr/>     | <hr/>     |
|                                                                        | 246,075   | 189,060   |

Two of the STEM education and outreach grants were awarded to individuals with the remaining 13 awarded to institutions (2022: all of the STEM education and outreach grants were awarded to institutions).

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2023

### 9. GRANTS AWARDED (continued)

#### (c) *Support for legacy estate*

|                                                                                 | 2023<br>£      | 2022<br>£        |
|---------------------------------------------------------------------------------|----------------|------------------|
| Imperial College London – Great Exhibition Road Festival 2025 and 2026          | 200,000        | -                |
| Science Museum – Power Hall refurbishment                                       | 100,000        | -                |
| Royal Society of Sculptors – Florilegium at Great Exhibition Road Festival 2023 | 10,000         | -                |
| Natural History Museum – 1851 Garden                                            | -              | 500,000          |
| Royal Horticultural Society – Plants for purpose                                | -              | 300,000          |
| Exhibition Road Cultural Group – SouthKenZen+                                   | 30,255         | 350,000          |
| Exhibition Road Cultural Group – Art installation on Exhibition Road            | -              | 25,000           |
| Royal College of Art – Open resource for purposeful design                      | -              | 15,000           |
|                                                                                 | <u>340,255</u> | <u>1,190,000</u> |

All of the grants in support of the legacy estate in both 2023 and 2022 were awarded to institutions.

#### (d) *Archives and alumni relations*

No awards were made in this category in 2023 or 2022.

In total, 17 grants were made to institutions and 46 to individuals (2022: 13 grants to institutions and 41 to individuals).

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2023

### 10. DIRECT COSTS

|                                         | Fellowships<br>and<br>studentships<br>£ | STEM<br>education<br>and<br>outreach<br>£ | Support<br>for legacy<br>estate<br>£ | Archives<br>and alumni<br>relations<br>£ | 2023<br>£      | 2022<br>£      |
|-----------------------------------------|-----------------------------------------|-------------------------------------------|--------------------------------------|------------------------------------------|----------------|----------------|
| Promotion and selection costs           | 76,708                                  | -                                         | -                                    | -                                        | 76,708         | 84,721         |
| Networking and educational events       | 49,417                                  | 141,420                                   | 5,703                                | 18,764                                   | 215,304        | 243,718        |
| Estate memberships, projects and advice | -                                       | -                                         | 30,587                               | -                                        | 30,587         | 30,035         |
| Archive supplies and acquisitions       | -                                       | -                                         | -                                    | 26,139                                   | 26,139         | 6,457          |
| Alumni website and expenses             | -                                       | -                                         | -                                    | 7,088                                    | 7,088          | 6,175          |
|                                         | <u>126,125</u>                          | <u>141,420</u>                            | <u>36,290</u>                        | <u>51,991</u>                            | <u>355,826</u> | <u>371,106</u> |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2023

### 11. SUPPORT COSTS

|                             | Cost of<br>generating<br>funds<br>£ | Fellowships<br>and<br>studentships<br>£ | STEM<br>education<br>and<br>outreach<br>£ | Support<br>for<br>legacy<br>estate<br>£ | Archives<br>and<br>alumni<br>relations<br>£ | 2023<br>£      | 2022<br>£      | Basis of<br>allocation |
|-----------------------------|-------------------------------------|-----------------------------------------|-------------------------------------------|-----------------------------------------|---------------------------------------------|----------------|----------------|------------------------|
| Governance costs (note 12)  | 6,795                               | 6,795                                   | 5,436                                     | 5,436                                   | 2,718                                       | 27,180         | 40,807         | Board time             |
| Staff costs (note 13)       | 36,611                              | 126,519                                 | 41,197                                    | 41,197                                  | 48,971                                      | 294,495        | 299,569        | Staff time             |
| Retired staff pension costs | 2,018                               | 6,976                                   | 2,272                                     | 2,272                                   | 2,700                                       | 16,238         | 7,240          | Staff time             |
| Facility costs              | 637                                 | 2,200                                   | 717                                       | 717                                     | 852                                         | 5,123          | 12,322         | Staff time             |
| Office refurbishment        | -                                   | -                                       | -                                         | -                                       | -                                           | -              | -              | Staff time             |
| Office costs                | 4,409                               | 15,239                                  | 4,962                                     | 4,962                                   | 5,899                                       | 35,471         | 33,919         | Staff time             |
| Legal and professional fees | 981                                 | 3,390                                   | 1,104                                     | 1,104                                   | 1,312                                       | 7,891          | 23,487         | Staff time             |
| Travel and entertaining     | 952                                 | 3,290                                   | 1,071                                     | 1,071                                   | 1,273                                       | 7,657          | 7,432          | Staff time             |
|                             | <u>52,403</u>                       | <u>164,409</u>                          | <u>56,759</u>                             | <u>56,759</u>                           | <u>63,725</u>                               | <u>394,055</u> | <u>424,776</u> |                        |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2023

### 12. GOVERNANCE COSTS

|                                     | 2023<br>£     | 2022<br>£     |
|-------------------------------------|---------------|---------------|
| Audit fees (including VAT)          |               |               |
| – Current year                      | 15,000        | 13,800        |
| – Prior year under / (over) accrual | -             | 460           |
| Actuarial fees                      | 2,220         | 2,040         |
| Consultancy fees                    | -             | 3,600         |
| Annual report                       | 4,994         | 1,861         |
| Meeting costs                       | 4,966         | 15,026        |
| Commissioner recruitment costs      | -             | 4,020         |
|                                     | <u>27,180</u> | <u>40,807</u> |

### 13. STAFF COSTS AND RELATED PARTY TRANSACTIONS

|                                       | 2023<br>£      | 2022<br>£      |
|---------------------------------------|----------------|----------------|
| Salaries (including benefits in kind) | 231,903        | 240,561        |
| Employer's NI                         | 20,713         | 23,238         |
| Pension contributions                 | 40,954         | 34,889         |
| Staff recruitment                     | -              | -              |
| Training and development              | 925            | 881            |
|                                       | <u>294,495</u> | <u>299,569</u> |

The average number of employees during the year analysed by function was:

|                            | 2023<br>No. | 2022<br>No. |
|----------------------------|-------------|-------------|
| Support and administration | 4.0         | 4.0         |
| Archive                    | 1.0         | 1.0         |
|                            | <u>5.0</u>  | <u>5.0</u>  |

The full-time equivalent number of employees during the year analysed by function was:

|                            | 2023<br>No. | 2022<br>No. |
|----------------------------|-------------|-------------|
| Support and administration | 2.8         | 2.9         |
| Archive                    | 0.4         | 0.4         |
|                            | <u>3.2</u>  | <u>3.3</u>  |



# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2023

### 13. STAFF COSTS AND RELATED PARTY TRANSACTIONS (continued)

One employee earned between £80,000 and £90,000. Pension contributions of £12,600 were paid in respect of this employee. (2022: no employee earned more than £60,000.)

Commissioners do not receive remuneration. During the year re-imbursements were made to three Commissioners in respect of travelling and other expenses totalling £1,423 (2022: to three Commissioners totalling £954). One Commissioner received an honorarium of £900 as a member of the Science and Engineering Fellowships Committee in recognition of specialist services provided in assessing potential candidates (2022: one Commissioner received £600).

The total amount paid in respect of key management personnel (i.e., the Secretary and Finance Director), including employer's national insurance and employer pension contributions, was £180,997 (2022: £194,519 – this figure was in respect of the outgoing Secretary, incoming Secretary and Finance Director).

There were no other related party transactions during the year (2022: none).

### 14. PENSIONS AND OTHER LONG-TERM EMPLOYEE BENEFITS

All current and new members of staff are eligible to join a personal pension scheme of their choice with the Commission contributing 15% of salary (2022: 15% of salary). There is no requirement for employee contributions. Staff may opt to sacrifice some of their salary in return for an additional employer contribution. Employer contributions of £40,954 (2022: £34,889) were made in the year of which £886 (2022: £820) were outstanding at the year-end. There were no prepaid contributions at the year-end (2022: £nil).

All current and new members of staff also benefit from an unfunded / uninsured death in service scheme under which the Commissioners (at their absolute discretion) may pay a nominated beneficiary a lump sum equivalent to 18 months' salary if an employee dies while employed by the Commission. No liability for the scheme is recognised in the accounts as Commissioners do not believe there is any sensible way to estimate the liability. Actuarial calculations based on assumptions comparable to those used in valuing the defined benefit pension liability (see below) suggest that any liability in respect of the death in service scheme would in any case be immaterial.

All current and new members of staff also benefit from a Group Income Protection policy with Canada Life which covers basic salary and pension contributions for staff unable to work due to long term illness.

The Commission operates an unfunded pension scheme in the UK (the 'Scheme'). The Scheme is an unregistered, non-contributory defined benefit scheme. As the Scheme is unfunded, no contributions are paid by the Commission, other than to meet benefits as they fall due. As no triennial valuations are carried out, a valuation is carried out at the balance sheet date each year by an independent qualified actuary.

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2023

### 14. PENSIONS AND OTHER LONG-TERM EMPLOYEE BENEFITS (continued)

The Scheme was closed to new members on 14 July 2004. As at 31 December 2023, all four remaining members of the Scheme are receiving a pension and there is no further accrual of benefits. There is therefore no service cost for the year. The amount recognised in arriving at net expenditure for the year is an expense of £16,238 (2022: £7,239) which is fully in respect of net interest on the net liability.

As regards the unfunded, defined benefit pension scheme:

*The principal assumptions used by the actuary were:*

|                                       | FRS102<br>Valuation<br>2023<br>(% p.a.) | FRS102<br>Valuation<br>2023<br>(% p.a.) |
|---------------------------------------|-----------------------------------------|-----------------------------------------|
| <b>Financial assumptions</b>          |                                         |                                         |
| Gross investment return               |                                         |                                         |
| In-service members                    |                                         |                                         |
| Pre-retirement                        | N/A                                     | N/A                                     |
| Post-retirement                       | N/A                                     | N/A                                     |
| Current pensioners                    | 4.5%                                    | 4.8%                                    |
| Pensionable earnings increases        | N/A                                     | N/A                                     |
| Price inflation                       | 3.6%                                    | 3.4%                                    |
| Pension increases                     | 3.6%                                    | 3.4%                                    |
| Allowance for administration expenses | 0.0%                                    | 0.0%                                    |
| <b>Demographic assumptions</b>        |                                         |                                         |
| Mortality                             |                                         |                                         |
| Pre-retirement                        | N/A                                     | N/A                                     |
| Post-retirement                       | 101%/104% S3PA                          | S3PA                                    |
|                                       | CMI 2022 1%                             | CMI 2021 1%                             |
| Withdrawal allowance                  | No allowance                            | No allowance                            |
| Early retirement allowance            | No allowance                            | No allowance                            |
| Proportion married                    | 90%                                     | 90%                                     |
| Wife's age                            | 3 years younger<br>than husband         | 3 years younger<br>than husband         |

The assumptions used by the actuary are best estimates chosen from a range of possible actuarial assumptions which, due to the timescale covered, may not necessarily be borne out in practice.

*Value of Scheme assets and liabilities:*

|                                     | 2023<br>£        | 2022<br>£        |
|-------------------------------------|------------------|------------------|
| Market value of Scheme assets       | —                | —                |
| Present value of Scheme liabilities | (345,000)        | (357,000)        |
| Scheme deficit                      | (345,000)        | (357,000)        |
| Related deferred tax asset          | —                | —                |
| Net liability                       | <u>(345,000)</u> | <u>(357,000)</u> |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2023

### 14. PENSIONS AND OTHER LONG-TERM EMPLOYEE BENEFITS (continued)

#### *Movements in the year:*

|                                        | 2023<br>£        | 2022<br>£        |
|----------------------------------------|------------------|------------------|
| Scheme deficit at beginning of year    | (357,000)        | (399,000)        |
| Current service cost                   | -                | -                |
| Interest on obligation                 | (16,238)         | (7,239)          |
| Actuarial gain / (loss) on liabilities | (9,173)          | 13,087           |
| Benefits paid directly by employer     | 37,411           | 36,152           |
|                                        | <u>(345,000)</u> | <u>(357,000)</u> |
| Scheme deficit at end of year          | <u>(345,000)</u> | <u>(357,000)</u> |

The interest on obligation of £16,238 (2022: £7,239) is disclosed within Support costs (note 11) while the actuarial loss on liabilities of £9,173 (2022: gain of £13,087) is disclosed within Other recognised gains and losses on the face of the SOFA.

### 15. INVESTMENT PROPERTIES AND OPERATING LEASES

|                                                        | 2023<br>£         | 2022<br>£         |
|--------------------------------------------------------|-------------------|-------------------|
| (a) <i>Movements in value of investment properties</i> |                   |                   |
| Balance at 1 January                                   | 20,765,350        | 20,940,350        |
| Sales during the year                                  | (365,000)         | -                 |
| Unrealised (loss) / gain on year-end revaluation       | (805,000)         | (175,000)         |
|                                                        | <u>19,595,350</u> | <u>20,765,350</u> |
| Valuation at 31 December                               | <u>19,595,350</u> | <u>20,765,350</u> |

The valuation as at 31 December 2023 shown above resulted from a full revaluation of the properties at 31 December 2019, undertaken by Cluttons LLP, Chartered Surveyors and Property Consultants. The valuation was carried out on an open market value basis in accordance with the RICS Appraisal and Valuation Manual and is based on existing usage and occupation of the land, and the duration of leases at ground and rack rents. In reaching the 31 December 2023 valuation, the value at 31 December 2019 has been adjusted, based on advice from Daniel Watney LLP, to take into account movements in local property market indices, changes in estimated rental values, the decreasing length of leases and lease extension / leasehold enfranchisement claims received. All of the investment properties are located in the UK.

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2023

### 15. INVESTMENT PROPERTIES AND OPERATING LEASES (continued)

#### (b) *Operating leases – lessor*

The Commission is entitled as landlord to income from investment properties under operating leases. Future minimum lease payments under non-cancellable operating leases, discounted for inflation, for each of the following periods are as follows:

|                                                   | 2023<br>£         | 2022<br>£         |
|---------------------------------------------------|-------------------|-------------------|
| Not later than one year                           | 94,538            | 94,538            |
| Later than one year and not later than five years | –                 | –                 |
| Later than five years                             | 10,903,421        | 10,429,261        |
|                                                   | <u>10,997,958</u> | <u>10,523,799</u> |

The Commission's investment properties are let for periods ranging up to 999 years. All leases are on full repairing and insuring terms. Leases of residential property are potentially subject to leasehold enfranchisement; this has been ignored in arriving at the above figures.

### 16. INVESTMENTS

|                                            | 2023<br>£             | 2022<br>£    |                       |           |
|--------------------------------------------|-----------------------|--------------|-----------------------|-----------|
| (a) <i>Movements in listed investments</i> |                       |              |                       |           |
| Market value 1 January                     | 112,318,792           | 133,023,295  |                       |           |
| Acquisitions at cost                       | 23,917,759            | 15,283,538   |                       |           |
| Disposals at cost                          | (20,252,654)          | (16,517,911) |                       |           |
| Net (losses) / gains on revaluation        | 13,031,928            | (19,470,130) |                       |           |
|                                            | <hr/>                 | <hr/>        |                       |           |
| Market value 31 December                   | 129,015,825           | 112,318,792  |                       |           |
|                                            | <hr/>                 | <hr/>        |                       |           |
| Value at cost 31 December                  | 96,844,702            | 93,179,598   |                       |           |
|                                            |                       |              |                       |           |
| (b) <i>Geographic breakdown</i>            |                       |              |                       |           |
|                                            | 2023<br>£             | 2023<br>£    | 2022<br>£             | 2022<br>£ |
|                                            | Listed<br>investments | Cash         | Listed<br>investments | Cash      |
| In the UK                                  | 54,650,993            | 1,114,072    | 52,328,177            | 3,516,273 |
| Outside the UK                             | 74,364,832            | 88           | 59,990,615            | 155,879   |
|                                            | <hr/>                 | <hr/>        | <hr/>                 | <hr/>     |
|                                            | 129,015,825           | 1,114,160    | 112,318,792           | 3,672,152 |

All investments are listed on a recognised stock exchange.

There were no individual holdings the market value of which is considered to be material in the context of the portfolio as a whole.

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2023

### 17. DEBTORS

|                         | 2023<br>£      | 2022<br>£      |
|-------------------------|----------------|----------------|
| Rents receivable        |                |                |
| – in hands of surveyors | 132,886        | 48,647         |
| – in arrears            | 126,391        | 299,016        |
|                         | <u>259,277</u> | <u>347,663</u> |
| Other debtors           | 28,244         | 338            |
| Prepayments             | 31,395         | 29,918         |
| Accrued income          | -              | -              |
|                         | <u>318,916</u> | <u>377,919</u> |

### 18. CREDITORS

|                                            | 2023<br>£        | 2022<br>£        |
|--------------------------------------------|------------------|------------------|
| <b>Amounts falling due within one year</b> |                  |                  |
| Grants payable                             | 3,866,077        | 4,379,636        |
| Other creditors                            | 212,825          | 215,726          |
|                                            | <u>4,078,902</u> | <u>4,595,362</u> |

|                                    | 2023<br>£      | 2022<br>£      |
|------------------------------------|----------------|----------------|
| <b>Analysis of other creditors</b> |                |                |
| Investment management fees         | 145,301        | 134,891        |
| Property management fees           | 24,398         | 8,400          |
| Audit fees                         | 15,000         | 13,800         |
| Other legal and professional fees  | 12,478         | 17,588         |
| Others                             | 15,648         | 41,047         |
|                                    | <u>212,825</u> | <u>215,726</u> |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2023

### 18. CREDITORS (continued)

|                                                     | 2023<br>£        | 2022<br>£        |
|-----------------------------------------------------|------------------|------------------|
| <b>Amounts falling due after more than one year</b> |                  |                  |
| Grants payable                                      | 3,206,557        | 3,106,492        |
| Due in one to two years                             | 2,195,140        | 2,188,881        |
| Due within two to five years                        | 1,011,417        | 917,611          |
|                                                     | <u>3,206,557</u> | <u>3,106,492</u> |

The analysis of grants payable by award is as follows

| Award                             | Period of<br>commitment | 2023<br>£        | 2022<br>£        |
|-----------------------------------|-------------------------|------------------|------------------|
| Fellowships and studentships      |                         |                  |                  |
| – Research Fellowships            | 3 years                 | 3,321,439        | 3,099,479        |
| – Industrial Fellowships          | 3 years                 | 2,286,548        | 1,595,090        |
| – Industrial Design Studentships  | 2 years                 | 286,942          | 339,645          |
| – Built Environment Fellowships   | 2 years                 | 80,000           | 58,402           |
| – Design Fellowships              | 2 years                 | 55,000           | 142,500          |
| – Regenerative Design Fellowships | 2 years                 | 132,500          | -                |
| – Enterprise Fellowships          | 1 year                  | 62,500           | 187,500          |
| – Sir Misha Black Award Bursaries | 1 year                  | 1,000            | -                |
| STEM education and outreach       | 1 year                  | 196,250          | 342,932          |
| Support for legacy estate         | 3 years                 | 640,455          | 1,410,050        |
| Archives and alumni relations     | 1 year                  | -                | 26,500           |
|                                   |                         | <u>7,072,634</u> | <u>7,486,128</u> |

### 19. FINANCIAL INSTRUMENTS

|                                                                                | 2023<br>£        | 2022<br>£        |
|--------------------------------------------------------------------------------|------------------|------------------|
| <b>Carrying amount of financial assets</b>                                     |                  |                  |
| Debt instruments measured at amortised cost<br>(debtors excluding prepayments) | 287,520          | 348,001          |
|                                                                                | <u>287,520</u>   | <u>348,001</u>   |
| <b>Carrying amount of financial liabilities</b>                                |                  |                  |
| Measured at amortised cost                                                     | 7,285,459        | 7,701,854        |
|                                                                                | <u>7,285,459</u> | <u>7,701,854</u> |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2023

### 20. FUNDS

|                     | At 1 January<br>£  | Income<br>£      | Expenditure<br>£   | Gains / (losses)<br>£ | Transfers<br>£ | At 31 December<br>£ |
|---------------------|--------------------|------------------|--------------------|-----------------------|----------------|---------------------|
| <b>Unrestricted</b> |                    |                  |                    |                       |                |                     |
| General             | 127,957,079        | 2,565,941        | (5,723,796)        | 16,621,009            | (691,549)      | 140,728,684         |
| Designated          |                    |                  |                    |                       |                |                     |
| – Special Projects  | 2,418,658          | -                | -                  | -                     | 691,549        | 3,110,207           |
|                     | <u>130,375,737</u> | <u>2,565,941</u> | <u>(5,723,796)</u> | <u>16,621,009</u>     | <u>-</u>       | <u>143,838,891</u>  |

In 2021, the Commissioners set up a designated Special Projects Fund. It is anticipated that this will be used to fund activities in connection with the 175th Anniversary of the Great Exhibition in 2026 and perhaps also to fund activities around the transition to net zero, although Commissioners retain the discretion to direct alternative uses and remain mindful of the desirability of maintaining disbursements through periods of inferior market return. The designated fund comprises listed investments. It is administered as part of the unrestricted fund.

## Administrative Information

### Structure, Governance and Management

The Commission is constituted as a limited company incorporated by Royal Charter. Its governing documents are the original Charter dated 3 January 1850 and a Supplemental Charter dated 2 December 1851.

The Commission may have up to twelve trustees, known as Royal Commissioners, at any one time, who together constitute the Board of Management, which meets formally twice a year. Commissioners are chosen to bring wide experience in areas relevant to the Commission's work – science, engineering, industry, design, architecture and finance. To maintain an appropriate balance of skills, Commissioners normally serve for 10 years, and Commissioners themselves identify possible successors, who may serve on a committee prior to election. Following election by the Board of Management, Commissioners are only appointed with the approval of the President.

All other committees are advisory in remit, are subordinate to the Board of Management and report to it, and all committee Chairmen are Commissioners. Ad hoc committees may be formed for limited periods and specific purposes. Any committee other than the Board of Management may have non-Commissioners as members subject to the wishes of the Chairman of that committee. All committees, except ad hoc committees, meet at least once annually. All committees are serviced by the Secretary and, where appropriate, by the Finance Director.

The Secretary also provides full briefing and induction programmes for all new Commissioners and committee members when appointed. As part of this introduction Commissioners are provided with a Governance Book containing full details of the Commission's history, role, strategy, procedures and Commissioners' responsibilities, as well as the relevant Charity Commission guidance for trustees. During their tenure, further opportunities for Commissioners to develop their knowledge of areas relevant to the Commission's activities are provided as appropriate.

Day to day running of the Commission is delegated to the Secretary, assisted by a small staff team. Matters of strategy, and all grants greater than £5,000, are decided by Commissioners.

Full details of Commissioners and Committee members in post during the year, as well as the small staff team, are provided on pages 76 to 78. Details of the Commission's professional advisers are provided on page 79.

### Remuneration

Commissioners are not remunerated in their role as trustees of the charity and do not receive benefits other than reimbursement of expenses incurred in attending meetings.

In order to maximise funds available for grant making, Commissioners are determined to keep staff numbers and associated office costs to a minimum. To attract and retain experienced staff of the right calibre, however, Commissioners recognise the need to set salaries in line with those for other grant-making charities in the London area, based on sector benchmarks and other publicly available data.

Salaries for all staff, including key management personnel, are reviewed annually by the Chairman of the Board and the Chairman of the Finance Committee as part of the performance appraisal process. Pay awards are dependent on performance and set based on increases in the cost of living and average salary increases for the sector. There are no automatic increments and no bonus scheme.

Commissioners recognise the importance of helping employees make adequate provision for retirement. All employees are therefore eligible to receive a 15% employer pension contribution to the pension scheme established for auto-enrolment purposes or a personal pension of their choice. All employees also benefit from a Group Income Protection policy that will cover basic salary and pension contributions if they are unable to work due to long-term illness. At their absolute discretion,



Commissioners may pay a nominated beneficiary a lump sum equivalent to 18 months' salary if an employee dies while employed by the Commission. All employees are also entitled to an interest free season ticket loan. All of the above benefits are available to all employees, including key management personnel. Employees do not receive any other benefits.

## Risk Policy

In discharging their responsibilities for the management of risk, it is the policy of the Commissioners to identify, analyse and seek to manage any risks to the ability of the Commission to carry out its role effectively and meet the obligations of its Royal Charter.

To this effect the Commissioners have given consideration to the major risks to which the Commission is, or may be, exposed. A full risk register has been drawn up, which is reviewed regularly. Insurance brokers have been appointed to advise on areas where risk can be effectively mitigated through insurance. Compliance risks are mitigated through taking and following appropriate professional advice.

The main remaining areas of strategic and operational risk and the steps taken to address them are summarised below.

### *Investments: security, performance, liquidity*

The Commission has a diversified portfolio, both in terms of investments held and managers appointed. It has adopted investment and disbursement policies designed to maintain the real value of the portfolio over time and hence the support available to current and future beneficiaries. Sufficient liquidity is held outside the portfolio to meet short term commitments. Commissioners have delegated review of investment performance to a Finance Committee comprising individuals with relevant expertise.

### *Grant making: applications, assessment, administration*

Commissioners have appointed specialist committees to review fellowship applications, work closely with other organisations active in the STEM arena to avoid unnecessary duplication or administrative effort and have appointed a communications company to assist with marketing of the awards to ensure they are brought to the attention of eligible recipients. Commissioners regularly seek feedback from potential applicants and other stakeholders to ensure the awards remain relevant.

### *Legacy estate: character, experience, relevance*

Commissioners take an active interest in the estate, seek to facilitate relevant initiatives across legacy institutions and provide financial support where possible to ensure the estate remains a beacon of excellence and inspiration in the worlds of science, engineering and design.

## Commissioners and Committee Members

### President

HRH The Princess Royal

### Commissioners (and Board of Management)

The Rt Hon Professor Lord Kakkar KBE PC FMedSci  
*Chairman, Board of Management*

Professor Jim Al-Khalili CBE FRS FInstP  
The Rt Hon Lord Burnett of Maldon PC  
Professor Dame Ann Dowling OM DBE FREng FRS  
Mr Jim Eyre OBE  
Professor Sir Andrew Hopper CBE FRS FREng FIET  
Professor Lord Mair CBE HonDSc FREng FICE FRS  
Dame Alison Nimmo DBE MRTPI FRICS HonFRIBA FICE  
Ms Sandra Robertson  
Professor Dame Carol Robinson DBE FRS FRSC FMedSci  
Professor Eleanor Stride OBE FREng HonFIET  
Professor Chris Wise RDI FREng FICE MStructE HonFRIBA FRSA

The Rt Hon Lord Burnett of Maldon was appointed to the Board on 8 September 2023

### Ex Officio Commissioners

The Lord President of the Council  
The First Lord of the Treasury  
The Chancellor of the Exchequer  
The Secretary of State for Science, Innovation and Technology  
The Secretary of State for the Environment, Food and Rural Affairs  
The President of the Institution of Civil Engineers  
The President of the Geological Society

### Finance Committee

Ms Sandra Robertson *Chairman*  
Ms Sarah Arkle  
The Rt Hon Lord Burnett of Maldon PC  
Professor Sir Andrew Hopper CBE FRS FREng FIET  
Dame Alison Nimmo DBE MRTPI FRICS HonFRIBA FICE  
Mr Thomas Seaman  
Mr Fabian Thehos CFA

The Rt Hon Lord Burnett of Maldon was appointed to the Committee on 7 December 2023  
Mr Thomas Seaman was appointed to the Committee on 14 September 2023

## Science and Engineering Fellowships Committee

Professor Dame Carol Robinson DBE FRS FRSC FMedSci *Chairman*

Professor Jim Al-Khalili CBE FRS FInstP

Professor Gillian Bates FRS FMedSci

Professor Mike Benton FRS FRSE

Professor Martin Bridson FRS

Professor Andrew Briggs

Professor Neil Champness FRSC FLSW

Professor Anne Dell CBE FRS FMedSci

Professor John Dewey FRS

Professor Cyril Hilsum CBE FREng FRS

Professor Patrick Keogh FREng

Dr Sandra Knapp OBE FRS

Professor Rachel O'Reilly FRS FRSC

Professor Sheena Radford OBE FRS FMedSci

Dr Dame Frances Saunders DBE CB FREng FInstP

Professor Christopher Tout

Professor Stuart West

Professor John Wood CBE FREng

Professor Trevor Stuart retired from the Committee on 1 January 2023

Dr Sandra Knapp was appointed to the Committee on 6 February 2023

Professor Stephen Muggleton retired from the Committee on 14 February 2023

## Brunel Fellowships Sub-Committee

Professor Dame Carol Robinson DBE FRS FRSC FMedSci *Chairman*

Professor Dame Anne Dowling OM DBE FREng FRS

Professor William Powrie FREng FICE

Professor John Wood CBE FREng

Professor David Ewins retired from the Committee on 1 January 2023

## Industry and Engineering Committee

Professor Dame Ann Dowling OM DBE FRS FREng *Chairman*

Professor Cees de Bont

Professor John Clarkson FREng

Dr Nicholas de León

Professor Andrew Lewis FREng FRSC FAPS FIMMM CChem CSI

Professor Lord Mair CBE HonDSc FREng FICE FRS

Professor Ron Pethig

Dr Malcolm Skingle CBE DSc

Professor Dame Sarah Springman DBE FREng

Professor Adam Stokes

Professor Eleanor Stride OBE FREng

Professor Cees de Bont was appointed to the Committee on 17 September 2023

Professor Adam Stokes was appointed to the Committee on 18 September 2023

## Built Environment and Design Fellowships Committee

Mr Jim Eyre OBE *Chairman*  
Professor Rachel Cooper OBE  
Ms Kat Scott

Dr Andrea Siodmok EMPP FRSA HonDCL  
Professor Chris Wise RDI FREng FICE MStructE HonFRIBA FRSA

Dame Alison Nimmo retired from the Committee on 1 January 2023

## Sir Misha Black Awards Committee

Ms Mary Mullin *Chairman*  
Professor Chris Wise RDI FREng FICE MStructE HonFRIBA FRSA  
Professor Peter Childs  
Dr Nicholas de León  
Professor Malcolm Garrett MBE RDI FISTD  
Professor Geoff Kirk RDI FREng

Professor Sir Christopher Frayling retired from the Committee on 1 January 2023

## Staff

Mr John Lavery MVO  
Mr Amahl Smith ACA  
Mrs Helen Harris  
Mrs Angela Kenny RMARA  
Ms Kat O'Dea

Secretary  
Finance Director  
Fellowship Programme Manager  
Archivist and Alumni Relations  
Office Manager / Executive Assistant

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# Accounts

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# Royal Commission for the Exhibition of 1851

Annual Report and Accounts

For the year ended 31 December 2022



## The Aims of the Royal Commission

The 1851 Royal Commission's governing document is its Supplemental Charter of 1851, which requires the Commission to  
*"increase the means of industrial education and  
extend the influence of science and art upon productive industry"*.

This was originally interpreted as a requirement to create a centre of intellectual excellence, which resulted in the acquisition of the South Kensington estate and its subsequent development with museums, academic establishments and a Central Hall of Arts and Sciences (the Royal Albert Hall).

Later, in 1890, the emphasis was switched to the support of individuals, starting with the award of Science Research Scholarships from 1891.

Today the Commission runs its own schemes for:

Research Fellowships  
Industrial Fellowships  
Industrial Design Studentships  
Built Environment Fellowships  
Fellowships in Design

In partnership with others it supports:

Enterprise Fellowships

It also supports worthy individuals and appropriate organisations by Special Awards.

The total number of individuals being supported in 2022 was 137

Registered Charity No. 206123



## Contents

|                                                 |       |
|-------------------------------------------------|-------|
| Chairman's Report                               | 1-3   |
| Secretary's Report                              | 3     |
| The Work of the 1851 Royal Commission           | 4     |
| Public Benefit                                  | 4     |
| Grant-making Policies                           | 5-6   |
| Achievements in 2022                            | 7-12  |
| Future Plans                                    | 13    |
| Awards Granted in 2022                          | 14-22 |
| Awards Completed in 2022                        | 23-38 |
| Alumni Awards, Honours and Achievements         | 39-42 |
| Report by the Chairman of the Finance Committee | 43-46 |
| Statement of Commissioners' Responsibilities    | 46    |
| Independent Auditor's Report                    | 47-49 |
| Statement of Financial Activities               | 50    |
| Balance Sheet                                   | 51    |
| Cash Flow Statement                             | 52    |
| Notes to the Financial Statements               | 53-71 |
| Administrative Information                      | 72-73 |
| Commissioners, Committee Members and Staff      | 74-76 |
| Professional Advisers                           | 77    |

## Chairman's Report

One cannot begin to comment on any activities undertaken in 2022 without first acknowledging the universal sadness and feeling of loss experienced by the entire nation upon the death of Her Majesty Queen Elizabeth II on the 8 September. The impact of The Queen's passing was immense and the response from across the United Kingdom and beyond felt both personal yet shared on a national and international scale as we all reflected on the quiet but steadfast dedication to service and leadership Her Majesty had shown within and outwith this country for well over three quarters of a century.

The Royal Commission for the Exhibition of 1851 has been hugely privileged to have enjoyed the generous support of the Royal Family since its creation and whilst the late Queen had no formal role with the Commission, she nevertheless graciously paid an interest in our activities and kindly offered encouragement and assistance whenever it was requested.

A slow but full re-emergence from the constraints imposed by the global pandemic has been seen during 2022. The Royal Commission took the decision to re-establish the live events that our Fellows and wider community value so much at an early stage and thus has enjoyed a complete calendar cycle of functions and evenings allowing our award holders to share and exchange their work and experiences. This was started at the end of March in Fishmongers' Hall with the attendance of our President Her Royal Highness The Princess Royal at the biannual President's Dinner. During the event Her Royal Highness saw examples of work from across the Commission's research and education programmes and spoke to a number of current Fellows about their work and its potential impact as well as spending time with the wider 1851 community. Her Royal Highness also appointed three new Royal Commissioners to the Board of Management, the theoretical physicist, author and broadcaster Professor Jim Al-Khalili, the renowned biomedical engineer Professor Eleanor Stride and myself.

I was delighted that we were also able to reinstate our annual Alumni Science Evening in a new venue, the Dyson building at Imperial College London. Almost a hundred of us enjoyed presentations from Drs Tessa Young and Christoph Schnedermann and Mr Robert Rouse and Ms Maral Bayaraa on subjects ranging from "characterizing the cobalt delivery pathway for vitamin B12" to "machine learning approaches to assessing future flood risk". The keynote address was given by Professor Dame Carol Robinson, Royal Commissioner and chair (designate) of the Science and Engineering Fellowship Committee, who shared highlights of both her early career experiences as well as the current focus of her work at the Kavli Institute.

The weekend of 18 and 19 June found the 1851-der tent providing the centrepiece for the Great Exhibition Road Festival. Volunteers from our programmes shared elements of their research and set out the Commission's function and history to some of the 40,000 visitors that came to experience examples of the diverse work and heritage of the institutions – big and small – that reside in Albertopolis. That same weekend the Royal Commission also hosted the seventh recording of "The Engineers" at the Science Museum, entitled "The Future of Cars". A collaborative, annual project, involving the BBC World Service saw the BBC presenter Kevin Fong encouraging a panel of three distinguished engineers from very different areas of the automotive environment to share their personal journeys and experiences. There was also discussion of future opportunities and developments for the car as we know it today and already on the design board for tomorrow. This year we were fortunate to have Ms Linda Zhang, the Chief Engineer of the F150 Lightning programme (electrification of the USA's most popular vehicle), Mr Jamie Sutton, Chief Scientist at Wayve (autonomous vehicle technology); and Mr Arjo van Der Ham, Chief Technology Officer at Lightyear (solar powered vehicles) participating on the panel. On the day the live audience was just over two hundred and fifty but when broadcast in August by the BBC World Service it reached a potential audience of 93 million.

In the autumn we acknowledged the latest recipients of our PhD support programme at our Industrial Fellowship awards, whilst the 2022 Sir Misha Black Awards recognised the long and distinguished work of Professor Elizabeth Tunstall in design education and the innovative and highly effective education programme being undertaken by Mr Judah Armani. I am delighted that all our research and postgraduate education programmes continue to be highly regarded, attracting talented

young scientists, engineers and designers who wish to pursue their work at the next level. This year the Royal Commission awarded eight research fellowships, ten industrial fellowships, five enterprise fellowships and fourteen industrial design studentships, along with the bi-annual design fellowship and a double award for the inaugural regenerative design fellowship. All told these programmes provided almost four million pounds of annual funding to support research and innovation.

In November the 1851 Group, comprised of the Chairs and Chief Executives of the 1851 legacy institutions, gathered at the Royal Geographical Society to receive a report on SouthKenZen+ – an initiative launched by the local borough in 2021 to coordinate efforts to make Albertopolis an exemplar zero emission urban neighbourhood. The initial report received unanimous support and it was agreed that the main elements of the recommended programme - zero emissions, circular economies and being nature positive – must be actioned with alacrity and ambition. A key enabler of such aspirations is adequate financial support and so the Royal Commission agreed to provide funding for three years to allow for the completion of the next stage of this project. Indeed, an environmental focus has been at the forefront of the charity's special awards activity more generally this year. In addition to the support provided for SouthKenZen+, the Commission has also awarded significant grants to the Natural History Museum's Urban Nature project and the Royal Horticultural Society's Plants for Purpose programme. Our commitment to STEM based careers and education for young people remains undiminished with ongoing grants being awarded to the Education and Training Foundation for the 1851 Technical Teaching Fellowships and STEM Learning, as well as an award to the Well North Enterprises "Skills City" project. The Commission has also re-affirmed its responsibilities towards the development of the design discipline and community with a special award to enable the Association of Royal Designers for Industry to hold summer schools in 2023 and 2024.

Reflecting upon the Royal Commission's activity during the last year, I am very conscious the work undertaken and the support offered would not be possible without the generosity of our committee members and my fellow Commissioners and the dedication of our small permanent staff. I want to take this opportunity to express my personal thanks and appreciation for all of their efforts over the past 12 months.

It has been a year of some major changes in the people who make up our organisation. Having thoroughly modernised the support structure of the executive and safely maintained our operations through the challenges of two years of COVID restrictions, and after eleven years of dedicated service as the Secretary, Captain Nigel Williams retired from the Commission in May. This was shortly followed by Professor Dame Kay Davies who stepped down as a Royal Commissioner at the end of her ten-year term of office on the Board of Management. Kay was a hugely distinguished and very active member of the 1851 family and chaired the Science and Engineering Fellowship Committee during the latter part of her tenure. Finally, the end of the year saw the Chairman of the Board of Management and Royal Commission, Mr Bernard Taylor, take his leave. Although Bernard himself made modest reference to this in his 2021 report, it is important to acknowledge again his incredible commitment to and championship of both the Royal Commission and the wider Albertopolis community, over the past 17 years. First as Chairman of the Finance Committee and then as Chairman of the Board of Management, his energy and passion for his duties and stewardship of the cultural district of South Kensington has been tremendous. Amongst his many achievements has been the re-energising of the 1851 group, the development of the Great Exhibition Road Festival, and The Engineers successful collaboration with the BBC. He has also been the driving force behind the Commission's support to a number of capital projects at both ends of the estate that have resulted in an 1851 Place by the Royal Albert Hall, an 1851 Courtyard within the Royal College of Music and an 1851 Garden that will be incorporated within the Natural History Museum's new landscaping. It was therefore most fitting that upon his retirement from the Board of Management he was presented with the 1851 Royal Commission Medal by Her Royal Highness who attended the farewell dinner given in his honour. We were also delighted that his exemplary service was also recognised by the award of Commander of the Royal Victorian Order (CVO) in His Majesty's New Year's Honours List.

As I take over the role of Chairman of the Board of Management, I am extremely conscious of the legacy of my distinguished predecessors all the way back to our founding President, Prince Albert.

Since its inception the 1851 Royal Commission has been committed to his vision, a vision that remains crucially aligned to the aspirations of modern Britain and our continued ambition to be one of the world's most innovative and productive economies. Like my forebears, I recognise that our contribution to meeting this challenge is to maintain, and where practical, improve our education and research programmes, continue support for STEM projects and interventions for young people whilst retaining active stewardship of the Albertopolis estate. I look forward to working with my fellow Commissioners, committee colleagues, 1851 fellows and alumni to deliver this ambition over the coming years.

The Rt Hon Professor Lord Kakkar KBE PC FMedSci

## Secretary's Report

I consider it a great honour to have been given the privilege of holding the post of Secretary of the Royal Commission for the Exhibition of 1851 in succession to Nigel Williams. Replacing someone who has mastered his role so completely, is widely known and respected, and has been extremely impactful during his tenure is challenging enough, but when combined with the Commission's compelling story, its tremendous achievements and its inspirational people, the future looks extremely daunting! Having experienced most of an annual cycle of events I still, in moments of reflection, wonder at the breadth of activity the Commission undertakes and the quiet influence it wields. Through its research and education Fellowship programmes it provides hugely talented early career engineers, scientists and designers the opportunity to undertake innovative and vitally important work across the widest possible gamut of disciplines. It provides much needed support to the sharing of best practice teaching methods in the secondary and further education environment through its Technical Teaching Fellowships and still has the resources to assist a number of STEM education projects. All overseen or assisted by a hugely dedicated and committed group of Royal Commissioners and committee members and delivered through a very small but utterly devoted and extremely industrious executive team - the latter having also had to cope with the significant additional burden of settling in a new Secretary. I have become an easily triggered, and overly verbose enthusiast!

It has also been an enormous pleasure to have been introduced to the other element of the Commission's legacy – the great cultural estate of Albertopolis. Establishing new relationships and working with the institutions that occupy South Kensington has been made very easy by the welcoming and collegiate approach extended to me by all, and that experience has been mirrored within the wider community of the Exhibition Road Cultural Group and the Knightsbridge Neighbourhood Forum.

I am very conscious that my journey with the Royal Commission has just started, my familiarity with our charitable activities and local responsibilities is growing with the help of much valued colleagues and I look forward to what we might achieve together in 2023.

John Lavery MVO

## The Work of the 1851 Royal Commission

The Commission's aim is to 'make a difference' by providing educational fellowships and studentships to the very best early career scientists, engineers and designers. Success is hard to measure within the confines of a single year but looked at over the longer term the Commission's achievement is evident, with 13 Nobel Prize winners and over 150 Fellows of the Royal Society among its previous award winners. The case studies of completing fellows and summaries of alumni achievements later in this report also bear witness to the Commission's success.

In addition to its core fellowship schemes, the Commission also provides special awards to its legacy institutions, to other organisations working to encourage STEM (science, technology, engineering and mathematics) education and to organisations that can help facilitate access to its incredible archives. Details of some of these awards and the impact they have made can also be found later in this report.

As well as the grants that it makes, the Commission itself organises a number of educational and networking events for the benefit of its award holders, alumni, legacy institutions and the general public, which together make a significant contribution to STEM education.

The Commission was originally established by Royal Charter in 1850 under the Presidency of Prince Albert, to organise and stage the Great Exhibition. Held in the spectacular Crystal Palace, constructed in Hyde Park, it was the first ever World Fair, and the most successful. With over six million visitors, it also made a substantial profit.

Consolidated by Supplemental Charter, and enjoined to invest the surplus from the Great Exhibition *strictly in accordance with the ends of the Exhibition...[to] increase the means of industrial education and extend the influence of science and art upon productive industry* the Commission purchased 87 acres of land in South Kensington and helped establish its three great museums, the Royal Albert Hall and renowned institutions of learning, including Imperial College and the Royal Colleges of Art and Music.

When this huge undertaking was complete, there remained sufficient funds for the Commission to initiate, in 1891, a programme of fellowships and studentships to support pure research in science and engineering, applied research in industry, industrial design and other projects.

The Commission continues its work to this day, both managing its freehold estate and awarding almost £5m a year in research fellowships, design studentships and other grants. The provision of long leases to the legacy colleges and the Royal Albert Hall also makes a very substantial contribution to scientific, engineering and artistic education.

## Public Benefit

The Commission ensures that its work is for the public benefit and takes full account of the published Charity Commission guidance. The Commission's events and awards programmes and support of the legacy institutions represent identifiable benefits and are available to all eligible members of the public. They satisfy the primary charitable purpose of the advancement of education.

## Grant-making Policies

The Commission primarily pursues its charitable purposes through the award of grants to individuals and organisations. The Commission awards grants under a number of defined programmes. Full details of the terms and conditions for each programme, including application forms and deadlines where appropriate, are provided on the Commission's website. A brief summary of the major programmes which the Commission supports is provided below:

### **Schemes administered by the Commission:**

#### *Post-doctoral Research Fellowships in Science or Engineering*

These are intended to give early career scientists or engineers of exceptional promise the opportunity to conduct a research project of their own instigation; an ultimate objective is to contribute to the knowledge base required for a healthy and innovative national culture. Around eight to ten awards are made each year, including one or more Brunel Fellowships for engineering projects addressing the primary infrastructure needs of modern society. The awards are for up to three years, subject to annual review and encompass an annual stipend and some support for travel and other expenses.

#### *Industrial Fellowships*

These are intended to encourage profitable innovation and creativity in British industry. Projects in any science or engineering discipline will be considered. A variable number of awards – usually around ten to fifteen - is available each year depending on the financial value of individual awards granted. An ERA Foundation Fellowship for the electro-technology sector is awarded as part of the scheme. Fellowships are awarded to selected exceptional graduates with the potential to make an outstanding contribution to industry, for a programme of research, supported by their employing / sponsoring company, leading to a patent, product or process improvement in conjunction with a higher academic award. Awards are for up to three years, subject to annual review, and include a contribution towards living costs, a travel allowance, an honorarium for the host university and in appropriate cases a contribution towards university fees or towards the cost of enhancing the research project.

#### *Industrial Design Studentships*

These are intended to stimulate industrial design capability among the country's most able science and engineering graduates. A variable number of awards – usually around ten to fifteen - are offered each year for outstanding engineers or scientists who wish to develop their capabilities in industrial design by taking a recognised master's course and who aspire to become leading designers in British industry. The award is for up to two years and includes a stipend, materials allowance, travel allowance and contribution towards tuition fees.

#### *Fellowships in Design and the Built Environment*

Awarded in alternate years, these Fellowships each provide a stipend for up to two years to enable those at a more advanced stage in their career to explore important current issues, selected by the Commission.

### **Schemes administered by other organisations:**

#### *Enterprise Fellowships*

Awarded through the Royal Academy of Engineering (RAEng), these fellowships are open to outstanding UK-resident engineering graduates seeking entrepreneurial success. A package of tailored mentoring, training and grant funding will enable recipients to pursue commercialisation of their technological ideas. Originally three fellowships a year were available, but this has now been increased to six.

### Special Awards:

Although the educational programmes described above represent the lion's share of its grant giving, the Commission also responds to all those requests for funding that commend themselves through the Special Awards procedure. Here the aim is to assist worthy individuals, organisations or projects whose aims in the broadest sense align to the Commission's, and all applications are carefully scrutinised at an appropriate level according to the amount of support requested. Grants range from a few hundred pounds to over a hundred thousand pounds. While Commissioners retain considerable flexibility in principle, in practice a majority of special awards are made either to institutions on the Commission's legacy estate or for educational outreach work by like-minded organisations seeking to draw the attention of the young to the opportunities presented by science, engineering and design. A small number of grants are also made to facilitate access to the Commission's archives.

In addition to the above schemes, the Commission also administers, in conjunction with the Sir Misha Black Awards Committee, two awards in the field of design education, for which nominations are sought each year. Full details are available on the Commission's website but in brief these are:

#### *Sir Misha Black Medal for Distinguished Services to Design Education*

Global in reach, the Medal acknowledges the important contribution of individuals to the teaching of design at all levels, from anywhere in the world – as designers, as champions, as mentors and as educators.

#### *Sir Misha Black Awards for Innovation in Design Education*

Salutes educators from across the United Kingdom and celebrates the innovative achievements of institutions and individuals. Recipients may receive a bursary of £10,000 to advance their work in innovative design education.

Together the Sir Misha Black Medal and Awards recognise those who by innovation, vision and contribution to theory or practice have measurably improved the education of designers and enhanced the profile of design education.

## Achievements in 2022

The core activity – and primary achievement – of the Commission is identifying early career science and engineering graduates of exceptional promise and supporting their work with its prestigious fellowships and studentships. Full details of the awards made during the year are given on pages 14 to 22.

The true impact of the Commission's award holders will only emerge over time, but some evidence of the success of the various programmes can be gleaned from the achievements of those Fellows who completed their awards during the year and the positions they go on to secure. A representative sample of case studies is provided on pages 23 to 38.

Many completing Fellows comment quite explicitly on the importance of their Fellowship to their success:

*I'd just like to thank everyone at the Commission for their support over the course of my PhD, and for providing me with opportunities that I never thought I'd have. The Industrial Fellowship really has changed the course of my life and career for the better.*

Dr Adam McKenzie, Industrial Fellow 2018

*The Industrial Fellowship has had a substantial impact on my PhD and Data Science career. Firstly, the generous funding afforded me an extra day to spend on my PhD each week, allowing me to spend more time on my research. It's unlikely that I would have finished in time without this funding. The travel budget has also allowed me to visit several international conferences and continue to grow my scientific network. The fellowship has driven me to think harder about the industrial applications of my research. I believe my PhD has been more impactful as a result of this focus, in academic and industrial terms.*

*I have been promoted twice during my time as an Industrial Fellow and am now a Lead Data Scientist. My PhD helped me to develop a unique skillset as a data scientist, which is important for those pursuing technical career paths. I often present at external conferences, write thought leadership pieces and present to potential new clients, and I feel that my affiliation with the fellowship has helped with my credibility in all of these.*

Dr Adam Hornsby, Industrial Fellow 2018

*The 1851 Industrial Fellowship and the endorsement by the Royal Commission are a formidable combination that will undoubtedly pave the way for numerous opportunities in my future career. With these accolades, I am confident that I can make significant contributions to research and development in the UK, furthering my aim to advance scientific and technological innovation.*

Dr Euan Rodgers, Industrial Fellow 2020

*I'd like to express my deepest gratitude to the 1851 Royal Commission for providing me with unwavering support over the length of my fellowship. I have highly valued the freedom that the Commission has permitted for my research, finances, and conference travel. As I approach the end of the fellowship, I can honestly say that I am satisfied with what I have been able to achieve and have enjoyed the time profusely.*

Dr Tim Haskett, Research Fellow 2018

*I have thoroughly enjoyed my time as an 1851 research fellow and am very grateful to the Royal Commission for giving me the independence, stability and opportunities to jump-start my scientific career.*

Dr Luke Rhodes, Research Fellow 2019

*It has been a real privilege to have been an 1851 fellow these past three years. The funding from the Commission has enabled me to pursue exciting and innovative research directions that would not otherwise have been possible, and I am looking forward to building on these new discoveries in the*



*future! Sincere thanks to you and all of those at the 1851 for making this possible. I look forward to keeping in touch as a member of the alumni community.*

Dr Tessa Young, Research Fellow 2019

*Since graduating from the Innovation Design Engineering program, I have founded my own start-up, BLOOP (getbloop.co), which has been accepted to the Techstars Filecoin class of 2022. We recently launched our private alpha and filed a provisional patent for its technology. I am now fundraising for my first round outside of Techstars and Protocol Labs, a prominent organization in this space, has committed \$250k. I've also had the good fortune of presenting my work at places like FOSDEM '22 (Free and Open Source Developers Meeting), Dweb Camp 2022, Dweb Berlin Oct 2022, and ethDenver 2023. The Royal Commission's generous support helped make this happen, as my start-up is an extension of my master's thesis. I will remain forever grateful for the support of this organization and community!*

Joy Zhang, Industrial Design Student 2020

For some, it is clear that without the award from the Commission, their project would not have gone ahead or would have been much more limited in scope:

*Without the support of the Royal Commission, it would not have been possible to undertake this project. The opportunity to study at Oxford University has accelerated my career progression immensely without the financial burden of leaving full time employment. Working within a world leading institution has not only improved my academic knowledge and skillset but granted me introductions to medical professionals collaborating with the university, offering me unique insights and opportunities within the medical device sector. This has enabled me to grow my professional network in spite of various obstacles during my graduate studies.*

Jonathan Vince, Industrial Fellow 2018

*Without the Royal Commission's support, acquiring the highest quality chemical reagents, equipment and analytical tools (which were essential for us meeting our proposed research goals) would have presented an additional financial hurdle that would have ultimately limited the scope and impact of the work that we were to accomplish over the course of my DPhil.*

Dr Tatiana Rogova, Industrial Fellow 2019

*The Industrial Fellowship, effectively, turbocharged my research, taking a project outline that my supervisors described as being very ambitious for a single PhD project and making it attainable. To highlight just some of the impact, my Fellowship funding gave me the resources to run thousands of simulations, take in expertise from academia and industry, and develop a far greater understanding of how to create actionable intelligence with commercial and market relevance. Without the Fellowship, the project would still have gone ahead, however, it would have been the lesser for it and the scope would have needed to be limited.*

Dr Robert Rouse, Industrial Fellow 2019

*Thanks to the 1851 Industrial Fellowship, I was able to take my project to the next level by accessing additional capital. This boost in funding enabled me to expand the scope of the project beyond my initial vision and achieve a significant leap forward for the technology. Without this support, such progress would not have been possible, and I am grateful for the opportunity to accelerate my work and deliver tangible results.*

Dr Euan Rodgers, Industrial Fellow 2020

Many Fellows comment on the importance of the networking events the Commission organises and the exploration of new avenues to which they lead:

*As well as the multiple conferences I attended throughout my PhD, I attended many 1851 events down in London. These events were without doubt one of the highlights of my PhD and I loved coming down to hear about the excellent research people were doing around the UK. However, the clear standout for me was the opportunity to present my work to HRH at the most recent Presidential Dinner in 2022. This was a real honour and something I will remember for the rest of my life. While these conference and 1851 events were great fun, they also provided an excellent opportunity for me to develop my soft skills and I am in no doubt these experiences will stand me in good stead going forward in my career.*

Dr Euan Ward, Industrial Fellow 2018

*As an early career scientist, access to networking opportunities within the 1851 community has also been invaluable both as a means to connect with like-minded individuals and as a source of inspiration through interactions with its many highly distinguished members.*

Dr Ben Barnes, Industrial Fellow 2018

*One of the most enjoyable aspects of the Fellowship was meeting others within the UK's scientific milieu. Each evening I spent in the company of peers at various stages of their careers was filled with conversations which were invariably stimulating and inspiring. It is an enduring regret that the coronavirus pandemic made these a rare treat.*

Dr Jack Sutro, Industrial Fellow 2019

*Being part of the 1851 network has been a game-changer for my early-stage research career. The in-person events have provided an invaluable opportunity to connect with like-minded individuals, including fellow awardees and alumni, and have opened doors to new avenues of work beyond my doctoral project. The presentations delivered at these events have been of exceptional quality, enabling me to stay abreast of the latest developments in diverse fields. Overall, the 1851 network has been a significant boost to my professional growth, and I am grateful for the opportunity to be part of such a dynamic community.*

Dr Euan Rodgers, Industrial Fellow 2020

*I've recently been discussing a collaboration with Jim Al-Khalili and Johnjo McFadden on understanding the role of vibrations in photosynthetic complexes, which has come directly out of a conversation with Jim about my poster at the 1851 presidential dinner in March 2022.*

Dr Susannah Bourne-Worster, Research Fellow 2018

It is gratifying that Fellows often comment on the ease of administration and quality of communication with the Commission:

*I appreciated the very light bureaucratic touch of the Commission, which to me was truly indicative that it was 'by scientists, for scientists'.*

Dr Jack Sutro, Industrial Fellow 2019

A sentiment echoed by Industrial and Academic Supervisors:

*The efficient and light-touch bureaucracy was most refreshing allowing all parties to focus on the science.*

Professor Jonathan Burton, Academic Supervisor

*The scheme is very well run and the lack of complication in the application process and the provision of funding etc makes it very attractive.*

Dr David Greig, Industrial Supervisor

Academic and Industrial Supervisors are also very complimentary about the Commission's Industrial Fellowships more generally:

*The 1851 Industrial Fellowship is truly wonderful, not just in enabling us to distribute our limited finances more broadly, but because it fosters relationships between the company and leading researchers, enables bright young scientists/engineers to realise their dream, and by investing in the student while they continue to work in the company aids retention.*

Sir Mike Brady, Industrial Supervisor

*I would most definitely recommend the Industrial Fellowship to other companies. Being associated with the Industrial Fellowship certainly increases the prestige of the project and really provides excellent recognition for the student and the academic group, I really cannot stress this enough. Also, there is minimal bureaucracy associated with the Industrial Fellowship and all contact with the Commission was very clear, succinct and much appreciated.*

Dr Adrian Hall, Industrial Supervisor

*I would sincerely recommend the Industrial Fellowship scheme to other companies, as the tremendous support and social network that results from participation in this programme is of great benefit to the company, the academic institute and scientific advancement as a whole.*

Dr Thomas Clohessy, Industrial Supervisor

*The Industrial Fellowship scheme of the Royal Commission for the Exhibition of 1851 is truly unique in the UK and I would recommend it whole heartedly to my colleagues. The resources available to the project allowing us to buy bespoke equipment and the expensive chemicals necessary to carry out the work were invaluable in allowing the exploration, discovery and ultimately development of the conceptually new and broadly applicable methodology.*

*The Industrial Fellowship is unique, simple in structure, responsive to individual project needs, and effective. Any scheme that puts the science front and centre is a great one, and long may it continue.*

Professor Darren Dixon, Academic Supervisor

*The contact made with the sponsoring company through the Industrial Fellowship has strengthened my ties with industry and raised the profile of my research group's chemistry and my research group in an industrial setting, giving not only added future benefits for me as a PI but for the future careers of my co-workers.*

Professor Jonathan Burton, Academic Supervisor

A more complete picture of the impact of the Commission's awards comes from the honours and awards bestowed on more senior alumni – some highlights are given on pages 39 – 42.

Many of our alumni tell us that their Fellowship has made a decisive – and lasting - difference to their career:

*My 1851 Fellowship laid the foundation for my current career as a Principal Investigator at the University of Edinburgh. My research focuses on fat accumulation within our bone marrow and how this influences health and disease, including conditions such as diabetes, osteoporosis and immune function. I never would have embarked on this area had it not been for the support of my 1851 Fellowship: it allowed me to pursue postdoctoral research at the University of Michigan, where I was first introduced to the topic of bone marrow adiposity. My research in this field continues to go well, as reflected by my promotion to Senior Lecturer in August 2022. In addition to my research interests, I have also taken an active role in science policy and communication, with a focus on Open Research. In 2021 I was appointed the University of Edinburgh Open Science Ambassador for LERU (The League of European Research Universities). My efforts in this role were recognised at the University of Edinburgh's inaugural "Good Research Practice Awards" in November 2022, where I was awarded the "Open Research Award". Despite many challenges, I very much enjoy continuing*

*to pursue the research that first began with my 1851 Fellowship, and I remain very grateful for the support this provided.*

Dr Will Cawthorn, Research Fellow 2009

*The award of the 1851 Research Fellowship was really a pivotal moment for my career. It was my first opportunity to undertake full-time postdoctoral research. The independent lines of research that I established during my fellowship are now bearing fruit in terms of my academic appointment, research funding and outputs, but it all started with my 1851 award.*

Dr Beth Mortimer, Research Fellow 2016

*The Industrial Fellowship really gave me the confidence to step outside of my primary discipline (chemistry) and to bring together biology, chemistry, engineering, and data science. I now lead a team of 30 fantastic scientists and engineers, and our business is going from strength to strength.*

Tom Fleming, Industrial Fellow 2016

As well as its core fellowships and studentships, the Commission also runs a very successful Special Awards programme, supporting individuals and institutions with similar aims to the Commission. As in previous years, many of the awards reflect the Commission's continuing commitment to raising the awareness of the young to the opportunities presented by science and engineering. They include awards to: Somerscience Trust for a STEM festival in Somerset; Smallpeice Trust for a series of residential courses designed to introduce young people to the full range of engineering disciplines and careers; EDT to support courses for disadvantaged young people to help them navigate the different routes into STEM degrees and apprenticeships; and Well North Enterprises to support initiatives to increase uptake of STEM apprenticeships in Rotherham.

The impact of such Special Awards may take some time to become apparent, but a brief look at some of the awards made in the last couple of years gives a flavour of what can be achieved.

In 2020, the Commission gave a Special Award to the London Transport Museum (LTM) to support their Engineering your Neighbourhood project, which aimed to create digital resources for use during the COVID pandemic which would raise the profile of engineering with primary school children at a time when museum visits were not possible. The project focused on one neighbourhood, Acton, an area with some of the UK's highest levels of deprivation where the museum has a strong presence through its depot.

The project aimed to develop children's knowledge about transport and engineering, improve their perceptions of transport and engineering careers, improve creative STEM skills and competencies and improve pupils' perceptions of their local area. Pre and post activity surveys suggest that the project had some success (albeit from a very low base), increasing confidence in understanding the importance of transport and engineering by 30% and enthusiasm for transport and engineering careers by 20%.

The enduring legacy of the project includes a teacher resource pack, a virtual workshop, session plans for use with the virtual workshop, a design challenge, and five videos that can be used with primary children to introduce them to transport engineering and the different careers available to them in that area. As of spring 2022, the virtual session had been used with over 540 children nationwide. From April 2023, LTM intend to devise a webinar version of the virtual session linked to a key annual moment such as British Science Week with the aim of reaching a much larger number of schools. LTM also hope to explore the potential for using the virtual session as the basis for ongoing teacher CPD sessions. Learning from the project is also influencing LTM's wider education work.

Perhaps the most successful element of the project was the local dimension, with teachers reporting that almost all pupils came away with a much better understanding of what was unique and special about their local area. LTM are hoping to develop long term partnerships with a number of local primary schools to support learning across the curriculum through catalysing local stories and assets. They anticipate sustained engagement of this sort will have a significant impact on negative gender perceptions around transport and engineering.

Another Special Award, this time focused on secondary school children, built on research by the Royal Society and the Education Endowment Foundation that has found that literacy skills are key to raising aspirations and closing the attainment gap in STEM subjects. They are also of course essential for employability.

In 2021 the Commission gave a Special Award to the National Literacy Trust (NLT) to enable them to roll out a digital teacher training offer linking literacy and careers within STEM to 259 secondary school science teachers working in areas with high numbers of disadvantaged young people. All CPD activities were based on evidenced research of what constitutes effective practice in the teaching of disciplinary literacy in STEM. Pre and post course reading was provided to signpost further opportunities. A number of high-profile STEM individuals were featured in the materials, talking about their career journey and the importance of literacy in their workplace.

An external evaluation found that the training offered “well-structured, impactful and evidence-based insight for science teachers exploring the value and importance of developing literacy to increase science attainment in school, as well as introducing key improvement strategies...and could be used as a driver for increasing overall literacy as well as science attainment across the UK, particularly in regions at disadvantage”.

NLT report that as a result of the training they have seen a marked increase in requests from participating schools for NLT to train whole departments rather than just individual teachers. In one area, Stoke-on-Trent, the training is now being made available to all secondary mathematics teachers. It is too early to evaluate how teachers who attended the training sessions are implementing and embedding it in practice, but NLT intend to conduct a number of case studies to follow up on this.

Parts of the training materials, in particular the careers resources, are also being made available on the Careers Corner part of NLT’s website, aimed at young people looking to improve their own literacy skills. This section of the website receives approximately 8,000 page views per month.

As the examples above illustrate, the Commission funds a wide range of innovative STEM initiatives at varying scales, recognising that not all will achieve huge success, but in the hope that most will transform individual lives, and some will go on to have considerable reach. Needless to say, not all Special Awards proceed completely smoothly, and many recent awards are suffering significant delays in implementation as a result of the pandemic. Nevertheless, anecdotal evidence suggests that it is interventions such as these that can make all the difference in stimulating young people to become the scientists and engineers of tomorrow and the Commission remains committed to doing what it can.

As well as funding STEM outreach projects, the Commission also provides Special Awards to enhance its legacy estate in South Kensington and help the world leading institutions of Albertopolis to extend their reach. As mentioned in the Chairman’s Report, in 2022 these included a grant to the Natural History Museum in support of its Urban Nature Project and a grant to the Exhibition Road Cultural Group in support of the SouthKenZEN+ initiative, which is discussed further in the next section.

## Future Plans

The Commission's Research Fellowship scheme celebrated its 100th anniversary in 2022 and various of its other Fellowship schemes have been going for over 30 years. The Commission continues to explore new schemes, however, and following a five-year pilot, Commissioners have approved the introduction of a new set of Technical Teaching Fellowships as part of the Commission's core programme. The first fellowships under the new scheme will be advertised in 2023 and commence in 2024. Awarded through the Education and Training Foundation (ETF), these fellowships will be open to outstanding UK-resident Further Education practitioners who are recognised for their high impact teaching practice. Fellows will be expected to share their expertise and learning across the sector as part of the award with the aim of supporting quality improvement in technical teaching and learning. Fellows will receive an award of £5,000 – £15,000 to support knowledge transfer activity and to ensure remission time is guaranteed. They will also be allocated a programme mentor to support them for the duration of the Fellowship and will attend developmental workshops. Commissioners have agreed to make available up to £100k pa to support these awards which it is hoped will do much over time to improve the provision of STEM learning within the FE sector.

The Commission is very conscious of its responsibilities in the field of sustainability. As explained in the Chairman's report, the Commission has been working with its legacy institutions on a new initiative, SouthKenZEN+ (South Kensington Zero Emission and Nature Positive Neighbourhood), intended to identify ways in which the Albertopolis institutions can work together and learn from each other to accelerate the transition of South Kensington as an exemplar, world class, zero emission and nature positive urban neighbourhood. During 2023, the Commission will be exploring the scope to apply the principles discussed as part of this initiative to the refurbishment of one of its short lease properties to see if it can provide a case study of what can be achieved in the Albertopolis area.

## Awards Granted in 2022

### Research Fellows

**Dr Harvey Dale**

*Subject:* Chemical origins of the genetic code: Lost in translation

*MRC Laboratory of Molecular Biology*

By assimilating Dr Dale's expertise in physical organic chemistry, the Sutherland group's renowned competence in prebiotic synthesis and the critical mass of biological expertise at the LMB, this project will address a perennial challenge in natural science: demonstrating a plausible mechanism for the prebiotic emergence of translation, and thereby the genetic code.

**Dr Mark England**

*Subject:* Investigating the near-term climate benefits of reducing methane emissions: Methane MIP

*University of Exeter*

Governments have made reducing methane emissions central in their climate policy. However, the climate impacts of methane mitigation strategies are largely unknown. This project will lead an internationally coordinated set of simulations with state-of-the-art comprehensive climate models to provide policymakers with the first robust estimate of the climate benefits of methane mitigation.

**Dr Tim Hageman**

*Subject:* Next-generation ice sheet fracture models to quantitatively predict sea-level rise

*Imperial College London*

This project will develop novel numerical methods to simulate ice sheet melting, fracture, and its effect on sea-level change. This will be achieved through combining upcoming numerical methods to simulate fluid flow within crevasses and fractures with state-of-the-art discretisation schemes, providing new insights into interactions between climate change and sea-level rise.

**Dr Gal Kronenberg**

*Subject:* Edge colouring and decomposition of graphs and hypergraphs

*University of Oxford*

One of the most basic problems in graph theory is decomposing a graph into simpler subgraphs. This project will consider this problem in the context of edge-colouring of hypergraphs (splitting into matchings), as well as the linear arboricity number (splitting a graph into linear forests), also in the random graph setting.

**Dr Harry Lane**

*Subject:* Stabilising magnetism in two dimensions

*University of St Andrews*

Two-dimensional (2d) magnets offer promising platforms for the creation of new quantum devices and memory storage media. Unfortunately, nature often conspires to destroy magnetism in 2d as fluctuations overcome the tendency to order. This project combines spectroscopy and modelling to suggest routes towards stable 2d magnetism, unlocking new applications.

**Dr Daniel Leybourne**

*Subject:* Elucidating the agro-ecological factors influencing virus success in cereal ecosystems

*University of Liverpool*

Barley yellow dwarf virus is a devastating aphid-vectorised cereal virus. Virus-vector-host interactions are rarely studied in an ecosystem context. This project will further our understanding of how the ecosystem influences virus-vector-host interactions, providing knowledge that will facilitate the development of nature-based pest and disease management solutions.

**Dr Alex Riley**

*Subject:* Constraining the nature of dark matter with galactic halo substructures

*Durham University*

This project combines observations with state-of-the-art cosmological simulations of galaxy formation in order to help answer one of the most fundamental questions in modern physics: what is dark matter? This will be achieved by modelling the orbits of dwarf galaxies and stellar streams around our Milky Way galaxy.

**Dr Sathyawageeswar Subramanian**

*Subject:* Quantum algorithms for testing and learning

*University of Warwick*

This project will construct novel quantum algorithms for practical problems such as testing how much entanglement an arbitrarily large quantum state contains by studying only minuscule fractions of it, while also tightly characterising their power in tackling such problems by proving bounds on their theoretical limits.

## Brunel Fellow

**Dr Roy Bartle**

*Subject:* Thermal desalination with renewable hydrogen energy

*University of the Highlands and Islands*

The aim of this project is to improve the sustainability, efficiency, and reliability of water desalination. Globally, water is a scarce commodity but essential to sustainable communities. Thermal desalination with hydrogen energy storage and seawater heat pumping has the potential to produce drinking water sustainably and efficiently from seawater.

## Industrial Fellows

**Joseph Counte**

*Subject:* Reducing temperature uncertainty in thermal memory coatings for advanced gas turbine applications

*Sponsor:* Sensor Coating Systems Ltd

*University of Nottingham*

The project will aim to reduce temperature uncertainty in Thermal History Coatings below  $\pm 10^\circ\text{C}$  across the temperature range of 800-1600°C. This will be achieved by building a self-consistent measurement framework informed by material analysis, using both luminescence life-time decay and emission spectra methodologies in parallel.

**Jessica Crompton**

*Subject:* Synthesis of quaternary stereocentres via hydrogen borrowing catalysis

*Sponsor:* GSK

*University of Oxford*

This proposal details the synthesis and derivatisation of quaternary stereocentres using the sustainable, green method of hydrogen borrowing catalysis, transforming the chemical space accessible via this method. This will have important applications in the pharmaceutical industry as increasing the three-dimensional space utilised by drug candidates can have significant beneficial effects.



**Matthew Diable**

*Subject:* Development and industrialisation of novel hyperbranched photopolymers via proprietary technology to revolutionise 3D printing

*Sponsor:* Scott Bader

*University of Liverpool*

This project focuses on overcoming persistent challenges in 3D printing technologies through the development and industrialisation of new and highly valuable hyperbranched photopolymers. Such polymers will be obtained via a novel and industrially relevant polymer technology recently developed at the University of Liverpool and exclusively licensed to Scott Bader (Polymer Mimetics).

**Finbar Gaffey**

*Subject:* Developing a platform to improve the identification of therapies for Motor Neurone Disease

*Sponsor:* LifeArc

*University of Sheffield*

This project addresses the urgent need for therapeutic targets against MND by developing a highly reproducible cellular model, suitable for automated industrial research. Using novel artificial intelligence and genetic engineering, genes/targets linked to MND will be investigated in this system and confirmed further in complex disease models.

**Magdalene Ho**

*Subject:* Home-grown therapeutics – using bioinspired nanotechnology to harvest patient-derived biologics for healing chronic wounds

*Sponsor:* ConvaTec

*Imperial College London*

This project aims at optimisation of a novel, interactive wound-healing biomaterial for clinical use by affordably sourcing protein therapeutics from blood and optimising design parameters to enable synergistic healing effects, thereby reducing required protein dosage for therapeutic efficacy. These optimisations would considerably reduce production cost and increase accessibility of treatment to frontline/low resource environments.

**Aleksandra Nikoniuk**

*Subject:* Integrating automated microfluidics process analytical technology platforms into autologous CAR-T cell manufacturing

*Sponsor:* Autolus

*University College London*

This project will aim to develop and integrate an automated microfluidics process analytical technology linked to semi-automated bioreactors used for autologous cell therapy manufacturing. This will remove the use of complex analytical equipment, improve precision and speed of analyses, which overall will lead to more consistent product quality.

**Nicholas Nyamayedenga**

*Subject:* Practical approaches to address non-dewatered alum sludge properties and benefits of dewatering

*Sponsor:* James Mae Group

*University of Bradford*

Alum Water Treatment Sludge is usually dewatered to about 18 to 20% solids and disposed of to landfill. This work proposes to explore and utilise the freeze-thaw technique to further dewater the sludge. The work will also explore both chemical and mechanical properties related to problems of dewatering alum sludge.

**Joe Ross**

*Subject:* Cell state estimation for modular battery packs

*Sponsor:* Brill Power

*University of Oxford*

This project aims to use the power electronics in a modular battery management system to develop a novel method of extracting state estimation information from cells in a battery pack. The goal is to develop a hardware augmented state estimation technique for modelling power capability and thermal induced voltage hysteresis.

**James Rowley**

*Subject:* A platform for the high-throughput screening of reactive fragments in cells

*Sponsor:* GSK

*University of Oxford*

This project aims to develop a novel platform for the high throughput screening of large libraries of reactive fragments (>1000) in live cells. Unlike current methods, which rely on low-throughput mass spectrometry, this platform will provide a way to simultaneously quantify the covalent labelling of proteins by reactive fragments.

**Yohn Taylor**

*Subject:* Development of hyperpolarised  $^{129}\text{Xe}$  magnetic resonance imaging to provide a novel translational drug-development imaging framework

*Sponsor:* GSK

*University College London*

Preclinical to clinical translational evaluation of gas exchange utilising hyperpolarised  $^{129}\text{Xe}$  MRI is limited due to the intrinsic combination of compartmental (tissue/RBCs)  $^{129}\text{Xe}$  MR signals in mice. This proposed research will develop novel techniques permitting compartmental interrogation, primarily for the translational assessment of lung function within the drug-development pipeline.

## Enterprise Fellows

**Ryan Beal**

*Company:* Sentient Sports

SentientSports has built an AI tool that analyses many years of historical data, that allows management to simulate how a given decision will impact the performance of their teams both strategically (e.g., buying players), and tactically (e.g., team tactics for each game). This acts as a “data-scientist-in-a-box” analytics package that saves teams the price of employing a data scientist/analyst (approximately £100k per year due to AI skill shortages) but still allows them to fully utilise their data effectively. The models allow coaches/managers/analysts to assess the likely real-world impact of their decisions thereby increasing their assurance that their decisions, taken in a high pressure and often tight timescale environment are the best that they can be. For example, in football recruitment the model can simulate how a player will link with teammates, fit the manager tactics and provide a return on investment.

**Henry Harrod**

*Company:* Fourier Audio [Financially supported by the ERA Foundation]

Fourier Audio’s *Transform* brings the power of studio-grade plugins to the live sound engineer, enabling a new world of creative possibilities in a dependable, show-ready platform. *Transform* is built on Fourier Audio’s novel audio processing engine designed with real-time reliability at its core. Crucially, engineers will no longer be tied down to a single manufacturer and be able to use the best plugins available to unleash their creativity without compromise. In addition, a beautifully intuitive control surface will let designers tweak and experiment with the speed and versatility needed in a live environment providing a single unified interface across the huge range of VST plugins available on the market. In a field dominated by Heath Robinson set-ups and single-manufacturer lock-ins, *Transform* will rip up the rulebook creating a whole new universal creative platform.

**Samuel Willis**

*Company:* PolyMetrix

PolyMetrix has developed a digital platform for autonomous personalisation of 3Dprintable wearable devices and for analytical processing (fit testing). Both services are available to a user simply by uploading their three-dimensional biometric data (captured using depth-sensitive mobile cameras found in most new smartphones). Since the services involve no human intervention or specialized equipment, they constitute the first affordable and reliable path for personalised wearable products. Current MVPs are personalised FFP3, CPAP, Nebuliser masks, eyewear, clinical facial mimics, and the digital fit-testing platform. Services will initially be offered B2B (to partner companies seeking to improve their value-chain through e-commerce services like digital fitting or introduce fully personalised products). Once the brand is established PolyMetrix will sell B2C (producing its own fully personalised products).

**Rowan Armstrong**

*Company:* BioLiberty

BioLiberty has developed a soft robotic glove which can be used as an active assessment tool for hand mobility, as well as a rehabilitative tool to help regain hand strength. BioLiberty's device can accurately track improvements over a period of time, and also help carry out customised rehabilitation programmes based on this data. The underlying technology behind BioLiberty's technology is soft robotics and biomedical signal processing.

**Joseph Bentley**

*Company:* ACT Medical

REACT is the world's first bleed control system designed specifically for knife wounds. It can stop bleeding much faster than current technology. It uses expandable, silicon-based tamponades to rapidly fill stab wounds. By equipping first responders, REACT could save thousands of lives.

**Will Dubin**

*Company:* Manhole Metrics [Financially supported by the ERA Foundation]

Manhole Metrics has developed ultra-low-cost, long-life sensors which can be mounted to the underside of manhole covers making for easy installation. This allows for collection of data from sewers and drains to give real-time flood warnings. Following correlation with weather data and water usage it also enables prediction of flooding and identification of blockages, enabling problems to be tackled proactively through effective interventions, limiting damage to assets and the resources required as well as mitigating the environmental and social consequences.

**Fergal Mackie**

*Company:* Metacarpal

Metacarpal has created an affordable purely mechanical prosthetic hand with all the features and cosmetics of electronic/bionic models, improving amputees' lives and confidence. To achieve those supreme functions, a variety of different mechanisms have been developed, many of which are entirely novel to prosthetics.

## Design Fellow

### **Robert Johnson**

*Subject:* Fatconomy – The Uncharted Future of Fat

*Mentor:* Kuang-Yi Ku, Sheffield Hallam University

Fatconomy is a waste design project set up to intervene in the UK's current oil and fat waste system. The current system sees waste oil and fats being disposed from commercial kitchens and subsequently converted to biofuel. It is edging closer to uncertainty with the impending reality of energy transition to hydrogen and electric; this transition will soon affect the small biofuel producers who are integral to our fat and oil waste cycle. By zooming in on the current biowaste issue that is prevalent throughout all small biofuel factories, a cross-collaborative approach is being formed to benefit non-extractive material innovations and future models for cleaner fuels.

The foundation of this project is to communicate and create stories of material and labour narratives around the system that produces waste fats and oils, and stories of labour and trade that highlight future thinking which champions innovation from everyday circumstances and objects. Looking through the lens of 'fat' as a valuable material resource in urban society, several design investigations will take place that will create a holistic service design methodology, acting as a connecting block between industry, the public, and governmental policy. The project will illustrate current obstacles that are in place within the biofuel sector, whilst creating future solutions where elements of the current biofuel cycle are harnessed to craft new materials from the same waste stream that is used to create biofuel. The project will probe new scenarios that utilize the power of speculative design to bring forward design-led ideas and innovation within the biofuel and bio-waste realms.

## Regenerative Design Fellows

### **Oliver Broadbent**

*Subject:* Developing practice-based methodology for regenerative design in the built environment

*Mentor:* Professor Rowan Conway, University College London

The aim of this project is to help move the built-environment sector away from a paradigm of extraction and growth towards a paradigm of continual renewal of human and natural systems in harmony with one another. This is Regenerative Design. Its principles are established in theory – the work of this project is to develop ways to bring theory into wider practice in construction and engineering.

The focus point for the project will be influential designers, construction industry professionals and policy writers, who between them have the power to shift the way we conduct design. The aim is to upskill these people to use their influence to move design and construction from a paradigm of extraction and growth to a paradigm of continual renewal.

Central to the project will be the Regenerative Design Lab, a newly established programme that explores and develops regenerative design principles through experiments in practice. Over the next two years it is hoped to work with 60 built environment professionals to develop a language and blueprint for how to turn regenerative design from theory into practice in our industry. The output will be the Regenerative Design Pattern Book. These are the patterns for thinking about regenerative design that can enable influential designers and construction-industry professionals to shift the system's rules and interrelationships towards more regenerative outcomes.

### **Michael Pawlyn**

*Subject:* Regenerative micro-dwelling

*Mentor:* Dr Daniel Christian Wahl, Design for Sustainability

This project aims to create a full-scale prototype of a regenerative micro-dwelling made entirely from materials sourced on the site itself. By using innovative mycelium insulation together with round-pole timber and natural stone, the intention is to create comfortable living conditions while taking carbon out of the atmosphere and regenerating the biodiversity of the site.

## Sir Misha Black Medal for Distinguished Services to Design Education

**Professor Elizabeth “Dori” Tunstall**

*Dean, Faculty of Design*

*OCAD University, Toronto, Canada*

Professor Tunstall is internationally recognised for her work decolonising design education and opening it up to people from Indigenous, Black and other ethnic minority peoples, providing pathways to making the sector more reflective of the society that it shapes.

Professor Tunstall has done that in two ways. First, by being a powerful symbol of what is possible. Professor Tunstall is the first Black and Black female Dean of a Faculty of Design anywhere in the world. She is a highly visible and vocal design thought leader. Second, by embedding an ethos of Respectful Design (valuing inclusivity and people’s cultures and ways of knowing) across the six design programmes at OCAD University - their enrolment, academic quality and student experiences – as well as creating an online course to help other institutions.

## Sir Misha Black Award for Innovation in Design Education

**Judah Armani**

*Founder, InHouse Records*

Judah Armani is best known as the founder of InHouse Records: a record label and design education project operating in multiple UK and USA prisons. It adopts a social innovation design approach to build hosting, convening, facilitating, illustrating and co-designing opportunities for prisoners. Engaging with the label is found to increase positive behaviour within prison. InHouse also achieves a re-offending rate of less than 1% in the community, with returning citizens able to continue working with recording studios across the south-east. This year InHouse will perform at the Brighton and Latitude festivals.

## Industrial Design Students

|                              |                                  |                                                     |
|------------------------------|----------------------------------|-----------------------------------------------------|
| G Antonio Alberti<br>Leonett | Design Thinking                  | Cranfield University                                |
| Grace Louise Duan            | Innovation Design Engineering    | Royal College of Art and<br>Imperial College London |
| Steph Jump                   | Innovation Design Engineering    | Royal College of Art and<br>Imperial College London |
| Vedika Lall                  | Global Innovation Design         | Royal College of Art and<br>Imperial College London |
| Jasper Mallinson             | Innovation Design Engineering    | Royal College of Art and<br>Imperial College London |
| Hunaid Nagaria               | Innovation Design Engineering    | Royal College of Art and<br>Imperial College London |
| Frintan Pritchard            | Industrial Design and Technology | Loughborough University                             |
| Mia Shepherd                 | Product Design                   | University of Strathclyde                           |
| Tori Simpson                 | Global Innovation Design         | Royal College of Art and<br>Imperial College London |
| Alexander Spencer            | Innovation Design Engineering    | Royal College of Art and<br>Imperial College London |
| Eve Townsend                 | Innovation Design Engineering    | Royal College of Art and<br>Imperial College London |
| Jacob Wellsbury              | Innovation Design Engineering    | Royal College of Art and<br>Imperial College London |
| Benjamin Williams            | Innovation Design Engineering    | Royal College of Art and<br>Imperial College London |

## Special Awards Granted

### *STEM education and outreach*

MadeHereNow – Website sponsorship

Smallpeice Trust – General engineering course

EDT – Routes into STEM: Industrial Cadets silver-level pilot

Well North Enterprises – STEM development in Rotherham and Liverpool

Somerscience Trust – Somerscience Festival

WoMars – STEM outreach

Royal Designers for Industry – Summer schools

### *Support for legacy estate*

Natural History Museum – 1851 Garden

Royal Horticultural Society – Plants for purpose

Exhibition Road Cultural Group – SouthKenZen+

Exhibition Road Cultural Group – Art installation on Exhibition Road

Royal College of Art – Open resource for purposeful design

## Awards completed in 2022

### Research Fellows

#### **Dr Susannah Bourne-Worster**

*Project:* New design principles for biomimetic photosynthesis

*University of Bristol*

The light-harvesting antennae of plants and bacteria transport absorbed solar energy to photosynthetic reaction centres with enviably high efficiency. Susannah's aim was to identify key design elements that could be mimicked to enhance the efficiency of our own light-harvesting technologies.

During her fellowship, Susannah revealed that close proximity of the light absorbing molecules (chromophores) in the antenna is more important than their precise arrangement (doi: 10.1021/acs.jpcclett.9b02625). This disproved the popular hypothesis that natural antenna complexes are optimally structured to preserve functionally important quantum effects. However, high concentrations of chromophores also give rise to rapid energy loss, in a way that is not fully understood. Susannah established the feasibility of the hypothesised loss mechanism and, moreover, showed that the relative 'stiffness' of the photosynthetic protein environment facilitates a perfect balance allowing chromophores close enough for efficient energy transfer without risking catastrophic energy loss (doi: 10.1073/pnas.2210811120).

Together, this work suggests a new approach to designing artificial light-harvesting materials, where synthetically challenging structural constraints could be relaxed, and more attention devoted to creating a host environment that supports transport and minimises loss. Susannah will explore these ideas further as a research associate with Graham Worth at UCL, looking at environmental influences on the light-driven behaviour of small molecules.

Modelling large photosynthetic complexes is challenging and Susannah has pioneered methods to investigate these systems at a previously unattainable scale. In particular, she developed a way to reliably use computationally inexpensive delta-SCF methods for calculating the properties of chromophores after absorbing light (doi: 10.1063/5.0041233).

#### **Dr Frances Dunn**

*Project:* The rise of animals: challenging Darwin's dilemma

*Oxford Museum of Natural History*

Our understanding of the evolutionary emergence of animals – one of the most profound events in Earth history – remains poorly constrained, with major questions concerning the tempo and pattern of the appearance of different animal lineages. However, the vast majority of studies concerned with understanding these and related macroevolutionary questions ignore the well-known fossils of the Ediacaran macrobiota, widely held to include antecedents to living animal groups. This is a significant problem because these data are directly relevant to understanding the nature of the Cambrian Explosion – a geologically rapid interval when the bodyplans of all major animal lineages appear near synchronously in the fossil record – but remain little explored. During her fellowship, Frances demonstrated the animal-affinity of a subset of Ediacaran macrofossils which possess totally extinct bodyplans and have extended the record of members of at least one living animal group to 30-million years before the onset of the Cambrian Period, confirming the baroque nature of early animal evolution.

Frances has now moved onto a 5-year NERC-funded independent research fellowship, which she holds alongside a permanent position at the University of Oxford in the Museum of Natural History as Senior Researcher. Her research programme will expand on themes she first investigated during her time as an 1851 Fellow, looking at the role Ediacaran macrofossils can play in our understanding of early animal evolution as well as moving up the geological record to study fossils from the time of the Cambrian Explosion itself. She hopes to establish whether the Cambrian Explosion does record the most rapid period of anatomical evolution in animal evolutionary history, or whether there is more nuance, with a rapid ancient radiation of some lineages deep in the Ediacaran Period.



**Dr Aden Forrow**

*Project:* Modelling and inference in single-cell RNA sequencing

*University of Oxford*

Aden set out to develop mathematical tools for analysis of single-cell sequencing data and to build productive relationships with theorists and experimentalists at Oxford. His core accomplishments were achieving those goals. He published an algorithm, LineageOT, for inference of gene expression dynamics from single-cell time courses with lineage-tracing barcodes, and he continues to work on improvements, extensions, and applications. Experimentally, he worked with Professor Tatjana Sauka-Spengler on studies of the zebrafish neural crest and Dr. Oliver Stone on developmental sources of lymphatic endothelium.

Aden's Fellowship also allowed him the freedom to take advantage of opportunities he had not foreseen. He participated in a consortium effort called COMBAT to characterise the immune response of patients to coronavirus infections of varying severity. On his own, he followed up a small, surprising observation by conducting a thorough analysis of the efficiency of likelihood-free inference algorithms, which the field sorely needed. Throughout his Fellowship, he complemented his research work with teaching and mentoring undergraduate and masters students in classes and for a series of summer research projects.

This fall Aden will start as an Assistant Professor in the Department of Mathematics at the University of Maine. His research will stay in the niche he has found at the interface of statistics and biology, with both continued projects with current collaborators and new directions with future colleagues.

**Dr Matthew Gleeson**

*Project:* Decoding the crystal record of volcanic eruptions

*Cardiff University*

Matthew's fellowship set out to use the chemical signature of volcanic crystals to further our understanding of magma transport prior to volcanic eruptions. Determining the nature of magma transport is a critical area of research in volcanology, as it has recently been discovered that most 'magma chambers' are dominated by solid crystal phases that raise the viscosity of the system and thus impede eruptions. As a result, for an eruption to occur, magma must first be extracted from these crystal-rich regions and Matthew's research aimed to provide new insights into the mechanism of melt extraction.

Owing to the COVID-19 pandemic, the focus of Matthew's fellowship was forced to shift from analytical to theoretical. He developed new computational models of the chemical reactions that take place in magma chambers beneath volcanoes, demonstrating that certain chemical and thermal parameters cause the permeability of magma mush systems to increase, aiding magma transport and accumulation prior to eruption. This theoretical work is now being tested via ongoing work focusing on volcanic products from Hawai'i and the Galápagos.

During the second year of his fellowship, Matthew was offered a position at the University of California, Berkeley, as a Lecturer and Assistant Researcher. In July 2022 he moved to California to take up this position and now teaches both general and specialized Earth and Planetary Science courses. In addition, his research into the nature of magma transport continues with new analytical methods being developed to identify porous flow in crystal rich magma systems.

**Dr Tim Haskett**

*Project:* Development of genetic tools for rhizosphere engineering

*University of Oxford*

Tim's fellowship focused on developing genetic tools to engineer soil bacteria for the benefit of sustainable agriculture. Tim not only developed several tools for this purpose but also applied these to generate the first "synthetic nitrogen fixing symbiosis" between soil bacteria and barley where the engineered cereal crop can trigger co-engineered soil bacteria to supply a source of available nitrogen that is essential for plant growth. Such a system could be pivotal to reduce current inputs of chemically synthesised nitrogen fertilisers that are becoming increasingly detrimental to the environment.

During his fellowship Tim published five peer reviewed papers as first author in prestigious journals such as PNAS and ISME J and published a further two papers as a co-author.

Tim is now working for the newly formed Silicon Valley start-up company SwitchBioworks (<https://www.switchbioworks.com/>) where he intends to further develop synthetic nitrogen-fixing symbiosis for practical use. He will be working primarily on the biotechnology side of the company but also intends to use this opportunity to further educate himself in non-scientific areas such as marketing, business and finance management, and protection of IP.

**Dr Amit Hazi**

*Project:* Diagram algebras via Soergel bimodules

*City, University of London*

The concept of symmetry is omnipresent in the sciences. The mathematical study of symmetry is called representation theory. Representation theory seeks to better understand abstract algebraic objects by representing them concretely as collections of symmetries of more familiar objects. Besides its intrinsic utility within mathematics itself, representation theory also underpins our current understanding of physics and has applications in chemistry and crystallography.

A fundamental problem within representation theory is to break down complicated symmetries into their irreducible constituent representations. The irreducible representations are roughly analogous to atoms in chemistry, forming the building blocks for all symmetries. The most successful approaches to this problem exploit 'higher' symmetry, or 'symmetries of symmetries'. Continuing with the chemistry analogy, this is akin to studying molecules which themselves exhibit reflection symmetry in three-dimensional space. Instead of decomposing a single molecule which exhibits higher symmetry, it is often easier to construct \*all\* molecules which exhibit some fixed higher symmetry (e.g., reflection symmetry about a line) and then to identify any given symmetric molecule with one that's already been constructed.

Amit's research focuses on diagrammatic Soergel bimodules, which provide the most general method for constructing such higher symmetries using diagrams involving coloured 'strings'. During his fellowship, he established a direct correspondence between diagrammatic Soergel bimodules and a classical diagram algebra (the cyclotomic Hecke algebra), considerably generalizing a celebrated result of Riche-Williamson. Amit also gave a complete description of diagrammatic Soergel bimodules in the setting of Hermitian symmetric pairs.

Amit is now a postdoctoral research associate at the University of York.

**Dr Luke Rhodes**

*Project:* Emergent electronic properties of strain tuned superconducting materials

*University of St Andrews*

A holy grail of condensed matter physics is the creation of a room temperature superconductor. A material that can conduct electricity without resistance, and therefore doesn't heat up or lose any energy when electricity is passed through it. This property also enables the creation of very large magnetic fields and is essential for future material-based quantum computers. Currently all known superconducting materials only work at extremely cold temperatures or under extreme pressure, which makes them very costly to operate. In this fellowship Luke set out to understand the microscopic interactions that govern how superconductors behave in a particular set of unconventional superconducting materials. His approach has been to perform experimental measurements, using the photoelectric effect and quantum tunnelling, to study how the electrons fundamentally behave in superconductors. He then combined the data from these measurements with theoretical models which have then been used to test and compare theories of superconductivity in these materials.

This work has proved incredibly fruitful, resulting in 12 publications over the three-year period and a better understanding of eight different unconventional materials. A particular highlight of the project has been the observation of how tiny structural distortions at the surface of  $\text{Sr}_2\text{RuO}_4$  modify the superconducting properties, which Luke found could potentially be used as a switch to turn on and off the superconducting state, as well as answering the question of how the energy levels of the electrons redistribute in the superconductor FeSe at low temperatures, which has enabled him to disentangle the superconducting information from the electronic information and therefore constrain the possible mechanism of superconductivity in this material in much greater detail.

Luke currently has additional funding to continue his research into superconductivity at the University of St Andrews and is in the process of writing independent fellowship applications to start his own group working on the theory of superconductivity in correlated quantum materials.

**Dr Christoph Schnedermann**

*Project:* Investigation and optimisation of highly efficient next generation photo-electrochemical devices

*University of Cambridge*

The 1851 Research Fellowship enabled Christoph to move to a new field and develop a multi-disciplinary research program at the Cavendish Laboratory of the University of Cambridge. During his fellowship (which was extended by six months due to Covid-related disruptions), he established novel optical characterisation techniques to understand, screen and improve the performance of next-generation photovoltaic and battery materials. These efforts resulted in several high-profile publications, forged indispensable collaborations across different research groups within the UK and significantly contributed to securing additional academic funding to expand the scope of the research program.

A particular research highlight is that, enabled by these new imaging methodologies, Christoph's team uncovered a new design strategy to charge Lithium-ion batteries up to five times faster than currently possible. The study was recently published in *Nature* and featured in several news outlets.

Apart from academic research, the flexibility and support provided by the Royal Commission allowed Christoph to effectively disseminate his research at various conferences within the UK and internationally, actively pursue mentorship roles and engage in entrepreneurial training.

In his next career step, Christoph will build on the skills and networks he curated during his Research Fellowship to pursue entrepreneurship. Through his work in the battery space, he was awarded an Entrepreneurial Fellowship from the Faraday Institution, which he will take up at the University of Cambridge. Here, he will establish a company to deliver low-cost and high-throughput optical screening tools that can significantly accelerate the research and development process of next-generation battery materials.

**Dr Tessa Young**

*Project:* Characterising the cobalt delivery pathway for vitamin B12

*Durham University*

Metals are at the heart of life's chemistry with almost half of all biological enzymes requiring a metallic element for function. It is vital that the correct metal (with the correct reactivity) is incorporated into each protein in a cell, a process called metalation. The ability to understand, and then to optimise, metalation in cells is becoming increasingly important for biotechnology: For example, so that metalloenzymes in a microorganism can be harnessed to produce important chemical resources in sustainable clean manufacturing. Untangling the "metalation code" inside living cells has been a major challenge in the field of biological inorganic chemistry.

Tessa's fellowship addressed this fundamental challenge by studying the metalation pathway of vitamin B12, an essential dietary nutrient which contains a critical cobalt atom at its centre and is manufactured solely using microorganisms. Plants do not contain vitamin B12 and inexpensive sources of the vitamin are needed for individuals on vegan and subsistence diets. The work revealed the mechanism of action of a suite of metal delivery proteins which supply cobalt during vitamin B12 biosynthesis and developed methods to calculate their metal occupancies inside living cells, under a range of different growth conditions. These key discoveries, published in *Nature Communications*, can be used to optimise the metal supply pathways for microbial production of vitamin B12. Moreover, the methods developed can be applied to understand and optimise the metalation of proteins more generally.

Tessa is now continuing her work as a Research Associate in the Department of Biosciences at Durham University.

## Industrial Fellows

### **Ben Barnes**

*Project:* Process development for recovery and purification of exosomes for regen therapy

*Sponsor:* ReNeuron

*University College London*

The importance of nanoparticles to encapsulate and deliver therapeutics has come centre stage with the success of the mRNA-based COVID-19 vaccine rollout. Exosomes are an important class of nanoparticles that are potentially significantly more efficacious and safer than commonly used synthetic nanoparticles. However, the complexity of exosome preparations requires innovations in manufacturing processes to improve specificity and scalability if exosome-based therapeutics are to be commercially successful.

This project aimed to develop novel technology to selectively capture and purify exosomes. This was achieved through the development of affinity chromatography techniques and custom chromatography resins that harnessed the ability of certain polysaccharides to bind exosomes. This technology represents a significant step forward in ReNeuron's exosome purification capabilities and is an important addition to the repertoire of proprietary technologies that ReNeuron holds to produce clinical-grade exosomes.

Having the opportunity to work with an industrial partner at the cutting edge of an emerging field has motivated Ben to pursue a career in the biopharmaceutical industry. He is confident the skills and experiences he gained from this project will be invaluable as he looks to apply his bioprocessing expertise to other novel therapeutics.

### **Veronica Glyn**

*Project:* Development of experimentally integrated process models for adaptive CAR T cell therapy manufacturing

*Sponsor:* Autolus

*University College London*

Autologous CAR T cell therapy has been effective in the treatment of several types of otherwise intractable cancers. The therapies, however, are derived from the patients' own cells, which can vary in quantity and quality. This contributes to process variability, out of specification products and increased production costs. Sometimes it can result in batch failures, delayed patient treatment and variable clinical outcome. One approach to addressing patient-to-patient variability is to design robust and adaptable CAR T production processes which are capable of compensating for the starting material variability. To provide a basis for such strategies, it is first important to improve fundamental understanding of how the differences between T cells from different individuals affect the manufacturing process and product quality. Veronica's work provides insights into the impacts of variation in donor starting material and process parameters on CAR T cell therapy manufacturing outcomes. This builds on existing process knowledge and highlights opportunities for improvements to control strategies; for example, by determining the criticality and/or appropriate operating ranges of starting material characteristics and process parameters. Proof of concept has been provided for a hybrid modelling strategy capable of predicting donor-specific process outcomes including final product attributes (transduction efficiency and CAR T cell number) and in-process behaviour (cell growth and metabolism). This provides scope for adaptive manufacturing using model-based control, which ultimately will reduce costs, increase process robustness and improve patient accessibility.

Veronica remains a Process Engineer at Autolus within the cell processing team, where she hopes to use the unique skillset she gained during her PhD to support Autolus' exciting work in the CAR T cell therapy space.

### **Adam Hornsby**

*Project:* A computational model of consumer preference formation and decision making

*Sponsor:* dunnhumby

*University College London*

As a customer data science company, dunnhumby gain a competitive advantage from computational methods that improve understanding and prediction of customer behaviour. For example, by understanding which products customers consider to be ‘essential items’, they can understand where retailers should invest in keeping prices low.

Adam’s project has uncovered several new analytical techniques for understanding customer behaviour that are rooted in a deeper understanding of consumer psychology. For example, Adam proposed using a “topic model” to learn themes from shoppers’ purchasing patterns. This technique is now being used across the business to understand the core shopping missions that exist in the minds of their customers and how these change as a result of seasonal trends (e.g., COVID lockdowns).

Adam also showed that different shoppers rely on different memory systems when they shop online and that this predicts the likelihood customers will forget products. This is helping dunnhumby to improve recommendations on sites to minimise forgotten items. This research also suggests a path to identifying early memory decline at scale, such as in Alzheimer’s; Adam hopes to explore this in future research.

Finally, Adam has helped quantify the effect that recommendations can have on long-term preferences. His findings showed that people often adjust their preferences to suit their past choices. This means that – with the correct sequence of recommendations – an algorithm may be able to encourage healthier choices over time. Research is ongoing in this area and Adam’s findings have laid the groundwork.

Adam has now been promoted to a Lead Data Scientist role at dunnhumby to help lead a new, multi-year engagement with a well-known retailer. He hopes to continue publishing academic research, as he feels he has many questions left unanswered.

### **Adam McKenzie**

*Project:* Photonic and electronic convergence: epitaxial growth on silicon

*Sponsor:* Sivers Photonics

*University of Glasgow*

The 1851 Industrial Fellowship has been crucial in facilitating the development of in-house metalorganic chemical vapour deposition (MOCVD) capabilities at Sivers Photonics. In the course of his time with Sivers, Adam’s work on process standardisation and customer-facing research and development projects has led to the roll-out of a number of new commercial production processes and devices. In addition, the Fellowship has strengthened the relationship between Sivers and the University of Glasgow, driving the success of the MOCVD collaboration, and establishing the joint-facility as a leader for epitaxial growth of III-V materials in Scotland.

The basis of Adam’s PhD research has been equally as fruitful. This has focused on developing a new type of laser which integrates a unique nano-structured layer within the device structure. Adam’s work on understanding the complex regrowth dynamics seen for these devices has resulted in a number of journal publications and presentations at international conferences. For this work he was also honoured to receive the prestigious 2020 Postgraduate Prize from the Institution of Engineering and Technology (IET).

Following the end of the Fellowship, Adam has left his role at Sivers to take up a position as a research associate at the University of Glasgow. Here his work will focus on the development of specialised failure analysis capabilities, centred around the suite of electron microscopes at the University, and tailored towards the study of III-V materials and devices. The project will build on the technical and commercial knowledge gained during his PhD and will allow the University of Glasgow to more fully support industrial and academic partners in their research and development and production activities.

**Elisabeth Pickles**

*Project:* Applying quantitative image analysis to liver cancer

*Sponsor:* Perspectum

*University of Oxford*

During her Industrial Fellowship, Lis aimed to develop novel techniques for early detection of liver cancer. Perspectum has an FDA, CE marked, liver cancer related MRI product, Hepatica, which is used for surgical planning. Through her work Lis contributed to extending the scope of Perspectum's products to include providing cancer detection tools.

Specifically, Lis developed an MRI sequence that will enable the detection of iron sparing, which is where, as a tumour develops in the liver, the amount of iron in the tumour can decrease compared to the surrounding liver. Lis validated this tool using phantoms (which contain chemicals to mimic the liver and tumours) and in healthy volunteers.

Throughout the Fellowship Lis played an important role in the DELIVER consortium, which is a large group of scientists and clinicians who aim to develop techniques to enable early assessment of cancer. One of the clinical studies which the consortium is working on is SELINA. This study involves the recruitment of 80 patients with early hepatocellular carcinoma who will be scanned with the novel MRI sequence Lis developed. The results from this study will verify whether her MRI protocol could be used for early detection of cancer.

Following her Fellowship Lis will be taking up a post as MRI Physicist at Guy's and St Thomas' NHS Trust. She is very much looking forward to using skills developed during her Fellowship in her new role, which will involve contributing to research as well as providing clinical scientist support for the many MRI scanners in the Trust.

**Euan Rodgers**

*Project:* Development of a permanently installed monitoring system using guided waves for safety critical nuclear components

*Sponsor:* Rolls-Royce plc

*Imperial College London*

During his project, Euan successfully developed a ground-breaking monitoring system for detecting cracks in complex nuclear components. By utilizing guided waves, which propagate along a structure while guided by its boundaries, his system can inspect large volumes of materials and components from a single fixed location. This represents a significant advancement in the inspection capabilities of Rolls-Royce and a major step forward in the field of structural health monitoring (SHM).

The traditional method of manually measuring ultrasonic probes is not only time-consuming but also costly. Euan's proposed system is designed to overcome these challenges by implementing innovative signal processing techniques that compensate for the loss in sensitivity associated with using guided waves over large areas. This approach ensures that industrially relevant cracks can be detected in real-world experiments on nuclear reactor components while maintaining precise safety standards. Through the development and application of these novel techniques, Euan's system significantly reduces the time and cost involved in ultrasonic probe monitoring while ensuring that safety is not compromised.

The implementation of this new system will significantly improve the performance of Rolls-Royce in the nuclear industry by providing a more efficient and accurate way to monitor complex components. This achievement has the potential to enhance safety standards, reduce costs and improve inspection times, ultimately benefiting both the company and the industry as a whole.

**Tatiana Rogova**

*Project:* Shining a new light on the synthesis of biologically relevant tertiary amines

*Sponsor:* GSK

*University of Oxford*

Tatiana's Fellowship was dedicated to the development of a highly robust and efficient chemical methodology that enabled the facile synthesis of previously inaccessible, branched, tertiary amine molecules for drug discovery research.

In a collaborative effort between GlaxoSmithKline (GSK) and the EPSRC Synthesis for Biology and Medicine Centre for Doctoral Training Programme (SBM CDT) at the University of Oxford, she was able to successfully demonstrate how tertiary amides – readily available and chemically robust starting materials – could be transformed into the target compounds under very mild, visible-light promoted, catalytic conditions.

As a result of these efforts, she was able to produce a library of eighteen, novel, tertiary amine-containing molecular structures and showcase how her designed reaction conditions could be adapted to target other medicinally relevant chemical motifs such as secondary and cyclic amines. Active discussions with industry partners at GSK enabled her to design her substrate scope to resemble previously identified bioactive molecules. Hence, she was able to showcase how her method could be applied in industry to synthesize and identify new active pharmaceutical ingredients that could be used to treat a wide range of ailments from motion sickness to heart disease.

Tatiana was delighted to be able to share her findings with the wider scientific community in a number of peer-reviewed publications. Furthermore, the project inspired further research within the academic group at the University of Oxford to apply photocatalysis in the design of other synthetic transformations that target a broader set of structurally diverse molecules and chemical bond reactivity.

Following the completion of her Fellowship, Tatiana has now taken up a postdoctoral position at RWTH Aachen University where her research efforts will be focused on the design of innovative, transition metal-based photocatalysts.

**Robert Rouse**

*Project:* Machine learning approaches to assessing future flood risk

*Sponsor:* Mott MacDonald

*University of Cambridge*

During his Fellowship, Robert was able to investigate multiple machine learning methods and their relevance to hydrological cycle problems in climate science, including developing new, data-lean frameworks capable of generalising to locations suffering from data paucity. Furthermore, he has been developing a new framework for creating more robust projections of climate impact. These methods will guide better future water resources management and help to better inform infrastructure adaptation and mitigation strategies, both of which are key activities for Mott MacDonald. The increasing relevance of data-driven algorithms in environmental and civil engineering is leading to increased collaboration between the research group at Cambridge and Mott MacDonald with a view to expanding upon the research conducted thus far.

Following the end of his Fellowship, Robert will be involved with running a climate-tech start-up, as the Chief Scientific Officer, working on the development of a process for the production of microalgae derived oil and protein products.



### **Jack Sutro**

*Project:* Synthetic approaches to medicinally relevant Euphorbia diterpenes

*Sponsor:* UCB BioPharma

*University of Oxford*

Jack's research during his Industrial Fellowship established an efficient, scalable, and modular synthetic route to the densely functionalised five-membered hydrocarbon ring which is the core motif in the jatrophone diterpenes, along with a second complex open-chain fragment.

The jatrophanes are a class of natural product, many members of which are of significant pharmaceutical interest due to their inhibition of proteins involved in multidrug resistance. These medicinally relevant compounds have thus far utterly eluded the efforts of synthetic chemists, due to a degree of structural complexity which is considerably above that found in most pharmaceutical targets. The scientific ambition and therapeutic relevance of this project allowed for a marriage of academic and industrial interests and made it a natural fit for the Industrial Fellowship.

In spite of the challenges associated with the project and the years during which it was conducted, the outcome of Jack's work is a concise and economical synthesis of a complex core fragment of the target molecules. In particular, elegant strategies for accessing a range of desirable stereochemical configurations around the cyclopentane ring were developed; this establishes a platform for a more thorough exploration of the chemical space surrounding the jatrophone diterpenes. The Industrial Fellowship was instrumental in facilitating this: a tighter industrial collaboration with UCB BioPharma led to frequent meetings between the Industrial Fellow, the academic supervisor, and the industrial supervisor. These meetings punctuated the progress of the project, continually informing the strategy taken and enriching the scientific experience of the Fellow.

Moreover, the extra resources provided by the 1851 Commission enabled a more vigorous exploration of the potential chemical technologies used in the project; this investment ultimately led to a more efficient and economical final product than that which would otherwise have been attainable.

Following the successful defence of his DPhil thesis, Jack is now working as a postdoctoral researcher in the Department of Organometallic Chemistry at the Max-Planck-Institut für Kohlenforschung.

### **Euan Ward**

*Project:* Improving the reliability of low-cost radar systems

*Sponsor:* Leonardo

*University of Edinburgh*

Euan's research focussed on developing techniques that will allow low-cost radar systems to operate in close proximity to one another. Solving this problem is extremely important for the future of driverless cars, which require radar technology to provide detailed information about the vehicle's surroundings. As the use of fully autonomous vehicles grows over the next decade, the potential for interference between systems will pose an ever-increasing threat to the safety of these vehicles. Unfortunately, the radar will not be immune to this effect, so it must learn to operate in an environment crowded with radio frequency energy.

The solutions that Euan developed during his Fellowship were based around advanced signal processing techniques that aimed to 'uncorrupt' the radar data so that the sensor can detect targets, which would otherwise be lost in the interference. Importantly, these techniques were specifically designed to mitigate nonlinear effects in the sensor's hardware, which can be stimulated by strong interference from other radars in the scene. This type of nonlinear interference is expected to be commonplace for the driverless car due to the vast number of radars operating in close proximity to one other. Crucially, by employing the sophisticated algorithms developed during his Fellowship, the radar can maintain its operational performance in the most challenging interference scenarios.

Throughout his Fellowship, Euan presented his research at various international conferences and published four peer-reviewed papers including one in the leading international journal for radar research. He currently works as a Senior Systems Engineer within Leonardo's radar modelling team in Edinburgh where he has been developing some of the techniques from his PhD for real-world application. Furthermore, he has been acting as a technical specialist within the company in this area and has actively been applying his knowledge to some of Leonardo's major radar programmes.

## Industrial Design Students

### Solomia Bogusz

Course: Architectural Design

University College London

During her master's degree, Solomia pursued a programme exploring the frontiers of advanced architectural design, and their convergence with science and technology, with an emphasis on the latest technological advances, particularly computational design and robotic fabrication.

Solomia's research, as part of the Material Architecture Lab, explored innovative applications of natural flax fibre in the built environment. Her project embraced the ecological advantages of flax as a biodegradable, antimicrobial, zero-waste material, and advocated for its wider adoption across architectural practices. It could serve well in temporary outdoor structures without contributing to the prevailing issue of construction waste, with the possibility to slowly decay, whereby at the end of its lifecycle it is returned to the earth, eventually becoming a host for nesting places for local wildlife. Flax's skin-like, sensorial material qualities also present the potential for the design of more tactile architectural spaces, in sharp contrast with more conventional building materials that are rigid in nature.

In her theoretical thesis, Solomia focused on mixed reality and metaverse representations in architecture and design. Her thesis explored whether there is a possibility for augmented reality and metaverse digital tools to find a significant place in the present-day design and architecture industry and shift the way people design, build, and share knowledge and skills permanently.

The Studentship has significantly helped Solomia to reach new opportunities and further advance her career in the design and architecture field. She is currently applying her new skillset in professional practice, exploring ways to bring innovative and sustainable design solutions to live projects, and leading a team of designers on a range of commercial schemes. Since being awarded the Studentship, Solomia has been honoured to be recognised with two industry awards, being a Finalist in The UK Interior Designer of the Year competition and receiving a Highly Commended Rising Star Design Award in The Brit List Awards.

### Luisa Charles

Course: Global Innovation Design

Royal College of Art and Imperial College London

During her Industrial Design Studentship, Luisa studied Global Innovation Design, focusing mainly on ethics in robotics and automation. Projects in her second year included the organisation, curation, and design of a large-scale, immersive technoethics exhibition in New York; design of an AI diagnostic tool for learning disorders, *Graphia*; and the creation of a DIY surface water drone for environmental monitoring, *FLOAT*. *FLOAT* was co-designed with a community in Sri Lanka, can be made out of everyday objects and assembled without specialist tools or skills, and costs 1/100th of the price of the cheapest commercial alternative. *Graphia* was awarded the Pratt Institute Start-up power award in April 2022, and *FLOAT* was awarded the Helen Hamlyn award for best inclusive innovation, as well as the Green Grads Changemaker award. *FLOAT* has been exhibited six times, nationally and internationally, including at London Design Festival, Prototypes for Humanity in Dubai, and our very own 1851-der tent at the Great Exhibition Road Festival.

Since graduating, Luisa has founded the green tech start-up, Wateraware Collective, which focuses on water quality monitoring using a combination of adaptive hardware, machine learning driven software, and citizen science initiatives. Having successfully raised funding through partnerships and grants, including working with Ordnance Survey, Northumbrian Water, and having won 3rd place at the Santander X UK awards, Wateraware Collective is helping UK water companies manage pollution events. Their citizen science initiatives go beyond borders, with the next pilot of *FLOAT* being rolled out in the Rupununi Savannah, Guyana. For this project they will be working alongside indigenous data technicians to co-design a new version of the surface water drone, focusing on monitoring fish biodiversity, malaria vector control, and flood mitigation.

### **Hemal Dias**

*Course:* Innovation Design Engineering

*Royal College of Art and Imperial College London*

Coming from a background in mechanical engineering, Hemal joined the Innovation Design Engineering program at Imperial College London and Royal College of Art to join multi-disciplinary teams and learn more about the convergence of science and art.

During his studies, he teamed up with his classmates – Diana Canghizer, Christina Lin and Emre Kayganaci to develop *homecell*: A system for storing green energy at home. The team developed numerous prototypes of a device which would connect to any standard plug socket in a house and automatically charge itself when the energy in the national grid was most green. When the energy in the grid is not clean, the battery can be discharged to power appliances in the house.

For his individual project, Hemal developed *HAPT* which is a wearable that allows blind people to play video games through touch. The wrist mounted device connects to mobile games through Bluetooth and provides the user with a different sensation of touch depending on which game element is touched, allowing blind people to navigate spatial interfaces.

Following his studies, Hemal has moved to Japan to work for the Design-Led X (DLX) platform within the University of Tokyo. The organization prides itself on doing everything in collaboration and has recruited Hemal to join a team of researchers looking at the future of mobility in Japan after the introduction of 6G.

### **Daniel Ellis**

*Course:* Industrial Design

*Central Saint Martins*

The 1851 Studentship was a key turning point in Daniel's professional and academic career as it meant that he could pursue advanced studies for two years in London and have the resources to fund the research for his dissertation. His thesis involved conducting experiments in material science aiming to create a carbon negative fabrication material for buildings. At times he needed to visit factories or research facilities in different parts of the country, and purchase materials and machinery for his research. The support from 1851 made this all possible.

Daniel now works with the Connected Places Catapult where his goal is to generate net-zero innovation in strategic areas for the UK economy.

### **Sean Fisher**

*Course:* Contextual Design

*Design Academy Eindhoven*

Sean's Studentship allowed him to do a two-year master's degree in Contextual Design at Design Academy Eindhoven, which has now given him a solid base to launch his art practice.

Having completed a master's in Product Design Engineering before, his practice now centres around engineering in a Pataphysical context (a branch of philosophy concerning the science of imaginary solutions). Since graduating, he has continued developing his practice, which culminated with showing his work at Dutch Design Week in October 2022.

As a result of the experience and connections he gained during his degree, he has since undertaken work through Design Academy Eindhoven as a photographer for regular events. He is also responsible for a project to increase engagement with the Academy via a series of interviews and portraits.

Sean has also had the opportunity to bring his new skills to work with Petor Georgallou (UK bike designer), producing Bespoked UK, Europe's biggest hand-built bike show exhibition. Sean was responsible for designing the booklet, making 3D graphics and the general production of the event.

With Maren Bang (an alumna of DAE), and supported by Dutch arts funding, Sean is setting up a pop-up gallery and hyperreal museum which will host a series of exhibitions throughout the year with Maren featuring in the final exhibition. Sean is responsible for all the graphical elements and producing the modular exhibition display.

### **Alasdair Grant**

*Course:* Global Innovation Designs

*Royal College of Art and Imperial College London*

Building on design engineering foundations developed during his first year, Alasdair used his second year of GID to research and alleviate systemic roadblocks in the transition to net-zero emissions. This work ranged from encouraging long distance train travel, to improving household energy efficiency, and aiding decision making for electric vehicle charging infrastructure.

His major project, *eDAP*, is a digital desktop modelling tool that helps local authorities plan the roll-out of electric vehicle on-street chargers. *eDAP* dynamically adapts to changes in local needs, ensuring resources are used most effectively. Considered metrics include hyper-local future charging point demand, live user experience, and alignment with wider policy objectives.

*eDAP*'s development was supported through interviews with dozens of expert stakeholders from a diverse range of organisations. This allowed otherwise hidden frictions to unveil themselves, such as inherent uncertainties in future demand and lack of capabilities in planning. Key stakeholders and lead users were engaged repeatedly throughout the design process to help test and develop iterations of prototypes.

The tool is built on the principles of Dynamic Adaptive Planning (DAP), an academic framework for Decision Making under Deep Uncertainty (DMDU). This was a novel approach to the problem area, as well as the first time DAP has been adapted to a digital modelling tool.

Earlier in the year Alasdair worked in a team to develop *GreenLandlord* – a tool for landlords to choose property improvements that maximise environmental and economic benefit whilst adhering to the latest regulation. The research approach was based on uncovering how broad, nation-wide legislative changes are affecting individuals and focused on traditional properties in rural Scotland and the associated stakeholders.

Alasdair now works as an Associate Consultant for Bain & Company in London, helping some of the world's largest companies and organisations tackle urgent challenges and redefine the future of their industries.

### **Georgia Mackenzie**

*Course:* Innovation Design Engineering

*Royal College of Art and Imperial College London*

While at the Royal College of Art, Georgia was able to pursue work related to women's health and health education. Through her major project, she was able to distribute informative visuals to pelvic organ prolapse support groups globally. She also valued the opportunity to meet incredible academics at the Royal Commission's events and enjoyed forging strong connections with the inspiring cohort of Industrial Design Students. Following her Studentship, Georgia began work as a design researcher at the University of Tokyo at the Institute of Industrial Science's DLX Design Lab.

## **Tahira Resalat**

**Course:** Innovation Design Engineering

**Royal College of Art and Imperial College London**

Engineers and designers are often taught to look outwards and find creative ways to solve problems. However, it is introspection which Tahira feels has been the most important lesson she has learned during her time studying for the Innovation Design Engineering programme at Imperial College London and the Royal College of Art. Throughout this time, she had the opportunity to experience and explore the principles and techniques which support all areas of design, before gravitating towards human-centred design. The body of work which she takes most satisfaction from completing during the programme is the mobile application, *Foodible*, that she created for her final project. *Foodible* is the future of personalised and culturally sensitive wellbeing support inspired by her own experiences with an eating disorder. Growing to understand the gaps in the healthcare industry through her own experiences and beyond, she questioned how design could help support eating disorder prevention, considering cultural sensitivities in particular. She collaborated with many notable mental health charities and built relationships with members of the South Asian community in the UK and worldwide to inform herself and contribute to her findings. Culturally sensitive mental health support systems within the NHS are very much in their infancy, so this app was intended to support individuals who were neglected by this system. Tahira says: "I am eternally grateful for the 1851 Industrial Design Studentship which supported me throughout my programme and allowed me the opportunity to give back to others in a less fortunate position than myself". Since graduating, Tahira has joined Mettle Studio, an innovative design consultancy in London. As a UI/UX designer, she continues to apply the skills she developed during her course to creatively solve design challenges.

## Enterprise Fellows

### Rebecca Donaldson

*Company:* Blue Tap

*Technology:* Chlorine doser

Blue Tap has developed a chlorine dosing system which inserts the correct amount of chlorine into a piped water system making it safe to drink according to WHO guidelines. In 2021-22, Blue Tap partnered with the University of Oxford's REACH programme and Kenyan NGO, FundiFix in a year-long pilot to install water treatment technology on community water points in Kitui, Kenya. In addition, Blue Tap carried out business development and entrepreneurship training in Nairobi, Kenya, with engineering students from Strathmore University. In July 2022 Rebecca joined Cambridge Consultants. She remains a non-executive director of Blue Tap.

### Natalie Kerres

*Company:* SCALED

*Technology:* Custom fit protective wearable

SCALED is a wearable technology company developing custom-fit wearables for athletes to minimize the risks of harmful long-term damage from joint injuries. SCALED can be used for leveraging injury prevention, rehabilitation and sports performance enhancement through regulated motion control. In June 2022, Natalie was named one of the UK's Top 50 Women in Engineering by the Women's Engineering Society. In October 2022, SCALED was awarded a £50,000 grant from Innovate UK.

### Naomi McGregor

*Company:* Movetru

*Technology:* Wearable technology for physiotherapy [Financially supported by ERA Foundation]

Movetru combines machine learning with technical textiles to improve outcomes for elite athletes. In 2022, Movetru was awarded a £500k Innovate UK Smart Grant Award and Naomi was awarded an Innovate UK Women in Innovation Award.

### Tom Simpson

*Company:* Ratio Technology

*Technology:* 16-speed bicycle drivetrain

Ratio Technology has developed a bicycle drivetrain that has 16 gears and a chain that is longer lasting, more efficient and more aerodynamic. In 2021, Ratio Technology products featured in Bikepacking.com's 'Gear of the Year' list.

### Ryan Beal

*Company:* Sentient Sports

*Technology:* Data scientist in a box for sports

Sentient Sports has developed an AI data analytics tool that allows management to simulate how a given decision will impact the performance of their teams both strategically and tactically. Sentient Sports has featured regularly in The Athletic and other sports sites. They are still exploring what aspect of the sports data analytics sector they should focus on.

### Henry Harrod

*Company:* Fourier Audio

*Technology:* Bringing studio grade plug-ins to live sound engineers [Financially supported by ERA Foundation]

Fourier Audio is bringing the software revolution to live audio: building a hardware-enabled audio software platform that enables engineers to create extraordinary audience experiences for the events of the future, while reducing the environmental impact of brilliant sound. Fourier Audio are seeking initial conversations with angel and institutional investors. They have raised over £620k so far.

**Samuel Willis**

*Company:* PolyMetrix

*Technology:* Personalised wearable products

PolyMetrix has developed a digital platform for autonomous personalisation of 3D-printable wearable devices and for analytical processing (fit-testing). In April 2022, PolyMetrix joined Imperial College's Techcelerate programme. PolyMetrix is collaborating with Imperial's Advanced Manufacturing Research group to launch its first digital fitting system.

## Built Environment Fellow

**David Rudlin**

*Subject:* What is the High Street for? Tales of the High Street

*Mentor:* Steven Bee, Urban Counsel

The last few years have seen a crisis on the high street as household names have disappeared, 75,000 stores have closed and 700,000 jobs have been lost. The aim of the 2020 Built Environment Fellowship was to understand the crisis by telling the stories of 100 high streets. In doing so it has revealed a much more complex picture than is told by the national statistics and what's more it is a hopeful story.

The 100 tales include large and small city centres, towns and villages, streets and suburban centres and out-of-town centres. They also included four case studies that were not specific locations like Ikea and nine that were online like Amazon. For 81 of the cases the research was able to use data from Experian to look at trends over the last ten years, supplemented with interviews, press reports and council commissioned retail assessments.

The overriding message in the book to be published this summer by RIBA Publishing, is that we don't have a crisis on the high street, we have had a crisis of big retail. The high street has been the victim of this and, while most town centres have suffered as flagship stores have closed, many are bouncing back as independent businesses and leisure uses take their place. The town centres that are doing best are those that have a good mix of retailers and uses rather than being reliant on multiples. By encouraging diversity, tackling vacancy, and building in resilience we can create the conditions for the high street to heal itself.

## Alumni Awards, Honours and Achievements

A selection of the alumni appointments, publications, honours and awards notified to the Commission. The Commission encourages all alumni to keep their alumni profiles up to date so that their successes can be celebrated.

### Overseas Scholars

Professor Dawn Bazely (1984 - 1987)

- Awarded Sandford Fleming Medal for Excellence in Science Communication, Royal Canadian Institute of Science

Professor Surya Thakur (1970 – 1973)

- Co-edited *Photoacoustic and Photothermal Spectroscopy*

### Research Fellows

Dr Jo Ashbourn (2002 - 2004)

- Organised a lecture by Dr Mario Livio on *Brilliant Blunders - Mistakes by Great Physicists that Changed Our Understanding of the Universe* and conferences on *The Nature of Light and Symmetries in Physics* at the St Cross Centre for the History and Philosophy of Physics

Dr Will Cawthorn (2009 – 2012)

- Appointed Senior Lecturer, BHF Centre for Cardiovascular Science, University of Edinburgh
- Awarded Open Research award, University of Edinburgh

Professor Helen Coxall (2000 – 2002)

- Appointed Professor in Marine Geology and Deputy Head, Department of Geological Sciences, Stockholm University

Dr Dong Liu (2015 – 2018)

- Appointed Associate Professor, School of Physics, University of Bristol
- Awarded Jubilee Global Diversity Award, American Ceramic Society Engineering Ceramics Division

Professor Apala Majumdar (2006 – 2008)

- Awarded Friedrich Wilhelm Bessel Research Award by the Alexander von Humboldt Foundation

Dr Guillaume Nataf (2018 – 2020)

- Awarded ERC Starting Grant to pursue research on a new mechanism to design compact and efficient thermal switches

Dr Emilio Martínez-Pañeda (2018 – 2021)

- Awarded President's Medal for Excellence in Research, Early Career category, Imperial College London

Dr Beth Mortimer (2016 – 2019)

- Appointed Associate Professor in Animal Biology, University of Oxford and Tutorial Fellow, Hertford College, Oxford

Professor Rachel Oliver (2003 – 2005)

- Awarded Royal Academy of Engineering Chair in Emerging Technologies



Professor Rachel O'Reilly FRS (2004 – 2006)

- Elected a Fellow of the Royal Society
- Awarded Netherlands Scholar Award for Supramolecular Chemistry
- Awarded ACS Global Outstanding Mentor Award in Polymer Science and Engineering
- Appointed International Referee, Natural Sciences and Engineering Panel, Swiss National Science Foundation
- Appointed jury member, WIMA Award in Materials Science

Dr Ben Pilgrim (2016 – 2019)

- Awarded Royal Society University Research Fellowship
- Awarded Early Career Prize for Excellence in Higher Education, Royal Society of Chemistry
- Awarded Lord Dearing Award, University of Nottingham

Dr Andy Tay (2019 – 2021)

- Awarded College of Design and Engineering Outstanding Young Alumni, National University of Singapore
- Recognised as one of the World's Top 2% Scientists by Stanford University based on 2021 citation data
- Awarded Early Career Conference Grant, The Association of Commonwealth Universities
- Awarded Christopher Hewitt Outstanding Young Investigator Award, Engineering Conference International
- Awarded Victor Rabinowitch Memorial Award for Young Leaders in International Scientific Cooperation, CRDF Global

Professor Mark Travis (2006 – 2009)

- Appointed Head of Division for Immunology, Immunity to Infection, and Respiratory Medicine, University of Manchester

Dr Timothy Walker (1969 – 1970)

- Published (with Frank Kelsall), *Nicholas Barbon, Developing London, 1667-98*

## Industrial Fellows

Dr Christopher Baylis (1999 – 2002)

- Appointed Global Microbiologist, Mondelez International
- Appointed Honorary Senior Lecturer, Chemical Engineering, University of Birmingham

Dr Mariastefania De Vido (2018 – 2021)

- Awarded Royal Society International Exchanges grant to conduct research on advanced materials manufacturing techniques for high energy lasers
- Appointed to the Management Committee of the Centre for Doctoral Training in Applied Photonics
- Selected to join the Science and Technology Facilities Council's Accelerated Development Programme

Mr Tom Fleming (2016 – 2019)

- Elected Fellow of the Royal Society of Biology
- Elected Fellow of the Royal Society of Chemistry
- Appointed an inaugural member of the UK Young Academy
- Arctoris listed as one of Top 20 EU Biotechs to Watch

Dr Chris Magazzeni (2018 – 2021)

- Appointed an Investor at IQ Capital, a venture capital fund focusing on SpaceTech

Dr Christopher Town (2001 – 2004)

- Appointed Bye-Fellow and Director of Studies in Computer Science at Jesus College, Cambridge

## Industrial Design Students

Mr Cameron Brookhouse and Mr Lorenzo Spreafico (2019 – 2020)

- Secured Series A funding of £10m and generated pre-order sales over £1m for Quell, a dedicated fitness gaming platform

## Enterprise Fellows

Mr Guillem Singla Buxarra (2017)

- Neurofenix (post-stroke rehabilitation) raised £5.9m for US expansion and clinical trials

Mr Matt Escott (2020)

- Protolaunch (small launch vehicles) awarded £1,904k by UK Space Agency to further advance its technology.

Mr Henrik Hagemann (2016)

- Puraffinity (customised membranes for water treatment) awarded £1.5m Innovate UK grant.

Mr Lewis Hornby (2020)

- Launched Jelly Drops (sugar-free hydrating sweets for dementia patients) in the US in April 2022. Over 3 million Jelly Drops have been produced.

Mr Ming Kong (2016)

- TGO (smart 3D sensing material) was granted its fourth patent for a lightweight, wearable, finger-tracking VR controller and device.

Mr Ben Lakey (2019)

- Syndi Health (digital mental health recommendations) received ISO accreditation and a £50k Innovate UK grant.

Mr Alexander Macdonald (2021)

- Successful Kickstarter campaign raised £104k for HindSight Technologies (rear vision cycling glasses).

Mr Alexander Murdock (2020)

- Thermulon (affordable nanoporous building insulation) was a finalist in Futurebuild's 2022 Big Innovation Pitch.

Mr Harish Pesala (2021)

- Balkerne (risk and early warning system for property owners) was a finalist in the Risk and Resilience category at the 2022 British Insurance Awards.

Mr Atif Syed (2018)

- Awarded Royal Academy of Engineering Princess Royal Silver Medal
- Wootzano's Avarai robotic system won the Fresh Produce Consortium Innovation Award and successfully packed vine tomatoes for Tesco, M&S and Amazon Fresh
- Wootzano was awarded a number of patents covering dextrous robotic manipulation
- Wootzano was awarded an Innovate UK innovation loan

Ms Reka Tron (2021)

- Multus Media (animal-free serum replacements) was a finalist in the 2022 Nutreco Feed and Food Tech Challenge
- Multus Media closed a \$9.5m Series A round to build a world first growth media manufacturing facility in the UK

## Technical Teaching Fellows

Ms Rosa Wells (2021 – 2022)

- Appointed Executive Dean Engineering, Digital & Sustainable Construction at University College Birmingham

## Rome Scholars

Mr Hugh Petter (1990)

- Awarded Georgian Group Award for best new building in a Georgian context for the Levin Building, Trinity College, Oxford

Ms Carole Robb (1979)

- British Library acquired five solo show catalogues
- British School in Rome acquired a Carole Robb painting to start their new Rome Scholar collection

## Report by the Chairman of the Finance Committee

### *Introduction*

The Board of Management has appointed the Finance Committee as a sub-committee to supervise the Commission's finances and investments; this Committee meets at least twice a year. I would like to thank all members of the Committee for their ongoing valuable contribution in overseeing the Commission's finances.

During 2022 there were two formal meetings of the Committee. In the spring meeting we reviewed the annual accounts and met with the Commission's auditors. We also heard presentations from the investments managers. In the autumn meeting the Committee focused on reviewing the investment strategy for the Commission, recognising that the return of inflation and a less accommodative monetary environment would be challenging for markets.

### *Investment Policy*

Over the long term, the Commission aims to disburse 4% per annum of the trailing three-year average value of the portfolio. However, the Commission has few if any fixed liabilities and annual budgets include an allowance for Special Awards that can be adjusted without detriment to other programmes so this can vary from year to year depending on grant making opportunities and investment returns.

The investment objective is to generate a return of at least inflation plus 4% per annum over the long term, after expenses. This should allow the Commission to at least maintain and ideally grow the real value of the assets, whilst generating a stable and sustainable return to fund annual expenditure as set out above. The Finance Committee has determined that the inflation measure most relevant to the Commission's expenditure is the Consumer Price Index.

The Finance Committee is charged with agreeing a high-level asset allocation strategy with the investment managers, which is set so as to achieve the overall Commission investment objective. The Finance Committee will revisit the strategic asset allocation, and consider the need for tactical deviations from it, on at least an annual basis. The Finance Committee is responsible for identifying and monitoring investment managers and investment vehicles for the Commission.

The Commission adopts a total return approach to investment, generating the investment return from income and capital gains or losses. Recognising the likely volatility of the capital, the Commission will typically aim to generate an overall income return of between 2% and 3% per annum to reduce the risk that losses will need to be crystallised to fund commitments.

The Commission recognizes that long term investment is subject to market, political, economic, counterparty and other risks, with financial instability in particular being a key risk. The Commission also recognizes long-term inflation as a significant risk to the long-term sustainability of its activities and one that the investment policy should mitigate against.

The trustees are able to tolerate volatility of the capital value, as long as the Commission is able to meet its short-term grant making commitments through either income or liquid capital assets. To allow for volatility of capital values, the trustees wish to maintain at least £5m in cash or lower risk fixed income investments. Bearing in mind income generated by the portfolio and the flexibility to curtail Special Awards, this should allow three years' worth of Fellowships to be funded without needing to sell risk assets.

### *Ethical Investment Policy*

The Commission recognises that its investments have wider impacts and seeks to align its investment strategy with its aims, reflecting the views of its stakeholders and taking into account broader public benefit. The Commission expects its investment managers to integrate Environmental, Social and Governance (ESG) considerations into the normal investment process and to fulfil the requirements of the UK Stewardship Code, actively engaging with the companies in which they invest to promote best practice corporate behaviour and sustainable business practices. Given its limited staff resources,

it is not practical for the Commission to engage directly with individual companies, but it does expect its investment managers to report annually on their engagement activities and results.

The Commission expects its investment managers to apply ESG considerations to both segregated holdings and pooled holdings, taking account of the extent to which suitable alternative investment vehicles are available and bearing in mind de minimis considerations. The Commission will only appoint managers who are signatories to the UN Principles of Responsible Investment (UN PRI) and will take into account the ranking assigned to those managers by the UN PRI.

The Commission may exclude certain stocks or sectors where these are seen to be in direct conflict with its objects and activities. Equally, where consistent with the financial objectives, the Commission seeks to invest in areas with positive environmental and / or social impact, such as clean energy and various areas of new technology.

The Commission recognises that climate change is a key challenge for the next decade and that limiting global temperature rises will require significant change in business, investment, technology development and fossil fuel use. The Commission monitors the carbon emissions of its main equity investment portfolio and through its investment managers seeks to reduce these emissions over time. The Commission is very aware, however, that certain companies and sectors that are critical to the transition to net zero are currently carbon intensive. The Commission does not exclude investment in such sectors but expects its investment managers to prioritise investment in companies that have a carbon reduction roadmap aligned with the goals of the Paris Agreement.

### *Investment Performance 2022*

2022 was another challenging year for investors. Key themes over the year included Russia's invasion of Ukraine, ongoing supply chain disruptions, persistent high inflation, a rapid increase in interest rates and a cost-of-living crisis. Equity and bond markets suffered sharp corrections, with the MSCI ACWI Index down 8.1% across the year and the Bloomberg Barclays Global Aggregate Index down 16.7% for the calendar year. Against this backdrop the Commission achieved a total return net of fees of approximately -8.9% (2021: 10.2%).

The Commission's portfolio is invested by three investment managers: Schroder & Co. Ltd; Charles Stanley & Co. Ltd and JP Morgan Asset Management (UK) Ltd. The Commission also has direct property holdings on its legacy estate in South Kensington. The asset allocation of the combined portfolio as at 31 December was 70.7% in global equities, 4.9% in listed alternative assets, 9.2% in cash and bonds and 15.2% in the legacy estate (at the end of 2021 the proportions were 75.4%, 3.1%, 8.8% and 12.7% respectively).

Schroder & Co. Ltd and Charles Stanley invest globally, predominately in equities and returned -9.1% and -15.6% respectively (2021: 11.8% and 11.7% respectively). JP Morgan Asset Management (UK) Ltd manage a short duration bond account and returned -2.6% (2021: 0.8%). The directly held property returned 0.9% (2021: 7.6%) rental income of £528,991 (2021: £594,269) compensating for unrealised losses on revaluation of £175,000 (2021: unrealised gains of £1,213,607), the latter reflecting the difficult small office market.

Managers are asked to measure the carbon emissions of their portfolios. As at the balance sheet date, companies comprising the segregated equity portfolio, managed by Schroder & Co, had a carbon footprint of 3,866 tonnes of CO<sub>2</sub> (2021: 1,601 tonnes) vs the MSCI AC World (TRI) USD of 7,990 tonnes of CO<sub>2</sub> (2021: 8,792 tonnes). The increase over the year was attributable to a particular investment in the materials industry; it is worth noting that this company has ambitious absolute emissions reduction targets for 2030 verified by the Science Based Targets Initiative and their 2050 carbon reduction roadmap is aligned with the goals of the Paris Agreement. Charles Stanley have estimated that the carbon intensity (T CO<sub>2</sub>E/\$M Sales) of the companies in the underlying ETFs was 131.5 versus their index of MSCI World (ETF) 148.2 T CO<sub>2</sub>E/\$M Sales. Comparative numbers for 2021 are not available.

### *Long term performance vs investment objective*

The investment objective is to achieve at least a 4% real return over the long term. The annualised real return over the past ten years has been 4.9% (annualised nominal return 8.5%), in line with the objective. High inflation and disappointing equity returns over the past year mean that the investment objective has not been met over shorter periods, however, the five year and three year real returns being 0.6% and -2.5% respectively (annualised nominal returns of 5.3% and 1% respectively).

With high inflation, tighter monetary policy and weak growth all set to continue, and the strong possibility of a recession in some developed market economies, the Commission recognises that meeting the investment objective over the short to medium term will be challenging and so remains flexible in its disbursement policy.

### *Financial performance for the calendar year to 31 December 2022*

Over the 12-month period the investment portfolio generated income of £2,386,031 (2021: £2,256,608). However, capital losses of £15,790,681 (2021: capital gains of £14,830,305) meant that, after grants and other expenditure, the total funds of the Commission fell from £150,029,559 to £130,375,737 as of 31 December 2022.

Expenditure on core Fellowships and Studentships fell slightly from £3,839,642 to £3,671,284. However, a number of large Special Awards meant that total expenditure on charitable activities increased from £4,538,642 to £5,470,448.

Expenditure on generating funds – which primarily comprises investment and property management fees – increased from £643,883 in 2021 to £799,328 in 2022. The increase primarily reflects the write off of rent relating to the lockdown period following an arbitration settlement.

### *Going concern*

Despite the disappointing investment performance during the year, the Commissioners do not believe there are any material uncertainties that call into doubt the Commission's ability to continue and the accounts have therefore been prepared on a going concern basis.

The Commission, like every other organisation, has been impacted by the pandemic and Russia's invasion of Ukraine which have resulted in ongoing supply chain disruption, persistent high inflation, increased interest rates and a cost-of-living crisis. Investment markets have been much more volatile, and the day-to-day value of the Commission's portfolio – including its year-end value - has inevitably reflected that. The Commission is a long-term investor, however, and Commissioners remain confident in the underlying strength of the portfolio; they see no evidence at this stage of any permanent loss of value. Similarly, while the Commission has had to defer or write off a certain amount of rent, there is not considered to be any risk to the long-term value of the estate. The Commission has sufficient assets, and sufficient liquidity, to ride out the current market disruptions. The Commission's core grant-making activity has therefore continued largely as planned and Commissioners expect it to continue to do so.

### *Reserves Policy*

The Commission's funds originated from the surplus arising from the Great Exhibition of 1851 and have been enhanced by careful stewardship of the assets invested over many years. They are technically unrestricted, giving the Commissioners the ability to spend the funds as they wish in fulfilment of the charitable objectives of the Commission. None of the funds are in assets that cannot readily be realised.

In order to balance the needs of current and potential future beneficiaries of the charity, the Commissioners recognise the need to maintain a strong capital base so as to deliver an appropriate level of return to enable the Commission to continue to fulfil its charitable objectives on a long-term basis. Accordingly, all of the Commission's funds are invested in line with the investment policy described above and normal expenditure commitments are set to match the assumed average return above inflation delivered by the portfolio.

Given the Commission's flexibility to spend capital if required, the Commissioners do not consider that there is any merit in identifying an optimum level of free reserves that might be readily available if required but will respond appropriately to spending needs identified as and when circumstances arise.

#### *The Commission's Auditor*

In 2008, Moore Kingston Smith LLP was appointed the Commission's auditor following a competitive tender. The audit partner meets with the Finance Committee at least once each year. In the interests of good governance, the audit manager changes at least every five years and the audit partner at least every ten years.

### Statement of Commissioners' Responsibilities

The Commissioners are responsible for preparing the Trustees' Report and the financial statements in accordance with applicable law and United Kingdom Accounting Standards (United Kingdom Generally Accepted Accounting Practice.)

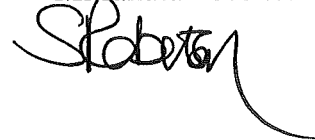
The law applicable to charities in England and Wales requires the Commissioners to prepare financial statements for each financial year which give a true and fair view of the state of the affairs of the Commission and of the incoming resources and application of resources of the Commission for that period. In preparing these financial statements, the Commissioners are required to:

- select suitable accounting policies and then apply them consistently;
- observe the methods and principles in the Charities SORP;
- make judgements and estimates that are reasonable and prudent;
- state whether applicable accounting standards have been followed, subject to any material departures disclosed and explained in the financial statements;
- prepare the financial statements on the going concern basis unless it is inappropriate to presume that the Commission will continue in business.

The Commissioners are responsible for keeping proper accounting records that disclose with reasonable accuracy at any time the financial position of the Commission and enable them to ensure that the financial statements comply with the Charities Act 2011, the Charity (Accounts and Reports) Regulations 2008 and the provisions of the Royal Charter. They are also responsible for safeguarding the assets of the Commission and hence for taking reasonable steps for the prevention and detection of fraud and other irregularities.

The Annual Report on pages 1 to 46 and 50 to 78 was approved by the Commissioners on 5 July 2023.

Ms Sandra Robertson



# Independent Auditor's Report to the Commissioners of Royal Commission for the Exhibition of 1851

## *Opinion*

We have audited the financial statements of the Royal Commission for the Exhibition of 1851 for the year ended 31 December 2022 which comprise the Statement of Financial Activities, the Summary Income and Expenditure Account, the Balance Sheet, the Cash Flow Statement and notes to the financial statements, including a summary of significant accounting policies. The financial reporting framework that has been applied in their preparation is applicable law and United Kingdom Accounting Standards, including FRS 102 'The Financial Reporting Standard Applicable in the UK and Republic of Ireland' (United Kingdom Generally Accepted Accounting Practice).

In our opinion the financial statements:

- give a true and fair view of the state of the charity's affairs as at 31 December 2022, and of its incoming resources and application of resources, for the year then ended;
- have been properly prepared in accordance with United Kingdom Generally Accepted Accounting Practice; and
- have been prepared in accordance with the requirements of the Charities Act 2011.

## *Basis for opinion*

We conducted our audit in accordance with International Standards on Auditing (UK) (ISAs (UK)) and applicable law. Our responsibilities under those standards are further described in the *Auditor's responsibilities for the audit of the financial statements* section of our report. We are independent of the charity in accordance with the ethical requirements that are relevant to our audit of the financial statements in the UK, including the FRC's Ethical Standard, and we have fulfilled our other ethical responsibilities in accordance with these requirements. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion.

## *Conclusions relating to going concern*

In auditing the financial statements, we have concluded that the Commissioners' use of the going concern basis of accounting in the preparation of the financial statements is appropriate.

Based on the work we have performed, we have not identified any material uncertainties relating to events or conditions that, individually or collectively, may cast significant doubt on the charity's ability to continue as a going concern for a period of at least twelve months from when the financial statements are authorised for issue.

Our responsibilities and the responsibilities of the Commissioners with respect to going concern are described in the relevant sections of this report.

## *Other information*

The other information comprises the information included in the annual report, other than the financial statements and our auditor's report thereon. The Commissioners are responsible for the other information. Our opinion on the financial statements does not cover the other information and, except to the extent otherwise explicitly stated in our report, we do not express any form of assurance conclusion thereon.

In connection with our audit of the financial statements, our responsibility is to read the other information and, in doing so, consider whether the other information is materially inconsistent with the financial statements or our knowledge obtained in the audit or otherwise appears to be materially misstated. If we identify such material inconsistencies or apparent material misstatements, we are required to determine whether there is a material misstatement in the financial statements or a material misstatement of the other information. If, based on the work we have performed, we



conclude that there is a material misstatement of this other information, we are required to report that fact.

We have nothing to report in this regard.

#### *Matters on which we are required to report by exception*

We have nothing to report in respect of the following matters where the Charities Act 2011 requires us to report to you if, in our opinion:

- the information given in the Commissioners' Annual Report is inconsistent in any material respect with the financial statements; or
- the charity has not kept adequate accounting records; or
- the financial statements are not in agreement with the accounting records and returns; or
- we have not received all the information and explanations we required for our audit.

#### *Responsibilities of Commissioners*

As explained more fully in the Commissioners' responsibilities statement set out on page 46, the Commissioners are responsible for the preparation of the financial statements and for being satisfied that they give a true and fair view, and for such internal control as the Commissioners determine is necessary to enable the preparation of financial statements that are free from material misstatement, whether due to fraud or error.

In preparing the financial statements, the Commissioners are responsible for assessing the charity's ability to continue as a going concern, disclosing, as applicable, matters related to going concern and using the going concern basis of accounting unless the Commissioners either intend to liquidate the charity or to cease operations, or have no realistic alternative but to do so.

#### *Auditor's responsibilities for the audit of the financial statements*

We have been appointed as auditor under section 144 of the Charities Act 2011 and report in accordance with regulations made under section 154 of that Act.

Our objectives are to obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is a high level of assurance but is not a guarantee that an audit conducted in accordance with ISAs (UK) will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements.

Irregularities, including fraud, are instances of non-compliance with laws and regulations. We design procedures in line with our responsibilities, outlined above, to detect material misstatements in respect of irregularities, including fraud. The extent to which our procedures are capable of detecting irregularities, including fraud is detailed below.

#### *Explanation as to what extent the audit was considered capable of detecting irregularities, including fraud*

The objectives of our audit in respect of fraud, are: to identify and assess the risks of material misstatement of the financial statements due to fraud; to obtain sufficient appropriate audit evidence regarding the assessed risks of material misstatement due to fraud, through designing and implementing appropriate responses to those assessed risks; and to respond appropriately to instances of fraud or suspected fraud identified during the audit. However, the primary responsibility for the prevention and detection of fraud rests with both management and those charged with governance of the charity.

Our approach was as follows:

- We obtained an understanding of the legal and regulatory requirements applicable to the charity and considered that the most significant are the Charities Act 2011, the Charity SORP, and UK financial reporting standards as issued by the Financial Reporting Council.
- We obtained an understanding of how the charity complies with these requirements by discussions with management.
- We assessed the risk of material misstatement of the financial statements, including the risk of material misstatement due to fraud and how it might occur, by holding discussions with management.
- We inquired of management and those charged with governance as to any known instances of non-compliance or suspected non-compliance with laws and regulations.
- Based on this understanding, we designed specific appropriate audit procedures to identify instances of non-compliance with laws and regulations. This included making enquiries of management and obtaining additional corroborative evidence as required.

As part of an audit in accordance with ISAs (UK) we exercise professional judgement and maintain professional scepticism throughout the audit. We also:

- Identify and assess the risks of material misstatement of the financial statements, whether due to fraud or error, design and perform audit procedures responsive to those risks, and obtain audit evidence that is sufficient and appropriate to provide a basis for our opinion. The risk of not detecting a material misstatement resulting from fraud is higher than for one resulting from error, as fraud may involve collusion, forgery, intentional omissions, misrepresentations, or the override of internal control.
- Obtain an understanding of internal control relevant to the audit in order to design audit procedures that are appropriate in the circumstances, but not for the purposes of expressing an opinion on the effectiveness of the charity's internal control.
- Evaluate the appropriateness of accounting policies used and the reasonableness of accounting estimates and related disclosures made by the Commissioners.
- Conclude on the appropriateness of the Commissioners' use of the going concern basis of accounting and, based on the audit evidence obtained, whether a material uncertainty exists related to events or conditions that may cast significant doubt on the charity's ability to continue as a going concern. If we conclude that a material uncertainty exists, we are required to draw attention in our auditor's report to the related disclosures in the financial statements or, if such disclosures are inadequate, to modify our opinion. Our conclusions are based on the audit evidence obtained up to the date of our auditor's report. However, future events or conditions may cause the charity to cease to continue as a going concern.
- Evaluate the overall presentation, structure and content of the financial statements, including the disclosures, and whether the financial statements represent the underlying transactions and events in a manner that achieves fair presentation.

We communicate with those charged with governance regarding, among other matters, the planned scope and timing of the audit and significant audit findings, including any significant deficiencies in internal control that we identify during our audit.

#### *Use of our report*

This report is made solely to the charity's Commissioners, as a body, in accordance with Chapter 3 of Part 8 of the Charities Act 2011. Our audit work has been undertaken so that we might state to the charity's Commissioners those matters we are required to state to them in an auditor's report and for no other purpose. To the fullest extent permitted by law, we do not accept or assume responsibility to any party other than the charity and charity's Commissioners as a body, for our audit work, for this report, or for the opinion we have formed.

*Moore Kingston Smith LLP*

Statutory auditor

*12/7/2023*

2 Appold Street, London EC2A 2AP

Moore Kingston Smith LLP is eligible to act as auditor in terms of Section 1212 of the Companies Act 2006.

# Royal Commission for the Exhibition of 1851

## Statement of Financial Activities for the Year Ended 31 December 2022

|                                                                   | Notes | Unrestricted<br>Funds<br>2022<br>£ | Unrestricted<br>Funds<br>2021<br>£ |
|-------------------------------------------------------------------|-------|------------------------------------|------------------------------------|
| <b>Income from:</b>                                               |       |                                    |                                    |
| Donations                                                         | 4     | 3,300                              | 3,000                              |
| Investments                                                       | 5     | 2,386,031                          | 2,256,608                          |
| Other                                                             | 6     | 4,217                              | 58                                 |
| <b>Total income</b>                                               |       | <b>2,393,548</b>                   | <b>2,259,666</b>                   |
| <b>Expenditure on:</b>                                            |       |                                    |                                    |
| Generating funds                                                  | 7     | 799,328                            | 643,883                            |
| Charitable activities                                             | 8     | 5,470,448                          | 4,538,642                          |
| <b>Total expenditure</b>                                          |       | <b>6,269,776</b>                   | <b>5,182,525</b>                   |
| <b>Net expenditure before gains and losses<br/>on investments</b> |       | <b>(3,876,228)</b>                 | <b>(2,922,859)</b>                 |
| <b>Net gains / (losses) on investments</b>                        |       |                                    |                                    |
| (Losses) / gains on property                                      |       | (170,900)                          | 1,213,607                          |
| (Losses) / gains on investments                                   |       | (15,619,781)                       | 13,616,698                         |
| <b>Total of net gains / (losses) on investments</b>               |       | <b>(15,790,681)</b>                | <b>14,830,305</b>                  |
| <b>Net (expenditure) / income</b>                                 |       | <b>(19,666,909)</b>                | <b>11,907,446</b>                  |
| <b>Other recognised gains and losses</b>                          |       |                                    |                                    |
| Actuarial gains / (losses) on<br>defined benefit pension scheme   | 14    | 13,087                             | (3,432)                            |
| <b>Net movement in funds</b>                                      |       | <b>(19,653,822)</b>                | <b>11,904,014</b>                  |
| <b>Reconciliation of funds</b>                                    |       |                                    |                                    |
| Total funds brought forward                                       |       | 150,029,559                        | 138,125,545                        |
| Net movement in funds                                             |       | (19,653,822)                       | 11,904,014                         |
| <b>Total funds carried forward</b>                                |       | <b>130,375,737</b>                 | <b>150,029,559</b>                 |

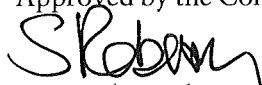
The notes on pages 53 to 71 form part of these accounts. Notes 1-2 provide details of the Commission's objectives and accounting policies.

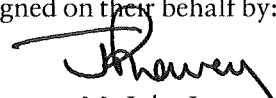
# Royal Commission for the Exhibition of 1851

## Balance Sheet as at 31 December 2022

|                                                         | Notes | Total<br>Funds<br>2022<br>£ | Total<br>Funds<br>2021<br>£ |
|---------------------------------------------------------|-------|-----------------------------|-----------------------------|
| <b>Fixed asset investments</b>                          |       |                             |                             |
| Investment properties                                   | 15    | 20,765,350                  | 20,940,350                  |
| Listed investments                                      | 16    | 112,318,792                 | 133,023,295                 |
| Cash held as part of the investment portfolio           |       | 3,672,152                   | 1,501,182                   |
|                                                         |       | <u>136,756,294</u>          | <u>155,464,827</u>          |
| <b>Current assets</b>                                   |       |                             |                             |
| Debtors                                                 | 17    | 377,919                     | 404,829                     |
| Cash at bank and in hand                                |       | 1,300,378                   | 1,577,788                   |
|                                                         |       | <u>1,678,297</u>            | <u>1,982,617</u>            |
| <b>Liabilities</b>                                      |       |                             |                             |
| Creditors: Amounts falling due within one year          | 18    | (4,595,362)                 | (4,070,791)                 |
| <b>Net current liabilities</b>                          |       | <u>(2,917,065)</u>          | <u>(2,088,174)</u>          |
| <b>Total assets less current liabilities</b>            |       | <u>133,839,229</u>          | <u>153,376,653</u>          |
| Creditors: Amounts falling due after more than one year | 18    | (3,106,492)                 | (2,948,094)                 |
| <b>Net assets excluding pension liability</b>           |       | <u>130,732,737</u>          | <u>150,428,559</u>          |
| Defined benefit pension scheme liability                | 14    | (357,000)                   | (399,000)                   |
| <b>Net assets</b>                                       |       | <u><u>130,375,737</u></u>   | <u><u>150,029,559</u></u>   |
| <b>The funds of the Charity:</b>                        |       |                             |                             |
| <b>Capital Funds</b>                                    |       |                             |                             |
| Balance as at 1 January                                 |       | 150,029,559                 | 138,125,545                 |
| Movement in year                                        |       | (19,653,822)                | 11,904,014                  |
| <b>Balance as at 31 December</b>                        |       | <u><u>130,375,737</u></u>   | <u><u>150,029,559</u></u>   |

Approved by the Commissioners on 5 July 2023 and signed on their behalf by:

  
Ms Sandra Robertson  
Chairman, Finance Committee

  
Mr John Lavery  
Secretary

The notes on pages 53 to 71 form part of these accounts.

# Royal Commission for the Exhibition of 1851

## Statement of Cash Flows for the Year Ended 31 December 2022

|                                                                    | Total<br>Funds<br>2022<br>£ | Total<br>Funds<br>2021<br>£ |
|--------------------------------------------------------------------|-----------------------------|-----------------------------|
| <b>Cash flows from operating activities</b>                        |                             |                             |
| Donations received (excluding donations in kind)                   | 3,300                       | 3,000                       |
| Grants and awards paid                                             | (4,093,117)                 | (4,310,580)                 |
| Payments to suppliers                                              | (1,033,626)                 | (1,030,464)                 |
| Payments in respect of employees                                   | (346,594)                   | (324,198)                   |
| Other payments                                                     | (24,638)                    | (24,570)                    |
| <b>Cash used in operating activities</b>                           | (5,494,675)                 | (5,686,812)                 |
| <b>Cash flows from investing activities</b>                        |                             |                             |
| Dividends, interest and rent from investments                      | 2,299,721                   | 3,063,600                   |
| Proceeds from sale of investments                                  | 20,366,979                  | 24,220,420                  |
| Purchase of investments                                            | (15,278,465)                | (20,639,072)                |
| <b>Net cash provided by investing activities</b>                   | 7,388,235                   | 6,644,948                   |
| <b>Change in cash and cash equivalents in the reporting period</b> | 1,893,560                   | 958,136                     |
| Cash and cash equivalents brought forward                          | 3,078,970                   | 2,120,834                   |
| <b>Cash and cash equivalents carried forward</b>                   | 4,972,530                   | 3,078,970                   |
| <b>Disclosed as:</b>                                               |                             |                             |
| Cash held as part of the investment portfolio                      | 3,672,152                   | 1,501,182                   |
| Cash at bank and in hand                                           | 1,300,378                   | 1,577,788                   |
|                                                                    | 4,972,530                   | 3,078,970                   |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2022

### 1. STATUS AND OBJECTIVES

The Commission for the Exhibition of 1851 was set up by Royal Charter in 1850 to plan and promote the Exhibition of Works of Industry of all Nations, which was to be held in London in 1851. When the affairs of the Great Exhibition had eventually been wound up, the Commissioners were appointed, under a Supplemental Charter, as a permanent body to administer the surplus funds at their disposal. These were to be applied in order to “increase the means of industrial education and extend the influence of science and art upon productive industry”.

### 2. ACCOUNTING POLICIES

The accounts are prepared under the historic cost convention, modified by the revaluation from time to time of certain fixed assets, and in accordance with the Financial Reporting Standard applicable in the UK and Republic of Ireland (effective January 2015) (FRS102), Accounting and Reporting by Charities: Statement of Recommended Practice applicable to charities preparing their accounts in accordance with the Financial Reporting Standard applicable in the UK and Republic of Ireland (effective January 2019) (SORP) and the Charities Act 2011.

In the estimation of the trustees (the Commissioners), there are no material uncertainties that call into doubt the Commission’s ability to continue and the accounts have therefore been prepared on a going concern basis.

The Commission, like every other organisation, has been impacted by the pandemic and Russia’s invasion of Ukraine which have resulted in ongoing supply chain disruption, persistent high inflation, increased interest rates and a cost-of-living crisis. Investment markets have been much more volatile, and the day-to-day value of the Commission’s portfolio has inevitably reflected that. The Commission is a long-term investor, however, and Commissioners remain confident in the underlying strength of the portfolio; they see no evidence at this stage of any permanent loss of value. Similarly, while the Commission has had to defer or write off a certain amount of rent, there is not considered to be any risk to the long-term value of the estate. The Commission has sufficient assets, and sufficient liquidity, to ride out the current market disruptions. The Commission’s core grant-making activity has therefore continued largely as planned and Commissioners expect it to continue to do so.

The Commission meets the definition of a public benefit entity under FRS102.

The financial statements are presented in sterling which is the functional currency of the charity. Monetary amounts are rounded to the nearest pound.

#### (a) Investments

- (i) Are shown in the balance sheet at market value; any unrealised gain over original cost is shown in the statement of financial activities.
- (ii) Income on investments is included in the accounts when receivable.
- (iii) Cash held as part of the investment portfolio includes short-term deposits held temporarily with the company’s bankers pending re-investment.

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2022

### 2. ACCOUNTING POLICIES (continued)

#### (b) Donations, legacies and similar income

Donations, legacies and similar income are included in the year in which they are receivable, that is, when the Commission becomes entitled to the income. Donations received for general purposes are included as unrestricted funds. Where the wishes of the donor are legally binding on Commissioners, donations are accounted for as Restricted Funds with their use limited to that defined by the donor.

#### (c) Fixed Assets and Depreciation

All purchases of capital items under £10,000 are written off in the year of purchase. Capital items over £10,000 are depreciated over their estimated useful economic lives. Currently no items are being depreciated.

#### (d) Investment Properties

All the Commission's properties are let to provide an income on a full repairing lease. All properties are inspected regularly by the Commission's Surveyors and revalued by them from time to time. The last full revaluation was undertaken at 31 December 2019 and was based on the existing use and occupation of the land, and the duration of leases at ground rents and rack rents. These valuations are reviewed and adjusted annually as described in note 15.

#### (e) Realised and Unrealised Gains on Investments

Gains and losses on investments and assets held for the Commission's use are treated in accordance with the Statement of Recommended Practice. They are recognised in the statement of financial activities for the year in which they occur.

#### (f) Cash and cash equivalents

Cash and cash equivalents include cash in hand, deposits held at call with banks, other short-term liquid investments with original maturities of three months or less, and bank overdrafts. Cash held on capital account pending investment by the charity's investment managers, together with cash for investment in transit between investment managers, is disclosed within fixed asset investments; all other cash and cash equivalents is disclosed within current asset investments.

#### (g) Lease premiums and licences

Premiums received for lease extensions are treated as capital receipts and included within gains / (losses) on property transactions. Certain other premiums received which do not materially affect the underlying value of the Commission's investment are treated as income receipts.

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2022

### 2. ACCOUNTING POLICIES (continued)

#### (h) Charitable activities

The primary charitable activity is the making of grants and awards. Grants and awards payable are accounted for on an accruals basis. Multi-year grants are accounted for in full in the year that the grant is awarded. The Commission recognises future liabilities discounted to their present value where material.

The majority of grants and awards are made to individuals who have been granted Fellowships or Studentships by the Commission. A limited number of awards are made to Institutions in furtherance of their educational needs. Some support is also provided to the legacy institutions on the Commission's South Kensington estate and to organisations facilitating access to the Commission's archives. A full analysis is shown in note 9.

The Commission also undertakes some direct charitable activities, in particular networking and educational events organised for the Commission's Fellows, Students, Alumni and the general public. Further details are shown in note 10.

#### (i) Allocation of support costs

Support costs are allocated on the basis of board or staff time as appropriate.

#### (j) Financial instruments

The Commission has elected to apply the provisions of Section 11 *Basic Financial Instruments* and Section 12 *Other Financial Instruments Issues* of FRS 102 to all of its financial instruments.

Financial instruments are recognised in the Commission's balance sheet when the Commission becomes party to the contractual provisions of the instrument.

##### *Basic financial assets*

Basic financial assets, which include trade and other debtors and cash and bank balances, are initially measured at transaction price including transaction costs and are subsequently carried at amortised cost using the effective interest method unless the arrangement constitutes a financing transaction, where the transaction is measured at the present value of the future receipts discounted at a market rate of interest.

##### *Other financial assets*

Other financial assets, including investments in equity instruments which are not subsidiaries, associates or joint ventures, are initially measured at fair value, which is normally the transaction price. Such assets are subsequently carried at fair value and the changes in fair value are recognised in the statement of financial activities, except that investments in equity instruments that are not publicly traded and whose fair values cannot be measured reliably are measured at cost less impairment.

Trade debtors, loans and other debtors that have fixed or determinable payments that are not quoted in an active market are classified as 'loans and receivables'. Loans and receivables are measured at amortised cost using the effective interest method, less any impairment.



# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2022

### 2. ACCOUNTING POLICIES (continued)

#### (j) Financial instruments (continued)

##### *Basic financial liabilities*

Basic financial liabilities, including trade and other creditors, are initially recognised at transaction price unless the arrangement constitutes a financing transaction, where the debt instrument is measured at the present value of the future payments discounted at a market rate of interest.

Debt instruments are subsequently carried at amortised cost, using the effective interest rate method.

Trade creditors are obligations to pay for goods or services that have been acquired in the ordinary course of business from suppliers. Accounts payable are classified as current liabilities if payment is due within one year or less. If not, they are presented as non-current liabilities. Trade creditors are recognised initially at transaction price and subsequently measured at amortised cost using the effective interest method.

##### *Other financial liabilities*

Derivatives, including interest rate swaps and forward foreign exchange contracts, are not basic financial instruments. Derivatives are initially recognised at fair value on the date a derivative contract is entered into and are subsequently re-measured at their fair value. Changes in the fair value of derivatives are recognised in the statement of financial activities in finance costs or finance income as appropriate, unless they are included in a hedging arrangement.

#### (k) Retirement benefits

Payments to defined contribution retirement benefit schemes are charged as an expense as they fall due.

The cost of providing benefits under defined benefit plans is determined separately for each plan using the projected unit credit method and is based on actuarial advice.

The net interest element is determined by multiplying the net defined benefit liability by the discount rate, taking into account any changes in the net defined benefit liability during the period as a result of contribution and benefit payments. The net interest is recognised in the statement of financial activities.

Remeasurement changes comprise actuarial gains and losses and the return on the net defined benefit liability excluding amounts included in net interest. These are recognised immediately in the statement of financial activities in the period in which they occur.

The defined net benefit pension liability in the balance sheet comprises the total of the present value of the defined benefit obligation (using a discount rate based on high quality corporate bonds).

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2022

### 2. ACCOUNTING POLICIES (continued)

#### (l) Significant judgements and key sources of estimation uncertainty

In the application of the charity's accounting policies, Commissioners are required to make judgements, estimates and assumptions about the carrying value of assets and liabilities that are not readily apparent from other sources. The estimates are based on historical experience and other factors that are considered to be relevant. Actual results may differ from these estimates. The key sources of estimation uncertainty that have a significant effect on the amount recognised in the accounts are:

- the valuation of investment properties, which are stated at their estimated fair value based on professional valuations as disclosed in Note 15;
- the valuation of multi-year grant commitments, which take into account estimates of future inflation, early withdrawal rates, claim rates and other factors affecting the final amount payable; in this context, given other uncertainties, discounting for the time value of money is not considered material;
- the valuation of the defined benefit pension scheme liability, which is based on actuarial assumptions and a professional valuation as set out in Note 14;
- the valuation of future minimum lease payments under non-cancellable operating leases, which are discounted for inflation in accordance with Bank of England targets and ignore the potential effects of leasehold enfranchisements, as set out in Note 15.

### 3. FUNDS

All the Commission's income and capital is expendable at the discretion of the Commissioners and is therefore shown as a single unrestricted fund. The Commissioners have designated part of the unrestricted fund as a Special Projects Fund. It is anticipated this will primarily be used to fund activities in connection with the 175th Anniversary of the Great Exhibition in 2026 and the transition to net zero. Movements on the designated fund are disclosed in Note 20.

### 4. DONATIONS

The Commission received donations from The Faculty of Royal Designers for Industry and The Royal Academy of Engineering. In each case the donation is for the general charitable purposes of the Commission. Some of the donations were made with an expressed wish that they be used to support the activities of the Sir Misha Black Awards Committee. These donations were used to part fund the ceremony held on 12 October 2022 at which the 2022 Medal and Award were presented. One of the donations was made with an expressed wish that it be used to support an event bringing together scientists and designers. This donation was used to part fund a collaborative event held at the Victoria and Albert Museum in March 2022. The Commissioners are very grateful to each of the donors for their support.

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2022

### 5. INVESTMENT INCOME

|                                  | 2022<br>£        | 2021<br>£        |
|----------------------------------|------------------|------------------|
| Rental income from UK properties | 528,991          | 594,269          |
| Income from managed investments  | 1,847,680        | 1,642,026        |
| Interest on cash deposits        | 9,360            | 20,313           |
|                                  | <u>2,386,031</u> | <u>2,256,608</u> |

### 6. OTHER INCOME

|                | 2022<br>£    | 2021<br>£ |
|----------------|--------------|-----------|
| Licence income | 4,217        | 58        |
|                | <u>4,217</u> | <u>58</u> |

### 7. COST OF GENERATING FUNDS

|                                   | 2022<br>£      | 2021<br>£      |
|-----------------------------------|----------------|----------------|
| Investment management fees        | 542,701        | 549,091        |
| Property management fees          | 61,185         | 33,130         |
| Legal fees                        | 32,438         | 8,226          |
| Write offs                        | 104,183        | -              |
| Allocated support costs (note 11) | 58,821         | 53,436         |
|                                   | <u>799,328</u> | <u>643,883</u> |

### 8. CHARITABLE ACTIVITIES

|                               | Grants<br>(note 9)<br>£ | Direct<br>costs<br>(note 10)<br>£ | Allocated<br>support<br>costs<br>(note 11)<br>£ | 2022<br>£        | 2021<br>£        |
|-------------------------------|-------------------------|-----------------------------------|-------------------------------------------------|------------------|------------------|
| Fellowships and studentships  | 3,354,327               | 147,628                           | 169,329                                         | 3,671,284        | 3,839,642        |
| STEM education and outreach   | 189,060                 | 161,712                           | 65,475                                          | 416,247          | 332,484          |
| Support for legacy estate     | 1,190,000               | 43,917                            | 65,475                                          | 1,299,392        | 294,351          |
| Archives and alumni relations | -                       | 17,849                            | 65,676                                          | 83,525           | 72,165           |
|                               | <u>4,733,387</u>        | <u>371,106</u>                    | <u>365,955</u>                                  | <u>5,470,448</u> | <u>4,538,642</u> |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2022

### 9. GRANTS AWARDED

#### (a) *Fellowships and studentships*

|                                    | 2022<br>No. | 2022<br>£        | 2021<br>No. | 2021<br>£        |
|------------------------------------|-------------|------------------|-------------|------------------|
| Research Fellowships               | 9           | 1,027,845        | 10          | 1,490,400        |
| Industrial Fellowships             | 10          | 1,312,595        | 13          | 1,165,435        |
| Industrial Design Studentships     | 13          | 437,789          | 11          | 466,506          |
| Built Environment Fellowship       | -           | 21,598           | 1           | 100,000          |
| Design Fellowship                  | 1           | 100,000          | -           | -                |
| Regenerative Design Fellowships    | 2           | 200,000          | -           | -                |
| Enterprise Fellowships             | 5           | 250,000          | 6           | 312,500          |
| Sir Misha Black Awards Bursaries   | 1           | 4,500            | 2           | 20,000           |
|                                    | <u>41</u>   | <u>3,354,327</u> | <u>43</u>   | <u>3,554,841</u> |
| Total fellowships and studentships | 41          | 3,354,327        | 43          | 3,554,841        |

All of the fellowships and studentships were awarded to individuals. The Annual Report includes more information on the awards granted, including where relevant details of each of the institutions at which individual recipients are carrying out their studies / research.

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2022

### 9. GRANTS AWARDED (continued)

#### (b) STEM education and outreach

|                                                                      | 2022<br>£ | 2021<br>£ |
|----------------------------------------------------------------------|-----------|-----------|
| MadeHereNow – Website development                                    | 2,000     | -         |
| Smallpeice Trust – General Engineering course                        | 10,000    | -         |
| Well North Enterprises – STEM development in Rotherham and Liverpool | 75,000    | -         |
| Somerscience Trust – Somerscience Festival                           | 15,000    | -         |
| WoMars – STEM outreach                                               | 1,000     | -         |
| Royal Designers for Industry – Summer Schools                        | 92,500    | -         |
| EDT – Routes into STEM / Virtual STEM work experience                | 14,060    | 10,186    |
| Royal Society of Chemistry – Steps into Science                      | -         | 15,000    |
| National Literacy Trust – Linking literacy and STEM careers          | -         | 18,648    |
| Education and Training Foundation – Technical Teaching Fellowships   | -         | 112,500   |
| Wellington Trust – Future maritime engineers                         | -         | 15,460    |
| Kids Invent Stuff – Mini YouTube STEM musical                        | -         | 5,000     |
| All Party Parliamentary Engineering Group – Meeting sponsorship      | -         | 5,000     |
| STEM Learning – Involving 1851 Fellows in primary STEM outreach      | -         | 14,875    |
| In2ScienceUK – Engineering research module / Alumni programme        | -         | 7,850     |
|                                                                      | <hr/>     | <hr/>     |
|                                                                      | 209,560   | 204,519   |
| Less: Past awards written back where not utilised in full            | (20,500)  | (4,680)   |
|                                                                      | <hr/>     | <hr/>     |
|                                                                      | 189,060   | 199,839   |
|                                                                      | <hr/>     | <hr/>     |

All of the STEM education and outreach grants were awarded to institutions (2021: all of the STEM education and outreach grants were awarded to institutions).

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2022

### 9. GRANTS AWARDED (continued)

#### (c) *Support for legacy estate*

|                                                                                                       | 2022      | 2021    |
|-------------------------------------------------------------------------------------------------------|-----------|---------|
|                                                                                                       | £         | £       |
| Natural History Museum – 1851 Garden                                                                  | 500,000   | -       |
| Royal Horticultural Society – Plants for purpose                                                      | 300,000   | -       |
| Exhibition Road Cultural Group – SouthKenZen+                                                         | 350,000   | -       |
| Exhibition Road Culture Group – Art installation on<br>Exhibition Road / South Kensington Green Trail | 25,000    | 30,000  |
| Royal College of Art – Open resource for purposeful design /<br>The empathetic engineer               | 15,000    | 13,500  |
| Royal Geographical Society – Upgrading 1 Kensington Gore                                              | -         | 155,200 |
|                                                                                                       | <hr/>     | <hr/>   |
|                                                                                                       | 1,190,000 | 198,700 |
| Less: Past awards written back where not utilised in full                                             | -         | (3,000) |
|                                                                                                       | <hr/>     | <hr/>   |
|                                                                                                       | 1,190,000 | 195,700 |
|                                                                                                       | <hr/>     | <hr/>   |

All of the grants in support of the legacy estate in both 2022 and 2021 were awarded to institutions.

#### (d) *Archives and alumni relations*

No awards were made in this category in 2022 or 2021. In 2021, £1,593 of past awards were written back where they had not been utilised in full. There were no further writebacks in 2022.

In total, 13 grants were made to institutions and 41 to individuals (2021: 12 grants to institutions and 43 to individuals).

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2022

### 10. DIRECT COSTS

|                                         | 2022           | 2021           |  |
|-----------------------------------------|----------------|----------------|--|
|                                         | £              | £              |  |
| Promotion and selection costs           | 84,721         | 85,323         |  |
| Networking and educational events       | 62,907         | 116,506        |  |
| Estate memberships, projects and advice | -              | 35,993         |  |
| Archive supplies and acquisitions       | -              | 4,898          |  |
| Alumni website and expenses             | -              | 6,785          |  |
|                                         | <u>147,628</u> | <u>249,505</u> |  |
| Fellowships and studentships            |                |                |  |
| STEM education and outreach             |                |                |  |
| £                                       | 161,712        |                |  |
| Support for legacy estate               |                |                |  |
| £                                       | 13,882         |                |  |
| Archives and alumni relations           |                |                |  |
| £                                       | 30,035         |                |  |
|                                         | <u>43,917</u>  | <u>17,849</u>  |  |
|                                         | <u>371,106</u> | <u>249,505</u> |  |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2022

### 11. SUPPORT COSTS

|                             | Cost of generating funds<br>£ | Fellowships and studentships<br>£ | STEM education and outreach<br>£ | Support for legacy estate<br>£ | Archives and alumni relations<br>£ | 2022<br>£      | 2021<br>£      | Basis of allocation |
|-----------------------------|-------------------------------|-----------------------------------|----------------------------------|--------------------------------|------------------------------------|----------------|----------------|---------------------|
| Governance costs (note 12)  | 10,202                        | 10,202                            | 8,161                            | 8,161                          | 4,081                              | 40,807         | 28,323         | Board time          |
| Staff costs (note 13)       | 37,932                        | 124,149                           | 44,716                           | 44,716                         | 48,056                             | 299,569        | 284,015        | Staff time          |
| Retired staff pension costs | 917                           | 3,000                             | 1,081                            | 1,081                          | 1,161                              | 7,240          | 5,343          | Staff time          |
| Facility costs              | 1,560                         | 5,107                             | 1,839                            | 1,839                          | 1,977                              | 12,322         | 12,321         | Staff time          |
| Office refurbishment        | -                             | -                                 | -                                | -                              | -                                  | -              | 180            | Staff time          |
| Office costs                | 4,295                         | 14,057                            | 5,063                            | 5,063                          | 5,441                              | 33,919         | 30,484         | Staff time          |
| Legal and professional fees | 2,974                         | 9,733                             | 3,506                            | 3,506                          | 3,768                              | 23,487         | 29,532         | Staff time          |
| Travel and entertaining     | 941                           | 3,081                             | 1,109                            | 1,109                          | 1,192                              | 7,432          | 3,588          | Staff time          |
|                             | <u>58,821</u>                 | <u>169,329</u>                    | <u>65,475</u>                    | <u>65,475</u>                  | <u>65,676</u>                      | <u>424,776</u> | <u>393,786</u> |                     |



# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2022

### 12. GOVERNANCE COSTS

|                                     | 2022<br>£     | 2021<br>£     |
|-------------------------------------|---------------|---------------|
| Audit fees (including VAT)          |               |               |
| – Current year                      | 13,800        | 11,000        |
| – Prior year under / (over) accrual | 460           | 480           |
| Actuarial fees                      | 2,040         | 1,800         |
| Consultancy fees                    | 3,600         | -             |
| Annual report                       | 1,861         | 1,801         |
| Meeting costs                       | 15,026        | 13,242        |
| Commissioner recruitment costs      | 4,020         | -             |
|                                     | <u>40,807</u> | <u>28,323</u> |

### 13. STAFF COSTS AND RELATED PARTY TRANSACTIONS

|                                       | 2022<br>£      | 2021<br>£      |
|---------------------------------------|----------------|----------------|
| Salaries (including benefits in kind) | 240,561        | 232,682        |
| Employer's NI                         | 23,238         | 21,874         |
| Pension contributions                 | 34,889         | 25,649         |
| Staff recruitment                     | -              | 2,956          |
| Training and development              | 881            | 854            |
|                                       | <u>299,569</u> | <u>284,015</u> |

The average number of employees during the year analysed by function was:

|                            | 2022<br>No. | 2021<br>No. |
|----------------------------|-------------|-------------|
| Support and administration | 4.0         | 4.0         |
| Archive                    | 1.0         | 1.0         |
|                            | <u>5.0</u>  | <u>5.0</u>  |

The full-time equivalent number of employees during the year analysed by function was:

|                            | 2022<br>No. | 2021<br>No. |
|----------------------------|-------------|-------------|
| Support and administration | 2.9         | 2.8         |
| Archive                    | 0.4         | 0.4         |
|                            | <u>3.3</u>  | <u>3.2</u>  |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2022

### 13. STAFF COSTS AND RELATED PARTY TRANSACTIONS (continued)

No employees earned more than £60,000 (2021: one employee earned between £100,000 and £110,000; no pension contributions were paid in respect of this employee).

Commissioners do not receive remuneration. During the year re-imbursements were made to three Commissioners in respect of travelling and other expenses totalling £954 (2021: to five Commissioners totalling £1,512). One Commissioner received an honorarium of £600 as a member of the Science and Engineering Fellowships Committee in recognition of specialist services provided in assessing potential candidates (2021: no Commissioners received an honorarium).

The total amount paid in respect of key management personnel (i.e., the outgoing Secretary, incoming Secretary and Finance Director), including employer's national insurance and employer pension contributions, was £194,519 (2021: £180,236).

There were no other related party transactions during the year (2021: none).

### 14. PENSIONS AND OTHER LONG-TERM EMPLOYEE BENEFITS

All current and new members of staff are eligible to join a personal pension scheme of their choice with the Commission contributing 15% of salary (2021: 15% of salary). There is no requirement for employee contributions. Staff may opt to sacrifice some of their salary in return for an additional employer contribution. Employer contributions of £34,889 (2021: £25,649) were made in the year of which £820 (2021: £781) were outstanding at the year-end. There were no prepaid contributions at the year-end (2021: £nil).

All current and new members of staff also benefit from an unfunded / uninsured death in service scheme under which the Commissioners (at their absolute discretion) may pay a nominated beneficiary a lump sum equivalent to 18 months' salary if an employee dies while employed by the Commission. No liability for the scheme is recognised in the accounts as Commissioners do not believe there is any sensible way to estimate the liability. Actuarial calculations based on assumptions comparable to those used in valuing the defined benefit pension liability (see below) suggest that any liability in respect of the death in service scheme would in any case be immaterial.

All current and new members of staff also benefit from a Group Income Protection policy with Canada Life which covers basic salary and pension contributions for staff unable to work due to long term illness.

The Commission operates an unfunded pension scheme in the UK (the 'Scheme'). The Scheme is an unregistered, non-contributory defined benefit scheme. As the Scheme is unfunded, no contributions are paid by the Commission, other than to meet benefits as they fall due. As no triennial valuations are carried out, a valuation is carried out at the balance sheet date each year by an independent qualified actuary.

The Scheme was closed to new members on 14 July 2004. As at 31 December 2022, all six remaining members of the Scheme are receiving a pension and there is no further accrual of benefits. There is therefore no service cost for the year. The amount recognised in arriving at net expenditure for the year is an expense of £7,239 (2021: £5,343) which is fully in respect of net interest on the net liability.

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2022

### 14. PENSIONS AND OTHER LONG-TERM EMPLOYEE BENEFITS (continued)

As regards the unfunded, defined benefit pension scheme:

*The principal assumptions used by the actuary were:*

|                                       | FRS102<br>Valuation<br>2022<br>(% p.a.) | FRS102<br>Valuation<br>2021<br>(% p.a.) |
|---------------------------------------|-----------------------------------------|-----------------------------------------|
| <i>Financial assumptions</i>          |                                         |                                         |
| Gross investment return               |                                         |                                         |
| In-service members                    |                                         |                                         |
| Pre-retirement                        | N/A                                     | N/A                                     |
| Post-retirement                       | N/A                                     | N/A                                     |
| Current pensioners                    | 4.8%                                    | 1.9%                                    |
| Pensionable earnings increases        | N/A                                     | N/A                                     |
| Price inflation                       | 3.4%                                    | 3.6%                                    |
| Pension increases                     | 3.4%                                    | 3.6%                                    |
| Allowance for administration expenses | 0.0%                                    | 0.0%                                    |
| <i>Demographic assumptions</i>        |                                         |                                         |
| Mortality                             |                                         |                                         |
| Pre-retirement                        | N/A                                     | N/A                                     |
| Post-retirement                       | 101%/104% S3PA<br>CMI 2021 1%           | S3PA<br>CMI 2020 1%                     |
| Withdrawal allowance                  | No allowance                            | No allowance                            |
| Early retirement allowance            | No allowance                            | No allowance                            |
| Proportion married                    | 90%                                     | 90%                                     |
| Wife's age                            | 3 years younger<br>than husband         | 3 years younger<br>than husband         |

The assumptions used by the actuary are best estimates chosen from a range of possible actuarial assumptions which, due to the timescale covered, may not necessarily be borne out in practice.

*Value of Scheme assets and liabilities:*

|                                     | 2022<br>£        | 2021<br>£        |
|-------------------------------------|------------------|------------------|
| Market value of Scheme assets       | —                | —                |
| Present value of Scheme liabilities | (357,000)        | (399,000)        |
| Scheme deficit                      | (357,000)        | (399,000)        |
| Related deferred tax asset          | —                | —                |
| Net liability                       | <u>(357,000)</u> | <u>(399,000)</u> |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2022

### 14. PENSIONS AND OTHER LONG-TERM EMPLOYEE BENEFITS (continued)

#### *Movements in the year:*

|                                        | 2022<br>£        | 2021<br>£        |
|----------------------------------------|------------------|------------------|
| Scheme deficit at beginning of year    | (399,000)        | (425,000)        |
| Current service cost                   | -                | -                |
| Interest on obligation                 | (7,240)          | (5,343)          |
| Actuarial gain / (loss) on liabilities | 13,087           | (3,432)          |
| Benefits paid directly by employer     | 36,153           | 34,775           |
|                                        | <u>(357,000)</u> | <u>(399,000)</u> |
| Scheme deficit at end of year          |                  |                  |

The interest on obligation of £7,240 (2021: £5,343) is disclosed within Support costs (note 11) while the actuarial gain on liabilities of £13,087 (2021: loss of £3,432) is disclosed within Other recognised gains and losses on the face of the SOFA.

### 15. INVESTMENT PROPERTIES AND OPERATING LEASES

|                                                        | 2022<br>£         | 2021<br>£         |
|--------------------------------------------------------|-------------------|-------------------|
| (a) <i>Movements in value of investment properties</i> |                   |                   |
| Balance at 1 January                                   | 20,940,350        | 23,345,382        |
| Sales during the year                                  | -                 | (3,680,032)       |
| Unrealised (loss) / gain on year-end revaluation       | (175,000)         | 1,275,000         |
|                                                        | <u>20,765,350</u> | <u>20,940,350</u> |
| Valuation at 31 December                               |                   |                   |

The valuation as at 31 December 2022 shown above resulted from a full revaluation of the properties at 31 December 2019, undertaken by Cluttons LLP, Chartered Surveyors and Property Consultants. The valuation was carried out on an open market value basis in accordance with the RICS Appraisal and Valuation Manual and is based on existing usage and occupation of the land, and the duration of leases at ground and rack rents. In reaching the 31 December 2022 valuation, the value at 31 December 2019 has been adjusted, based on advice from Daniel Watney LLP, to take into account movements in local property market indices, changes in estimated rental values, the decreasing length of leases and lease extension / leasehold enfranchisement claims received. All of the investment properties are located in the UK.

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2022

### 15. INVESTMENT PROPERTIES AND OPERATING LEASES (continued)

#### (b) *Operating leases – lessor*

The Commission is entitled as landlord to income from investment properties under operating leases. Future minimum lease payments under non-cancellable operating leases, discounted for inflation, for each of the following periods are as follows:

|                                                   | 2022<br>£         | 2021<br>£        |
|---------------------------------------------------|-------------------|------------------|
| Not later than one year                           | 94,538            | 94,538           |
| Later than one year and not later than five years | –                 | –                |
| Later than five years                             | 10,429,261        | 9,800,137        |
|                                                   | <u>10,523,799</u> | <u>9,894,675</u> |

The Commission's investment properties are let for periods ranging up to 999 years. All leases are on full repairing and insuring terms. Leases of residential property are potentially subject to leasehold enfranchisement; this has been ignored in arriving at the above figures.

### 16. INVESTMENTS

|                                            | 2022<br>£          | 2021<br>£          |
|--------------------------------------------|--------------------|--------------------|
| (a) <i>Movements in listed investments</i> |                    |                    |
| Market value 1 January                     | 133,023,295        | 119,307,960        |
| Acquisitions at cost                       | 15,283,538         | 20,645,106         |
| Disposals at cost                          | (16,517,911)       | (15,820,788)       |
| Net (losses) / gains on revaluation        | (19,470,130)       | 8,891,017          |
|                                            | <u>112,318,792</u> | <u>133,023,295</u> |
| Market value 31 December                   | 112,318,792        | 133,023,295        |
|                                            | <u>93,179,598</u>  | <u>94,413,971</u>  |
| Value at cost 31 December                  | 93,179,598         | 94,413,971         |

#### (b) *Geographic breakdown*

|                | 2022<br>£             | 2022<br>£        | 2021<br>£             | 2021<br>£        |
|----------------|-----------------------|------------------|-----------------------|------------------|
|                | Listed<br>investments | Cash             | Listed<br>investments | Cash             |
| In the UK      | 52,328,177            | 3,516,273        | 64,605,641            | 1,501,182        |
| Outside the UK | 59,990,615            | 155,879          | 68,417,654            | –                |
|                | <u>112,318,792</u>    | <u>3,672,152</u> | <u>133,023,295</u>    | <u>1,501,182</u> |

All investments are listed on a recognised stock exchange.

There were no individual holdings the market value of which is considered to be material in the context of the portfolio as a whole.

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2022

### 17. DEBTORS

|                         | 2022<br>£      | 2021<br>£      |
|-------------------------|----------------|----------------|
| Rents receivable        |                |                |
| – in hands of surveyors | 48,647         | 36,978         |
| – in arrears            | 299,016        | 318,667        |
|                         | <u>347,663</u> | <u>355,645</u> |
| Other debtors           | 338            | 9,844          |
| Prepayments             | 29,918         | 28,871         |
| Accrued income          | -              | 10,469         |
|                         | <u>377,919</u> | <u>404,829</u> |

### 18. CREDITORS

|                                     | 2022<br>£        | 2021<br>£        |
|-------------------------------------|------------------|------------------|
| Amounts falling due within one year |                  |                  |
| Grants payable                      | 4,379,636        | 3,895,445        |
| Other creditors                     | 215,726          | 175,346          |
|                                     | <u>4,595,362</u> | <u>4,070,791</u> |

|                                    | 2022<br>£      | 2021<br>£      |
|------------------------------------|----------------|----------------|
| <b>Analysis of other creditors</b> |                |                |
| Investment management fees         | 134,891        | 106,558        |
| Property management fees           | 8,400          | 19,733         |
| Audit fees                         | 13,800         | 11,000         |
| Other legal and professional fees  | 17,588         | 9,309          |
| Others                             | 41,047         | 28,746         |
|                                    | <u>215,726</u> | <u>175,346</u> |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2022

### 18. CREDITORS (continued)

|                                                     | 2022<br>£        | 2021<br>£        |
|-----------------------------------------------------|------------------|------------------|
| <b>Amounts falling due after more than one year</b> |                  |                  |
| Grants payable                                      | 3,106,492        | 2,948,094        |
| Due in one to two years                             | 2,188,881        | 2,040,027        |
| Due within two to five years                        | 917,611          | 908,067          |
|                                                     | <u>3,106,492</u> | <u>2,948,094</u> |

The analysis of grants payable by award is as follows

| Award                             | Period of<br>commitment | 2022<br>£        | 2021<br>£        |
|-----------------------------------|-------------------------|------------------|------------------|
| Fellowships and studentships      |                         |                  |                  |
| – Research Fellowships            | 3 years                 | 3,139,121        | 3,099,479        |
| – Industrial Fellowships          | 3 years                 | 2,030,084        | 1,595,090        |
| – Industrial Design Studentships  | 2 years                 | 369,398          | 339,645          |
| – Built Environment Fellowships   | 2 years                 | 55,000           | 58,402           |
| – Design Fellowships              | 2 years                 | 165,000          | 142,500          |
| – Regenerative Design Fellowships | 2 years                 | 155,000          | -                |
| – Enterprise Fellowships          | 1 year                  | 62,500           | 187,500          |
| – Sir Misha Black Award Bursaries | 1 year                  | 6,500            | -                |
| STEM education and outreach       | 1 year                  | 238,325          | 342,932          |
| Support for legacy estate         | 3 years                 | 1,265,200        | 1,410,050        |
| Archives and alumni relations     | 1 year                  | -                | 26,500           |
|                                   |                         | <u>7,486,128</u> | <u>6,843,539</u> |

### 19. FINANCIAL INSTRUMENTS

|                                                                                | 2022<br>£        | 2021<br>£        |
|--------------------------------------------------------------------------------|------------------|------------------|
| <b>Carrying amount of financial assets</b>                                     |                  |                  |
| Debt instruments measured at amortised cost<br>(debtors excluding prepayments) | 348,001          | 375,958          |
|                                                                                | <u>348,001</u>   | <u>375,958</u>   |
| <b>Carrying amount of financial liabilities</b>                                |                  |                  |
| Measured at amortised cost                                                     | 7,701,854        | 7,018,885        |
|                                                                                | <u>7,701,854</u> | <u>7,018,885</u> |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2022

### 20. FUNDS

|                                  | At 1 January<br>£  | Income<br>£      | Expenditure<br>£   | Gains / (losses)<br>£ | Transfers<br>£ | At 31 December<br>£ |
|----------------------------------|--------------------|------------------|--------------------|-----------------------|----------------|---------------------|
| Unrestricted<br>General          | 147,743,822        | 2,393,548        | (6,269,776)        | (15,777,594)          | (132,921)      | 127,957,079         |
| Designated<br>– Special Projects | 2,285,737          | -                | -                  | -                     | 132,921        | 2,418,658           |
|                                  | <u>150,029,559</u> | <u>2,393,548</u> | <u>(6,269,776)</u> | <u>(15,777,594)</u>   | <u>-</u>       | <u>130,375,737</u>  |

In 2021, the Commissioners set up a designated Special Projects Fund. It is anticipated that this will be used to fund activities in connection with the 175th Anniversary of the Great Exhibition in 2026 and perhaps also to fund activities around the transition to net zero, although Commissioners retain the discretion to direct alternative uses and remain mindful of the desirability of maintaining disbursements through periods of inferior market return. The designated fund comprises listed investments. It is administered as part of the unrestricted fund.



## Administrative Information

### Structure, Governance and Management

The Commission is constituted as a limited company incorporated by Royal Charter. Its governing documents are the original Charter dated 3 January 1850 and a Supplemental Charter dated 2 December 1851.

The Commission may have up to twelve trustees, known as Royal Commissioners, at any one time, who together constitute the Board of Management, which meets formally twice a year. Commissioners are chosen to bring wide experience in areas relevant to the Commission's work – science, engineering, industry, design, architecture and finance. To maintain an appropriate balance of skills, Commissioners normally serve for 10 years, and Commissioners themselves identify possible successors, who may serve on a committee prior to election. Following election by the Board of Management, Commissioners are only appointed with the approval of the President.

All other committees are advisory in remit, are subordinate to the Board of Management and report to it, and all committee Chairmen are Commissioners. Ad hoc committees may be formed for limited periods and specific purposes. Any committee other than the Board of Management may have non-Commissioners as members subject to the wishes of the Chairman of that committee. All committees, except ad hoc committees, meet at least once annually. All committees are serviced by the Secretary and, where appropriate, by the Finance Director.

The Secretary also provides full briefing and induction programmes for all new Commissioners and committee members when appointed. As part of this introduction Commissioners are provided with a Governance Book containing full details of the Commission's history, role, strategy, procedures and Commissioners' responsibilities, as well as the relevant Charity Commission guidance for trustees. During their tenure, further opportunities for Commissioners to develop their knowledge of areas relevant to the Commission's activities are provided as appropriate.

Day to day running of the Commission is delegated to the Secretary, assisted by a small staff team. Matters of strategy, and all grants greater than £5,000, are decided by Commissioners.

Full details of Commissioners and Committee members in post during the year, as well as the small staff team, are provided on pages 74 to 76. Details of the Commission's professional advisers are provided on page 77.

### Remuneration

Commissioners are not remunerated in their role as trustees of the charity and do not receive benefits other than reimbursement of expenses incurred in attending meetings.

In order to maximise funds available for grant making, Commissioners are determined to keep staff numbers and associated office costs to a minimum. To attract and retain experienced staff of the right calibre, however, Commissioners recognise the need to set salaries in line with those for other grant-making charities in the London area, based on sector benchmarks and other publicly available data.

Salaries for all staff, including key management personnel, are reviewed annually by the Chairman of the Board and the Chairman of the Finance Committee as part of the performance appraisal process. Pay awards are dependent on performance and set based on increases in the cost of living and average salary increases for the sector. There are no automatic increments and no bonus scheme.

Commissioners recognise the importance of helping employees make adequate provision for retirement. All employees are therefore eligible to receive a 15% employer pension contribution to the pension scheme established for auto-enrolment purposes or a personal pension of their choice. All employees also benefit from a Group Income Protection policy that will cover basic salary and pension contributions if they are unable to work due to long-term illness. At their absolute discretion,

Commissioners may pay a nominated beneficiary a lump sum equivalent to 18 months' salary if an employee dies while employed by the Commission. All employees are also entitled to an interest free season ticket loan. All of the above benefits are available to all employees, including key management personnel. Employees do not receive any other benefits.

## Risk Policy

In discharging their responsibilities for the management of risk, it is the policy of the Commissioners to identify, analyse and seek to manage any risks to the ability of the Commission to carry out its role effectively and meet the obligations of its Royal Charter.

To this effect the Commissioners have given consideration to the major risks to which the Commission is, or may be, exposed. A full risk register has been drawn up, which is reviewed regularly. Insurance brokers have been appointed to advise on areas where risk can be effectively mitigated through insurance. Compliance risks are mitigated through taking and following appropriate professional advice.

The main remaining areas of strategic and operational risk and the steps taken to address them are summarised below.

### *Investments: security, performance, liquidity*

The Commission has a diversified portfolio, both in terms of investments held and managers appointed. It has adopted investment and disbursement policies designed to maintain the real value of the portfolio over time and hence the support available to current and future beneficiaries. Sufficient liquidity is held outside the portfolio to meet short term commitments. Commissioners have delegated review of investment performance to a Finance Committee comprising individuals with relevant expertise.

### *Grant making: applications, assessment, administration*

Commissioners have appointed specialist committees to review fellowship applications, work closely with other organisations active in the STEM arena to avoid unnecessary duplication or administrative effort and have appointed a communications company to assist with marketing of the awards to ensure they are brought to the attention of eligible recipients. Commissioners regularly seek feedback from potential applicants and other stakeholders to ensure the awards remain relevant.

### *Legacy estate: character, experience, relevance*

Commissioners take an active interest in the estate, seek to facilitate relevant initiatives across legacy institutions and provide financial support where possible to ensure the estate remains a beacon of excellence and inspiration in the worlds of science, engineering and design.

## Commissioners and Committee Members

### President

HRH The Princess Royal

### Commissioners (and Board of Management)

The Rt Hon Professor Lord Kakkar KBE PC FMedSci  
*Chairman, Board of Management*

Professor Jim Al-Khalili CBE FRS FInstP  
Professor Dame Ann Dowling OM DBE FREng FRS  
Mr Jim Eyre OBE  
Professor Sir Andrew Hopper CBE FRS FREng FIET  
Professor Lord Mair CBE HonDSc FREng FICE FRS  
Dame Alison Nimmo DBE MRTPI FRICS HonFRIBA FICE  
Ms Sandra Robertson  
Professor Dame Carol Robinson DBE FRS FRSC FMedSci  
Professor Eleanor Stride OBE FREng HonFIET  
Professor Chris Wise RDI FREng FICE MStructE HonFRIBA FRSA

The Rt Hon Professor Lord Kakkar was appointed to the Board on 2 February 2022  
Professor Eleanor Stride was appointed to the Board on 6 July 2022  
Professor Dame Kay Davies retired from the Board on 6 July 2022  
Mr Bernard Taylor retired from the Board on 8 December 2022

### Ex Officio Commissioners

The Lord President of the Council  
The First Lord of the Treasury  
The Chancellor of the Exchequer  
The Secretary of State for Science, Innovation and Technology  
The Secretary of State for the Environment, Food and Rural Affairs  
The President of the Institution of Civil Engineers  
The President of the Geological Society

### Finance Committee

Ms Sandra Robertson *Chairman*  
Ms Sarah Arkle  
Professor Sir Andrew Hopper CBE FRS FREng FIET  
Dame Alison Nimmo DBE MRTPI FRICS HonFRIBA FICE  
Mr Fabian Thehos CFA

Mr Fabian Thehos was appointed to the Committee on 15 August 2022  
Mr Nicholas Moakes retired from the Committee on 11 November 2022

## Science and Engineering Fellowships Committee

Professor Dame Carol Robinson DBE FRS FRSC FMedSci *Chairman*  
Professor Jim Al-Khalili CBE FRS FInstP  
Professor Gillian Bates FRS FMedSci  
Professor Mike Benton FRS FRSE  
Professor Martin Bridson FRS  
Professor Andrew Briggs  
Professor Neil Champness FRSC FLSW  
Professor Anne Dell CBE FRS FMedSci  
Professor John Dewey FRS  
Professor Cyril Hilsum CBE FREng FRS  
Professor Patrick Keogh FREng  
Professor Stephen Muggleton FREng  
Professor Rachel O'Reilly FRS FRSC  
Professor Sheena Radford OBE FRS FMedSci  
Dr Dame Frances Saunders DBE CB FREng FInstP  
Professor Trevor Stuart FIC FRS  
Professor Christopher Tout  
Professor Stuart West  
Professor John Wood CBE FREng

Professor Jane Langdale retired from the Committee on 6 July 2022  
Professor Dame Kay Davies retired from the Committee on 8 December 2022

## Brunel Fellowships Sub-Committee

Professor Dame Carol Robinson DBE FRS FRSC FMedSci *Chairman*  
Professor Dame Anne Dowling OM DBE FREng FRS  
Professor David Ewins DSc FREng FRS  
Professor William Powrie FREng FICE  
Professor John Wood CBE FREng

Professor Dame Carol Robinson was appointed to the Sub-Committee on 1 January 2022  
Professor Dame Kay Davies retired from the Sub-Committee on 8 December 2022

## Industry and Engineering Committee

Professor Dame Ann Dowling OM DBE FRS FREng *Chairman*  
Professor John Clarkson FREng  
Dr Nicholas de León  
Professor Andrew Lewis FREng FRSC FAPS FIMMM CChem CSI  
Professor Lord Mair CBE HonDSc FREng FICE FRS  
Professor Ron Pethig  
Dr Malcolm Skingle CBE DSc  
Professor Dame Sarah Springman DBE FREng  
Professor Eleanor Stride OBE FREng HonFIET

Professor Dame Sarah Springman was appointed to the Committee on 14 October 2022  
Professor Andrew Lewis was appointed to the Committee on 9 September 2022  
Ms Naomi Climer retired from the Committee on 7 June 2022

## Built Environment and Design Fellowships Committee

Mr Jim Eyre OBE *Chairman*  
Professor Rachel Cooper OBE  
Dame Alison Nimmo DBE MRTPI FRICS HonFRIBA FICE  
Ms Kat Scott  
Dr Andrea Siodmok EMPP FRSA HonDCL  
Professor Chris Wise RDI FREng FICE MIStructE HonFRIBA FRSA

Ms Kat Scott was appointed to the Committee on 1 January 2022

## Sir Misha Black Awards Committee

Ms Mary Mullin *Chairman*  
Professor Chris Wise RDI FREng FICE MIStructE HonFRIBA FRSA  
Professor Peter Childs  
Dr Nicholas de León  
Professor Sir Christopher Frayling FCSD FRSA FRIBA  
Professor Malcolm Garrett MBE RDI FISTD  
Professor Geoff Kirk RDI FREng

## Staff

|                            |                                      |
|----------------------------|--------------------------------------|
| Mr John Lavery MVO         | Secretary (from May 2023)            |
| Mr Nigel Williams LVO CEng | Secretary (to May 2023)              |
| Mr Amahl Smith ACA         | Finance Director                     |
| Mrs Helen Harris           | Fellowship Programme Manager         |
| Mrs Angela Kenny RMARA     | Archivist and Alumni Relations       |
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# Accounts

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# Royal Commission for the Exhibition of 1851

Annual Report and Accounts

For the year ended 31 December 2021



## The Aims of the Royal Commission

The 1851 Royal Commission's governing document is its Supplemental Charter of 1851, which requires the Commission to  
*"increase the means of industrial education and extend the influence of science and art upon productive industry"*.

This was originally interpreted as a requirement to create a centre of intellectual excellence, which resulted in the acquisition of the South Kensington estate and its subsequent development with museums, academic establishments and a Central Hall of Arts and Sciences (the Royal Albert Hall).

Later, in 1890, the emphasis was switched to the support of individuals, starting with the award of Science Research Scholarships from 1891.

Today the Commission runs its own schemes for:

Research Fellowships  
Industrial Fellowships  
Industrial Design Studentships  
Built Environment Fellowships  
Fellowships in Design

In partnership with others it supports:

Great Exhibition Scholarships  
Enterprise Fellowships

It also supports worthy individuals and appropriate organisations by Special Awards.

The total number of individuals being supported in 2021 was 136

Registered Charity No. 206123

## Contents

|                                                 |       |
|-------------------------------------------------|-------|
| Chairman's Report                               | 1-2   |
| Secretary's Report                              | 3     |
| The Work of the 1851 Royal Commission           | 3-4   |
| Public Benefit                                  | 4     |
| Grant-making Policies                           | 4-5   |
| Achievements in 2021                            | 6-10  |
| COVID-19                                        | 11    |
| Future Plans                                    | 12    |
| Awards Granted in 2021                          | 13-20 |
| Awards Completed in 2021                        | 21-38 |
| Alumni Awards, Honours and Achievements         | 39-41 |
| Report by the Chairman of the Finance Committee | 42-44 |
| Statement of Commissioners' Responsibilities    | 45    |
| Independent Auditor's Report                    | 46-49 |
| Statement of Financial Activities               | 50    |
| Balance Sheet                                   | 51    |
| Cash Flow Statement                             | 52    |
| Notes to the Financial Statements               | 53-71 |
| Administrative Information                      | 72-73 |
| Commissioners, Committee Members and Staff      | 74-76 |
| Professional Advisers                           | 77    |

## Chairman's Report

In common with the nation as a whole, we were greatly saddened by the news of the death of HRH The Duke of Edinburgh on 9 April. As our President for forty-four years, His Royal Highness played a leading role in modernising the Commission, and that it continues to thrive today is due in great measure to his influence and interest: he gave us so much of his time and continued to follow our fortunes and offer encouragement throughout his retirement. We look back with great fondness and respect for a most remarkable man, whose vision and determination shaped the Commission's purpose for more than a quarter of its existence in the same spirit as our founder, Prince Albert.

2021 began with continued restrictions on movement as a result of the COVID-19 pandemic, and the office did not reopen until the summer. Thus, for a second year the annual fellowship rounds were conducted entirely online, a process which ran very smoothly and produced an excellent result, with some truly exceptional new appointments. For the first time the Brunel Fellowship was run as a separate competition, attracting a strong field as a result, and it was very encouraging to see a record number of applications from industry for Industrial Fellowships, reflecting well on our Fellowship Programme Manager after her first full year in post.

Unable to meet in person, we held our annual Alumni Science Evening in February online for the first time. Although a poor substitute for a live event, it did enable those from further afield to take part and was well received by all who did so. While we intend to return to the live model next year, we are looking at options for live streaming it, thus extending its reach to our alumni around the world as well as those in the UK who are unable to come to London.

As life slowly resumed a semblance of normality from mid-May onwards, the Commissioners met together in person for a strategy day to consider whether our approach to the task of "increasing the means of industrial education and extending the influence of science and art upon productive industry" was still making best use of our resources. An open and far-reaching debate concluded that there was no need for a revolution, but it is clear that we could be doing more to promote good industrial design, more to encourage sustainability, both as an outcome of research and across the legacy estate, and more to encourage a greater exchange of ideas through our alumni network. We also had a good look at the impact of the many interventions we have funded to promote STEM to school children. We agree with the growing consensus that the best results are achieved by focussing on teachers, in particular on primary school teachers, many of whom have a limited science background. Work is now in hand to develop all these themes further. Overall, it was a very productive day and the first opportunity to bring together the four new commissioners who have joined us since the beginning of last year with those of longer standing. It was good to see them in person, contributing fresh ideas which suggest the Commission is in good hands going forward.

In July we were able to hold our annual 'Engineers' event with the BBC World Service. Last year it was entirely virtual, so it was good to be able to draw a small live audience to the Victoria and Albert Museum to join a worldwide virtual audience on-line. The subject this time was Clean Energy, with three excellent speakers. Henry Snaith, Head of the Photovoltaic Group at Oxford and Kristian Holmefjord, Project Director Fuel Cells at Corvus Energy, both appeared live with BBC presenter Kevin Fong, and were joined virtually by Danielle Merfeld, Chief Technology Officer with GE Renewable Energy in California, for a wide-ranging discussion and some probing questions from the audience. The programme was broadcast on the BBC World Service and also, for the first time, on BBC World News television, both attracting large audiences.

September saw the staff return to the office for at least part of the week and we held our first live event, the Industrial Fellowships Awards Ceremony in early October, when we welcomed two years' worth of new award holders to the 1851 family. That was swiftly followed by the first celebration of the Sir Misha Black Awards since taking them under our wing in early 2020. This is a community whose aims are a very close fit with the Commission's: the celebration and promotion of good industrial design. They are a very welcome addition to our stable.

In November we were delighted to welcome The Princess Royal to a Fellows' Reception at Fishmongers' Hall. This was the first time we had been able to bring together award holders from across all our programmes since December 2019 and it was heartening to witness the enthusiasm

with which they interacted with each other. These gatherings of exceptionally bright early career scientists, engineers and designers are often cited as one of the greatest benefits of our awards and from the lively conversations around the room it was clear that they had been much missed. Award holders presented work from across the whole spectrum of our work to the President, including displays from our newest category of award, the Technical Teaching Fellowship, which aims to improve the quality of teaching in the Further Education sector. It was a most stimulating evening, and we are immensely grateful to Her Royal Highness for her continued interest in our work.

November also saw the 1851 Group, comprising the Chairs and Chief Executives of the 1851 legacy institutions, come together for the first time in two years. As well as endorsing plans for the Great Exhibition Road Festival in 2022, we discussed one of the defining issues of our time: the climate emergency. Although each institution is already committed to decarbonising their own footprint and inspiring change, there was a genuine enthusiasm to do more, and do more together, to make Albertopolis an exemplar zero emission urban neighbourhood. Thus, the South Kensington Zero Emission Neighbourhood (SouthKenZEN) initiative launches in January 2022 with the Commission funding initial baselining work.

As the Royal Albert Hall celebrated its 150th anniversary, albeit in a more muted style than originally planned, it was good to see the completion of the public realm works around the north of the building, which the Commission has helped to fund. The improvement to the setting is spectacular, with more space around the north porch and a much easier crossing to the Albert Memorial. Phase 2 – more elegant barriers and a new surface – is eagerly awaited.

The last two years have seen a significant turnover of Commissioners with four reaching the end of their ten-year terms of office. I am very grateful for their support, and that of the whole Board of Management who give so generously of their time. We have some excellent new Commissioners to replace them who are already making their mark.

Our Secretary, Nigel Williams, retires in May 2022 after nearly twelve years in post. Nigel was due to retire in 2021, but very kindly agreed to stay on until we could recruit his successor in a more normal post pandemic world. He will be much missed – he has done a spectacularly good job and I could not have had a more thoughtful, engaged and hard-working colleague. His successor is John Lavery, and I am delighted that he has agreed to join us, and I look forward to working with him during my final year.

I too have completed my term of office and I retire in December 2022 so this will be my final Annual Report. I have been a Commissioner for more than eighteen years and it has been a great privilege to lead the Board of Management for the last ten years. I am immensely proud of what the Commission achieves. I have seen, during my time as a Commissioner, a five-fold increase in the level of our resources and a commensurate increase in the amount of work we are able to do to make a difference to all the members of our ‘1851 family’. I will hand on the Chairmanship to Lord Kakkar and I am confident that under his leadership and with a very strong and refreshed Board of Management, the Commission could not be in better hands.

I finish by thanking all who have been part of the Commission or helped us as advisers during my time as Chairman. I send a particular thank you to our dedicated staff and to all my fellow Commissioners. I have no doubt that ‘The 1851’ will continue to flourish in making a difference by meeting the task set 170 years ago by Prince Albert: to increase the means of industrial education.

Bernard Taylor CBE DL FRSC

## Secretary's Report

As the Chairman has intimated above, my time as Secretary to 'The 1851' is almost up and by the time this report is published the post will be in the very capable hands of John Lavery. It has been an enormous privilege to lead the small team charged with the day to day running of this extraordinary, but little heard of organisation, and one of the greatest pleasures has been seeing the realisation dawn on peoples' faces when I explain why a Royal Commission set up to organise an Exhibition in 1851 is still so relevant today. Watching our eminent committee members selecting the most talented early career scientists, engineers, embryonic designers and entrepreneurs, then observing them flourish with the benefit of our support over the course of their awards and beyond, has been one of the most rewarding aspects of the job. The 1851 family is a remarkable body whose influence and contribution across the board continues to grow. Equally, being at the heart of the unique cultural community that is Albertopolis which, with the help of the 1851 Group and the broader Exhibition Road Cultural Group is doing more together than ever before, has been an unforgettable experience in which I have been immensely proud to have played a part. My only frustration is that, despite my best efforts, we are still relatively unheard of; I leave that challenge for my successor!

I am incredibly grateful for all the support I have received from the Commissioners, committee members, staff and award holders and my colleagues across the legacy estate and beyond over more than 11 years and I wish the Commission every success going forward.

Nigel Williams CEng

## The Work of the 1851 Royal Commission

The Commission's aim is to 'make a difference' by providing educational fellowships and studentships to the very best early career scientists, engineers and designers. Success is hard to measure within the confines of a single year but looked at over the longer term the Commission's achievement is evident, with 13 Nobel Prize winners and over 150 Fellows of the Royal Society among its previous award winners. The case studies of completing fellows and summaries of alumni achievements later in this report also bear witness to the Commission's success.

In addition to its core fellowship schemes, the Commission also provides special awards to its legacy institutions, to other organisations working to encourage STEM (science, technology, engineering and mathematics) education and to organisations that can help facilitate access to its incredible archives. Details of some of these awards and the impact they have made can also be found later in this report.

As well as the grants that it makes, the Commission itself organises a number of educational and networking events for the benefit of its award holders, alumni, legacy institutions and the general public, which together make a significant contribution to STEM education.

The Commission was originally established by Royal Charter in 1850 under the Presidency of Prince Albert, to organise and stage the Great Exhibition. Held in the spectacular Crystal Palace, constructed in Hyde Park, it was the first ever World Fair, and the most successful. With over six million visitors, it also made a substantial profit.

Consolidated by Supplemental Charter, and enjoined to invest the surplus from the Great Exhibition *strictly in accordance with the ends of the Exhibition...[to] increase the means of industrial education and extend the influence of science and art upon productive industry* the Commission purchased 87 acres of land in South Kensington and helped establish its three great museums, the Royal Albert Hall and renowned institutions of learning, including Imperial College and the Royal Colleges of Art and Music.

When this huge undertaking was complete, there remained sufficient funds for the Commission to initiate, in 1891, a programme of fellowships and studentships to support pure research in science and engineering, applied research in industry, industrial design and other projects.

The Commission continues its work to this day, both managing its freehold estate and awarding £4m a year in research fellowships, design studentships and other grants. The provision of long leases to the legacy colleges and the Royal Albert Hall also makes a very substantial contribution to scientific, engineering and artistic education.

## Public Benefit

The Commission ensures that its work is for the public benefit and takes full account of the published Charity Commission guidance. The Commission's events and awards programmes and support of the legacy institutions represent identifiable benefits and are available to all eligible members of the public. They satisfy the primary charitable purpose of the advancement of education.

## Grant-making Policies

The Commission primarily pursues its charitable purposes through the award of grants to individuals and organisations. The Commission awards grants under a number of defined programmes. Full details of the terms and conditions for each programme, including application forms and deadlines where appropriate, are provided on the Commission's website. A brief summary of the major programmes which the Commission supports is provided below:

### Schemes administered by the Commission:

#### *Post-doctoral Research Fellowships in Science or Engineering*

These are intended to give early career scientists or engineers of exceptional promise the opportunity to conduct a research project of their own instigation; an ultimate objective is to contribute to the knowledge base required for a healthy and innovative national culture. Around eight to ten awards are made each year, including one or more Brunel Fellowships for engineering projects addressing the primary infrastructure needs of modern society. The awards are for up to three years, subject to annual review and encompass an annual stipend and some support for travel and other expenses.

#### *Industrial Fellowships*

These are intended to encourage profitable innovation and creativity in British industry. Projects in any science or engineering discipline will be considered. A variable number of awards – usually around ten to fifteen – is available each year depending on the financial value of individual awards granted. An ERA Foundation Fellowship for the electro-technology sector is awarded as part of the scheme. Fellowships are awarded to selected exceptional graduates with the potential to make an outstanding contribution to industry, for a programme of research, supported by their employing / sponsoring company, leading to a patent, product or process improvement in conjunction with a higher academic award. Awards are for up to three years, subject to annual review, and include a contribution towards living costs, a travel allowance, an honorarium for the host university and in appropriate cases a contribution towards university fees or towards the cost of enhancing the research project.

#### *Industrial Design Studentships*

These are intended to stimulate industrial design capability among the country's most able science and engineering graduates. Around eight to ten awards are offered each year for outstanding engineers or scientists who wish to develop their capabilities in industrial design by taking a recognised Master's course and who aspire to become leading designers in British industry. The award is for up to two years and includes a stipend, materials allowance, travel allowance and contribution towards tuition fees.

### *Fellowships in Design and the Built Environment*

Awarded in alternate years, these Fellowships each provide a stipend for up to two years to enable those at a more advanced stage in their career to explore important current issues, selected by the Commission.

### **Schemes administered by other organisations:**

#### *Enterprise Fellowships*

Awarded through the Royal Academy of Engineering (RAEng), these fellowships are open to outstanding UK-resident engineering graduates seeking entrepreneurial success. A package of tailored mentoring, training and grant funding will enable recipients to pursue commercialisation of their technological ideas. Originally three fellowships a year were available, but this has now been increased to six.

#### *Great Exhibition Scholarships*

The Commission's 5-year commitment to this scheme ended in 2018 when ten scholarships were awarded. These scholars will graduate in 2022. Awarded through The Institution of Engineering and Technology (IET), these scholarships were open to UK residents who achieved 3 A grades or above at 'A' level or equivalent joining an IET accredited undergraduate degree. Up to ten scholarships a year were available. Scholars receive an annual stipend. Similar scholarships continue to be available through the IET.

### **Special Awards:**

Although the educational programmes described above represent the lion's share of its grant giving, the Commission also responds to all those requests for funding that commend themselves through the Special Awards procedure. Here the aim is to assist worthy individuals, organisations or projects whose aims in the broadest sense align to the Commission's, and all applications are carefully scrutinised at an appropriate level according to the amount of support requested. Grants range from a few hundred pounds to over a hundred thousand pounds. While Commissioners retain considerable flexibility in principle, in practice a majority of special awards are made either to institutions on the Commission's legacy estate or for educational outreach work by like-minded organisations seeking to draw the attention of the young to the opportunities presented by science, engineering and design. A small number of grants are also made to facilitate access to the Commission's archives.

In addition to the above schemes, the Commission also administers, in conjunction with the Sir Misha Black Awards Committee, two awards in the field of design education, for which nominations are sought each year. Full details are available on the Commission's website but in brief these are:

#### *Sir Misha Black Medal for Distinguished Services to Design Education*

Global in reach, the Medal acknowledges the important contribution of individuals to the teaching of design at all levels, from anywhere in the world – as designers, as champions, as mentors and as educators.

#### *Sir Misha Black Awards for Innovation in Design Education*

Salutes educators from across the United Kingdom and celebrates the innovative achievements of institutions and individuals. Recipients may receive a bursary of £10,000 to advance their work in innovative design education.

Together the Sir Misha Black Medal and Awards recognise those who by innovation, vision and contribution to theory or practice have measurably improved the education of designers and enhanced the profile of design education.

## Achievements in 2021

The core activity – and primary achievement – of the Commission is identifying early career science and engineering graduates of exceptional promise and supporting their work with its prestigious fellowships and studentships. Full details of the awards made during the year are given on pages 13 to 20.

The true impact of the Commission's award holders will only emerge over time, but some evidence of the success of the various programmes can be gleaned from the achievements of those Fellows who completed their awards during the year and the positions they go on to secure. A representative sample of case studies is provided on pages 21 to 38.

Many completing Fellows comment quite explicitly on the importance of their Fellowship to their success:

*The 1851 Fellowship was instrumental in giving me a platform to establish my own independent research, and I'm grateful to all involved for the support I received over the three years.*

Dr Stephen Cox, Research Fellow 2017

*I am extremely grateful to the Royal Commission for enabling me to pursue my research and for the doors this position has opened up for me. I am now continuing my research as a post-doc at the University of Oxford and am in the process of submitting grants to start up my own research group exploring research questions enabled by this Fellowship.*

Dr Paul Holloway, Research Fellow 2017

*The Industrial Fellowship was the principal enabler of this project. The support of the Fellowship allowed me to justify and validate the ambition of a far-reaching research project, and it helped open important doors in this path. It is a great honour to be a Fellow of the Commission, and a fact that I will carry with pride for the rest of my career.*

Alexandre Raymond, Industrial Fellow 2018

For some, it is clear that without the award from the Commission, their project would not have gone ahead:

*Without the support of the Royal Commission, it would not have been possible to undertake this project. The opportunity to study at Oxford University has accelerated my career progression immensely without the financial burden of leaving full time employment. Working within a world leading institution has not only improved my academic knowledge and skillset but granted me introductions to medical professionals collaborating with the university, offering me unique insights and opportunities within the medical device sector. This has enabled me to grow my professional network in spite of various obstacles during my graduate studies.*

Jonathan Vince, Industrial Fellow 2018

It is gratifying that Fellows often comment on the ease of administration and quality of communication with the Commission:

*I recently finished my 1851 Fellowship, and I just wanted to say a huge thank you to everyone on the Royal Commission team! The Fellowship has been an amazing experience and has been instrumental in my career. Everyone at the Royal Commission has always been extremely helpful and easy to communicate with, and I really appreciate this.*

Dr Paul Knott, Research Fellow 2017

A sentiment that often persists long after a Fellowship has finished:

*My memories of the Royal Commission are of a caring, generous and understanding organisation, which promoted research while respecting independence.*

Professor Crispin Gardiner, Overseas Scholar 1965



Many Fellows have been impacted by the pandemic and have appreciated the Commission's flexibility and additional support:

*I wish to take this opportunity to thank you for the endless opportunities that this fellowship has brought, and for the outstanding support during the pandemic (without the additional measures you've taken to facilitate working from home, I would have not been able to get to this point). A special thank you to Amahl, for the infinite patience with which he's dealt with my requests / questions.*

Dr Davide Foffa, Research Fellow 2018

Academic and Industrial Supervisors are also very complimentary about the Commission's Fellowships:

*This is the fourth Industrial Fellowship that I have had the pleasure of supervising and in my experience, this is the best scheme I have come across for developing individuals within industry that have the potential to undertake research for a higher degree without them having to sacrifice their employment.*

Professor Andrew Lewis, Queen Mary University of London

*Based on my excellent experience, I will definitely recommend the Industrial Fellowship scheme to my colleagues – it worked very well, and I very much appreciated the limited amount of paperwork. Thank you very much to all members of the Royal Commission for the Exhibition of 1851 for the prompt and flawless support during this fellowship!*

Dr Patrick Gruber, University of Surrey

A more complete picture of the impact of the Commission's awards comes from the honours and awards bestowed on more senior alumni – some highlights are given on pages 39-41.

The real-world impact of the work done by our alumni should never be underestimated. To give one topical example:

*I wanted to send a short update on my 2020/2021 role as the Lead Scientist on the NHS COVID-19 app, deployed in England and Wales, with over 23m downloads. The algorithms deployed as part of the risk calculation within the app were developed (in part) during my PhD, as part of my 1851 Commission Fellowship. The risk scoring algorithm in the NHS app is considered to be world leading. I advised Google and Apple on their roadmap, worked with nations around the world, and provided scientific evidence to government ministers during the peak of the crisis to inform decisions. I led the team that developed the scientific basis for the app, including ensuring that the app received MHRA approval. We recently published a paper in Nature showing that the app reduced the number of cases of COVID-19 by (median) 600,000 in its first three months of operation (<https://www.nature.com/articles/s41586-021-03606-z>), which translates into thousands of potential COVID-19 related deaths averted too. The success of the NHS COVID-19 app is a direct result of my 1851 Commission Fellowship.*

Dr Mark Briers, Industrial Fellow 2003

Moreover, the impact that our alumni go on to achieve is truly international. To take a couple of further examples almost at random:

*In 2021, I designed and engineered an accessible all-in-one hand wash station to help improve hygiene in refugee camps and other areas of need around the globe.*

*The hand wash station delivers a complete and considered solution, whilst being very cheap to manufacture and fits perfectly in an air shipped palette, reducing overall costs. Thousands of the hand washing stations have been deployed by Oxfam to various refugee camps. Detailed feedback has shown them to be very effective, reliable and popular with users.*

Matthew White, Industrial Design Student 1998

*In 2021, one of the companies I set up at the end of my Fellowship, Omanos Analytics, worked in Kenya measuring the impact of geothermal plants on rural communities, connecting objective space data with the lived experience of those displaced by these large-scale complexes, and also worked in Indonesia allowing locals in the area to track the damage caused by tailing dams on their mobile phones through mixing geolocation, Earth imagery and local data collection.*

Dr Stephen Greenland, Industrial Fellow 2013

Many of our alumni tell us that their Fellowship has made a decisive – and lasting – difference to their career:

*The 1851 Studentship when I was at the Royal College of Art made a huge difference to me personally and without it, I do not think I would have been able to afford to do the Innovation Design Engineering masters and go on to found Concrete Canvas.*

Peter Brewin, Industrial Design Student 2003

*The 1851 Studentship had a huge impact on my career. The freedom it afforded meant that I had the resources to do an internship with YCombinator Research in Los Angeles over the summer in between the two years of my Master's, and to continue that work in my second year. The Principal Investigator I worked with gave me full freedom, and the work I completed on novel interfaces for music software eventually led to me moving to Los Angeles to work with Output to work on music creation tools used by hundreds of thousands of musicians, including some of the biggest names in pop music and film scoring. They hired me to lead the design of a new project – their most ambitious to date – based on the work during my time supported by the Fellowship. I am forever grateful.*

Arthur Carabott, Industrial Design Student 2015

*I was an Industrial Fellow from 1998-2001, when the Commission funded my PhD in artificial intelligence. At the time AI was so unfashionable that we played it down in our publications, but what we now call machine learning methods were key to the project's success. Through this, I co-developed AI-based software to measure the quality of phone calls, and in 2000 I co-founded a spin-out, Psytechnics, to commercialise it. The company was acquired in 2011 by one of its customers and still employs 59 people in the UK.*

*After 15 years in other industries, I have returned to AI and secured substantial seed investment in Lucida Medical in February 2021. Lucida Medical applies AI to find cancer in MRI scans, quickly and accurately. Our vision is to enable early detection of cancer and improve the outcomes of millions of cancer patients. The company has progressed quickly, achieving its first CE mark certification and completing a successful technology integration with GE Healthcare and the East Midlands Imaging Network (EMRAD). We are now raising investment again to put the technology into the hands of clinicians. It's a privilege to be drawing once more on a basis of research that the Commission made possible.*

Dr Antony Rix, Industrial Fellow 1998

Even some of our more recent initiatives, such as the graduate Enterprise Fellowships run in conjunction with the Royal Academy of Engineering, are already having significant impact. Since its inception in 2016, awardees have raised just under £33m in external investments and grants and created over 200 jobs.

As well as its core fellowships and studentships, the Commission also runs a very successful Special Awards programme, supporting individuals and institutions with similar aims to the Commission. As in previous years, many of the awards reflect the Commission's continuing commitment to raising the awareness of the young to the opportunities presented by science and engineering. They include awards to: the Royal Society of Chemistry to support its Steps into Science programme providing resources for primary science teachers; In2ScienceUK to produce an engineering research module to encourage disadvantaged secondary school students to consider a degree in engineering; Wellington Trust for its future maritime engineers project, exposing young people and, significantly, school

careers advisers to the breadth of STEM careers in the maritime sector; and EDT for its virtual STEM work experience project, providing secondary school students with exposure to real STEM workplaces even during the pandemic.

Most of these Special Awards are intended to have an impact over many years, but some initial successes are already evident. For example:

*The aim of the Royal Society of Chemistry's (RSC's) Steps into Science is to solve the challenges of primary teachers lacking confidence and specialist knowledge in science, coupled with not knowing where to turn for 'trusted' resources, by developing a new primary science website bringing together in one place, for free, more than 160 new and existing high-quality teaching resources, including teacher notes, and support with accessing continuous professional development and funding.*

*The website went live in February 2021. Since then, it has had 47,000 visitors. Over 2500 teachers have signed up – on top of the 7500 previously registered with the RSC more broadly – giving them access to ongoing support. The first 11 primary science investigations – engaging experiments that link to the curriculum for 7 – 11-year-olds, including demonstration videos, classroom slides and detailed notes to support teachers – have been accessed more than 2750 times since being uploaded in July 2021.*

*The RSC continues to develop Steps into Science and is currently commissioning new careers resources to include on their Meet the Scientists page, along with plans for a set of cross-curricular resources linking science learning with numeracy and literacy. Resources translated into Welsh and Irish are also currently being user tested. All resources are developed in consultation with primary school teachers and many in collaboration with other organisations such as the Primary Science Teaching Trust and Primary Science Quality Mark. Feedback from users of the site has been very positive.*

Or again:

*EDT's Virtual Work Experience for 12-18- year-olds ran at the start of the Summer Break 2021. EDT ran a week of live interactive sessions allowing students to engage with over 30 STEM professionals from a variety of backgrounds including graduates and apprentices. Students were given an insight into the different careers and career pathways available to them, with speakers from Sky, Vodafone, Camwood, Profusion, Leidos and many more. The students took part in an industry led mini project at the end of each day. These included a future technologies creative project, an app design project and a virtual reality design project, which involved creating a solution to a problem within their local community, that can be controlled by an app. Students also completed a research project on one of the companies that featured during their week. At the end of their work experience students submitted their workbook which helped them reflect on the skills they had developed and the varied pathways they had heard about alongside employability skills activities to support the careers live sessions they took part in.*

*Of the 250 students that took part, over 50% were BAME and over 50% female, 16% were on free school meals, 4% said they are student carers while 7% declared they had a disability. 94% of the students reported greater awareness of key skills and confidence in their next steps after participation, 82% felt confident making career choices compared to just 52% pre-course and 84% indicated they would be pursuing a career in STEM.*

As the examples above illustrate, the Commission funds a wide range of innovative STEM initiatives at varying scales, recognising that not all will achieve huge success, but in the hope that most will transform individual lives, and some will go on to have considerable reach. A project from 2020 gives some feel for the numbers who can benefit:

*Great British Minds is a series of audio programmes, broadcast on Fun Kids Radio and available as podcasts to listen and download, through which children can find out about 20 British inventors and technologists – who they are and what they achieved – providing inspiration for them to explore STEM topics. Each episode features one invention exhibited at the Great Exhibition and one from a contemporary inventor. Contemporary inventors featured include at least one 1851 alumnus. The*

*series also included information about the Great Exhibition itself, with tips on how children could organise their own Great Exhibition for family and friends. Fun Kids Radio also promoted the Great Exhibition at Home competition on air and online.*

*The initial broadcasts reached an audience of over 360,000 and the podcasts have been downloaded over 12,000 times. The associated webpages with further information have been viewed over 13,000 times. The materials are still available and still promoted.*

As well as funding STEM outreach projects, the Commission also provides Special Awards to enhance its legacy estate in South Kensington and help the world leading institutions of Albertopolis to extend their reach. In 2021 these included support for the South Ken Green Trail and a new Empathetic Engineer website:

*The South Ken Green Trail was designed to welcome people back to Albertopolis in Summer / Autumn 2021, while also promoting urban biodiversity with hubs for nature, and exploring inspiring ideas for a greener future.*

*A series of free-to-visit architectural installations were commissioned by the Exhibition Road Cultural Group from emerging and small architectural practices, working with London Festival of Architecture, the V&A, Goethe-Institut and Science Museum. By bringing together leading design and current research in biodiversity and sustainability and building connections with the work within institutions on the legacy estate, the installations epitomised the area's role in promoting debate and driving progress to address society's most pressing challenges.*

*The installations were seen by circa 1.5m visitors to Exhibition Road between 23 July and 20 October. Audience evaluation found that:*

- *95% of visitors agreed or strongly agreed that the installations made Exhibition Road a more welcoming and enjoyable place to be*
- *85% of visitors agreed having things to see in Exhibition Road makes them more likely to visit South Kensington again.*

*The Empathetic Engineer is a new website which provides online resources for engineering students, recent graduates and professional engineers to enable them to apply human centred design principles to their engineering practice. The Empathetic Engineer was developed by the Royal College of Art and the Engineering Design Centre at Cambridge University with input from the Dyson School of Design Engineering at Imperial College. It describes a highly structured process, provides online and downloadable tools, case studies and video content examining best practice. The design process and toolkit have been developed by Nick de Leon and John Clarkson from the RCA and Cambridge respectively and exploit a variety of existing tools and methods along with wholly new content including case studies and input from 1851 Industrial Design Student Alumni. The content is open source and freely available for any individual or university to use.*

Needless to say, not all Special Awards proceed completely smoothly, and many recent awards are suffering significant delays in implementation as a result of the pandemic. Nevertheless, anecdotal evidence suggests that it is interventions such as these that can make all the difference in stimulating young people to become the scientists and engineers of tomorrow and the Commission remains committed to doing what it can.

## COVID-19

As made clear in the Chairman's Report, the Commission, like every other organisation, has been impacted by the pandemic; many events had to be cancelled and some programmes moved on-line. In terms of its core grant-making activity, however, the Commission has largely been able to continue as planned and Commissioners do not believe that any adjustments to the accounts are required.

As soon as the possibility of a pandemic became clear, the Finance Committee acted to ensure that there were sufficient cash or near cash assets in place to fund at least three years' expenditure in full. This gave confidence that the Commission would be able to ride out the immediate disruption and need not curtail any of its programmes. The Committee also met regularly with the investment managers to monitor the position. Investment markets have, to be sure, been much more volatile and the day-to-day value of the Commission's portfolio has inevitably reflected that. The Commission is a long-term investor, however, and Commissioners remain confident in the underlying strength of the portfolio; they see no evidence at this stage of any permanent loss of value. Indeed, the value of the Commission's portfolio has risen over the year.

Similarly, while some of the Commission's tenants have asked for and received temporary support with deferred rent demands and the like, there is not considered to be any risk to the long-term value of the estate. That is not to say of course that some of our legacy institutions have not been severely impacted.

The Commission had robust business continuity plans in place and Commissioners, committee members and staff have adapted relatively straightforwardly to the need for remote working. The 2020 and 2021 award rounds for all the Commission's Fellowships and Studentships have gone ahead as planned with a full complement of awards made. A majority of existing award holders have been able to adapt their workflow patterns to fit the unusual circumstances imposed by lockdowns etc. Where this has not been possible, the Commission has granted extensions and provided the necessary financial support. Commissioners have also been pleased to provide 'paid sabbaticals' where award holders' specialist skills have enabled them to support the fight against COVID-19, whether through testing, modelling or other means.

All in all, Commissioners are confident that whatever the short-term disruptions, the pandemic should not have any material, long-term impact on the Commission's work.

## Future Plans

As explained in the Chairman's report, the Commissioners held a Strategy Day during the year at which a number of themes were discussed including the need to do more to encourage sustainability, to promote good industrial design, and to encourage exchange of ideas through our alumni network.

Sustainability is a huge theme requiring action across investments, grant making and the estate. The Commission will be reviewing its investment strategy with an increased focus on ESG (Environmental, Social and Governance) considerations, including in particular the need to respond to the climate emergency. In 2022 the Commission is launching a new Fellowship in Regenerative Design, targeting ways in which not merely to lessen the harm of human development, but rather to put design and construction to work as positive forces that repair natural and human systems. Commissioners are also exploring ways in which the existing Fellowship programmes can be encouraged to address the challenges of climate change and biodiversity. Finally, the Commission is working with its legacy institutions on a new initiative, SouthKenZEN (South Kensington Zero Emission Neighbourhood), intended to identify ways in which the Albertopolis institutions can work together and learn from each other to accelerate the transition of South Kensington as an exemplar, world class, zero emission urban neighbourhood.

As regards industrial design, the Commission is currently engaging with the Royal Designers for Industry to see whether any joint initiatives are possible that might enhance the UK's industrial design capability. The Commission is also engaging with a number of UK universities to explore ways in which the Commission might encourage greater awareness of design amongst young scientists and engineers.

The Commission has long recognised the need to ensure a future pipeline of applicants for its awards by raising awareness amongst the young of the excitement and importance of STEM, something it does primarily through its Special Award programme. The Commission is keen to more closely involve award holders and alumni in this work and is exploring with STEM Learning ways in which this might be done. The Commission is also working closely with the other Albertopolis institutions on the 2022 Great Exhibition Road Festival, which should provide another opportunity for award holders and alumni to engage with the public and promote the excitement and importance of STEM.

## Awards Granted in 2021

### Research Fellows

**Dr Thomas Breithaupt**

*Subject:* Redefining the relationship between crystal defects and mantle flow

*University of Southampton*

The prediction of viscosities in the Earth involves substantial extrapolation of laboratory-derived models. Extrapolation of a novel theory makes strikingly different predictions to traditional flow laws. This project will test the hypotheses laid out by this new theory, with potentially major implications for simulations involving flow of the Earth's interior.

**Dr Gregory Chaplain**

*Subject:* Novel development of elastic metamaterials

*University of Exeter*

This proposal aims to mathematically model, simulate and fabricate elastic metamaterial devices which can passively control vibration. This shall be achieved by taking inspiration from successes in analogous electromagnetic systems, enabling the design of structured, periodic elastic materials whose composite nature endows them with unexpected wave control phenomena.

**Dr Amparo Güemes**

*Subject:* Development of neurotechnology systems for improving glucose control

*University of Cambridge*

Existing therapies for diabetes suffer from shortcomings that hinder optimal glucose control. To overcome them, this project proposes a novel closed-loop platform that incorporates neurotechnology in traditional pharmaceutical-based devices. This multi-disciplinary research will generate novel hardware and algorithms that can be extended to other fields, further enhancing its great scientific significance.

**Dr Tim Lamont**

*Subject:* Ecological function on restored coral reefs

*Lancaster University*

Coral reef restoration can regrow coral, but can it provide food, income and coastal protection for vulnerable communities, as natural reefs do? This project will evaluate the functional performance of restored coral reefs, in order to optimise goals and methods that provide meaningful benefit to people and nature worldwide.

**Dr Monireh Kabirnezhad**

*Subject:* A holistic approach to neutrino-nucleus interaction calculations for  
neutrino experiments

*Imperial College London*

The purpose of this project is to build the most precise model for neutrino-nucleus scattering by using modern statistical and computational methods. The research outcome from this proposal will not only produce essential results for existing neutrino oscillation experiments but will also provide the crucial input required for next-generation experiments.

**Dr Jasmine Lee**

*Subject:* Mapping conservation actions for Antarctic biodiversity facing rapid  
global change

*British Antarctic Survey*

Climate change is set to intensify already growing pressures on Antarctica and its unique species. Yet we have limited knowledge of which conservation actions to take or where to implement them. This project will determine how we can best conserve Antarctic species by mapping threats and actions across time and space.

**Dr Benjamin Walker**

*Subject: Multifilament methods on the microscale*

*University College London*

This research will consider the fluid-structure interactions of slender elastic filaments in a viscous fluid, aiming to realise computational methods that are simultaneously efficient and accurate. User-friendly and open-source implementations will facilitate a new generation of cross-disciplinary investigations into the rich dynamics of microfilaments, spanning biology, mathematics and engineering sciences.

**Dr Matthew Westaway**

*Subject: Simple representations of modular Lie algebras*

*University of Birmingham*

The goal of this research is to understand the simple representation theory of Lie algebras over fields of positive characteristic. This shall be done by using category theory to compute the number of appearances of each simple module in the composition series of certain nice modules, called baby Verma modules.

**Dr Philip Wijesinghe**

*Subject: Revealing cell mechanics with light-sheet microscopy*

*University of St Andrews*

The role of mechanics in biology can be as important as chemistry and genetics in development and disease. This project proposes a light-sheet microscope with an unprecedented capacity to rapidly quantify mechanics at cellular resolutions and over large volumes. Revealing mechanics at this scale can improve therapies and disease detection.

## Brunel Fellow

**Saikumar Reddy Yeddula**

*Subject: Dynamics of the shock wave in supersonic air-intake systems*

*Imperial College London*

With the increased interest in high-speed aircraft and zero-to-low carbon emission engines, this project will develop simplified lower-order models to predict the shock response and improve engine air-intake performance and then apply these models to the air-intake of the industrial hydrogen-powered engine under development by Reaction Engines to ensure stability, efficiency.

## Industrial Fellows

**Daniya Aynetdinova**

*Subject: Cationic cyclisation cascades mediated by carbon-electrophiles for the formation of novel polycyclic products*

*Sponsor: Vertex Pharmaceuticals*

*University of Oxford*

This project aims to develop a biomimetic cyclisation methodology to expand the existing compound libraries in drug discovery by stereoselective formation of new carbon-carbon bonds in a divergent single step procedure. This would enable medicinal chemists to rapidly construct structurally diverse natural product-like scaffolds to access their pharmacological properties.

**Augusto Bartolome Diaz de Budalles**

*Subject: Development of a hierarchical nanocoating technology for enhanced electrode efficiency of commercial alkaline electrolyzers*

*Sponsor: Oxford nanoSystems*

*University College London*

This project will develop a nanostructured hierarchical coating, easily and cheaply applicable on the electrodes to significantly improve their efficiency for green hydrogen production; the larger pores will promote rapid mass transport whilst the smaller ones will dramatically increase the surface area with more active catalytic sites for reactions.



**Kyle Bowman**

*Subject:* Accelerating the commercial implementation of electromethanogenic reactors

*Sponsor:* WASE

*University of Westminster*

Electro-methanogenesis (EM) is a process where methane is produced by microbial conversion of electrical current, hydrogen and carbon dioxide to methane. EM improves upon anaerobic digestion, improving treatment times and efficiency. Further research is needed to fully understand and optimise EM, so that it can be of benefit to society.

**Shefali Bhumbra**

*Subject:* Developing a medicine designed to modulate cancer patients' immune systems to selectively eliminate cancerous cells

*Sponsor:* Adaptate Biotherapeutics

*Imperial College London*

This project will contribute to the development of novel antibody-based cancer medicines designed to target V $\delta$ 1 T-cells, a specific immune-cell subset, to eradicate a patient's cancerous tumour. The project involves characterization of V $\delta$ 1-specific antibodies to rank the medicines' effectiveness as cancer therapeutics ahead of potential clinical development.

**Liam Bussey**

*Subject:* A quantum optical receiver for ultra-sensitive wireless digital communications

*Sponsor:* BT

*University of Birmingham*

The non-linear quantum-optical effect of electromagnetically-induced-transparency (EIT) in an atomic vapour provides an ultra-sensitive SI-traceable electric-field sensor at radio frequencies (RF). This can be used as an all-optical electrically passive receiver for analogue and digital RF communications. This project studies the use of the EIT effect in RF communication systems.

**Thomas Corner**

*Subject:* Development of potent AspH inhibitors as novel small-molecule anti-cancer therapeutics

*Sponsor:* GSK

*University of Oxford*

Aspartate/asparagine- $\beta$ -hydroxylase (AspH), a 2-oxoglutarate-dependant oxygenase, is overexpressed in several cancer cell types. Inhibition of AspH catalysis is proposed as a successful mode of action for a novel, small molecule anti-cancer therapeutic. The project will focus on the design of efficient AspH inhibitors, targeting both its 2-oxoglutarate and substrate binding pockets.

**Isobel Gordon**

*Subject:* Quantitative MRI of the breast parenchyma to improve detection and diagnosis of breast cancer

*Sponsor:* Perspectum

*University of Oxford*

Mammography is not effective for pre-menopausal women and misses half of all tumours in 'dense' breasts. This project will develop quantitative, non-contrast MRI methodologies which will be applied to the breast parenchyma. This will enable earlier detection of breast cancer with higher specificity, remove operator variability and improve patient comfort.

**Amelia Markfort**

*Subject:* AI technologies for the next generation of quantum imaging

*Sponsor:* Photek

*University of Leicester*

This project will explain why modern large-scale Artificial Intelligence (AI) is broadly successful, focusing on applications in quantum imaging. Bridging the gap between existing knowledge, which demands huge volumes of data for guaranteed learning, and vast empirical evidence showing that such learning occurs on smaller datasets.

**Daire O'Dubhthaigh**

*Subject:* Smart green manufacturing for mass customisation in the textile industry

*Sponsor:* Interface UK Manufacturing

*Queen's University Belfast*

Interface are a global commercial flooring company that manufacture carpet tiles and resilient flooring. The aim of this project is to evaluate and implement leading technology to transform Interface's manufacturing processes, allowing them to meet the evolving customer needs of customisable, complex and smaller batch size products.

**Parijat Patel**

*Subject:* Artificial intelligence to improve cardiometabolic risk evaluation using CT (ACRE-CT)

*Sponsor:* Caristo Diagnostics

*University of Oxford*

This project will improve early detection of diabetes, pre-diabetes and identification of individuals at risk of future diabetes and its cardiovascular conditions from routine CT scans using AI and deep learning methods. It will aid in preventing future heart attacks and strokes, making a profound impact on global health welfare.

**Daniel Pybus**

*Subject:* Alternative production methodologies for formation of complex-geometry graphite components from recovered graphite powder

*Sponsor:* Mersen UK Teesside

*Teesside University*

To develop new, inorganic binding materials to 3D print high-concentration graphite components as an alternative to traditional machining. Material is sourced from recovered graphite powder, segregated to remove trace metals and resins. A digital decision-making tool will be developed to advise the most efficient manufacturing method according to experimental results.

**Andrei-Claudiu Roibu**

*Subject:* Mapping brain network activity from structural connectivity using deep learning

*Sponsor:* F. Hoffmann-LaRoche

*University of Oxford*

By using the latest advances in neuroimaging and artificial intelligence, this project seeks to address one of the major goals in neuroscience, which is understanding the structure-function relationship of the central nervous systems, by creating a deep learning model capable of predicting an individual's functional connectivity from their structural connectivity.

**Elliott Smyth**

*Subject:* Discovery of novel small molecules for the treatment of human coronaviruses

*Sponsor:* LifeArc

*University of Leeds*

This project will aim to develop novel anti-viral therapeutics to treat human coronaviruses, addressing the urgent unmet medical need for current and future pandemics. Three deadly zoonotic coronaviruses have emerged in the last 20-years and to date no specific anti-viral drugs for the treatment of coronavirus infections have been developed.

## Enterprise Fellows

**Brendan Digney**

*Company:* Machine Eye Technology [Financially supported by the ERA Foundation]

Machine Eye Technology uses computer vision, underpinned by AI algorithms, to accurately sense the environment around the machine, and understand the presence of any risks (at the moment, humans). Being able to give sight to a machine in this manner increases accuracy, eliminating a lot of the errors and challenges encountered by traditional sensing systems such as radar systems, which struggle with the variability and environmental conditions on farms and industrial sites. It means the system can identify a person, determine if they are at risk, and take appropriate action to warn, or intervene, both the operator and at-risk person.

**Alexander Macdonald**

*Company:* HindSight Technologies

HindSight have designed rear vision cycling glasses which allow competitive cyclists and urban commuters to achieve vastly improved awareness of their surroundings, enabling them to make better, safer decisions in less time and with more information. A scientifically designed rear-view mirror is integrated into a pair of specialised, stylish, professional cycling glasses, via lenses which allow rearward viewing without impeding the user's forward vision.

**Harish Pesala**

*Company:* Balkerne

Balkerne offers an easy-to-use risk and early warning system to property owners as an add-on service to an existing insurance policy. The platform captures data from over 35 different sources including IoT, geospatial modelling, news and social media, recognising factors such as chronology, context and geo-spatial relevance to build location intelligence. The key differentiator is that the data captured is granular, real-time, and trusted. This is achieved through using machine intelligence techniques such as computer vision on satellite imagery and natural language processing on news and social media feeds of trusted feeds from local emergency services, local authorities.

**Reka Tron**

*Company:* Multus Biotechnology

Multus create true animal-free serum replacements that support high-performance growth across multiple cell lines. With a statistically driven approach, Multus screen thousands of different combinations of ingredients to find the optimum composition for each step of the production process. Their machine learning based protein optimisation platform is used to enhance the performance characteristics of key protein ingredients within their growth media to make them suitable for large scale cultivated meat production. With a focus on the cultivated meat industry, they use vegan, food-safe ingredients that can be produced at scale to meet demand.

**Rebecca Donaldson**

*Company:* Blue Tap

Blue Tap is a social enterprise that has designed a chlorine doser which inserts the correct amount of chlorine into a piped water system, making it safe to drink according to WHO guidelines. The system is designed specifically for community water supplies, and other locations where larger volumes of water are treated, where chlorination is the most cost-effective purification solution.

**Natalie Kerres**

*Company:* SCALED

SCALED is a custom-fit protective wearable, inspired by the natural world. It uses a parametric algorithm to design an interlocking geometry of scales. This engineering innovation allows flexibility in specific directions, with protection and support in others. It calculates each individual scale's geometry to control the structure's properties.

**Naomi McGregor**

*Company:* Movetru [Financially supported by the ERA Foundation]

Movetru has designed wearable technology that provides the user with information to correct their alignment and improve mobility between physiotherapy sessions while creating a long-term medical history with a numerical analysis of the user.

**Tom Simpson**

*Company:* Ratio Technology

Ratio Technology has designed a 16-speed bicycle drivetrain. The inverted teeth of these chains meet the sprockets at low contact velocities, transferring load over large contact areas. As a result, they are quiet, efficient and highly wear resistant.

## Design Fellow

**Tijana Blanus**

*Subject:* Restoring nature in the city

*Mentor:* Dr Ross Cameron, University of Sheffield

Urban hedges are a simple, space-saving, cost-effective green intervention with the potential to alleviate a number of local environmental problems (localised flooding, poor air quality, excessive noise to name just a few).

Focusing solely on the benefits of singular plant varieties could however generate a homogenised cityscape with negative implications for biodiversity and pest and disease resistance. There are also practical barriers to wider uptake (e.g., in school settings in urban areas where they could bring considerable benefits) due to concerns around the safety, cost and time inputs into plant management.

Two key components of this project will be 1. Research into the required plant structural and functional traits for the delivery of multiple environmental benefits of mixed hedging and 2. A school 'case study' testing a science-driven solution in practice, in order to capture the environmental and social benefits of diverse planting, whilst addressing the practical concerns in implementation and maintenance.

The project will further link the research and school case-study through a 'living lab'-type demonstration at RHS Garden Wisley, where the engaging, publicly accessible interpretation will showcase examples of best practice which passed both the research and practical criteria. It is hoped that a planned strong and varied programme of dissemination (with the support of the RHS media and RHS education networks, with links to thousands of schools nationally) should facilitate popularisation and uptake of the tested solutions.

## Sir Misha Black Medal for Distinguished Services to Design Education

**Professor Don Norman**

*Director of the Design Lab*

*University of California San Diego*

Professor Norman is widely regarded for his expertise in the fields of design, usability engineering, and cognitive science and a pioneer of user centred design that has influenced designers all over the world. Many of his books, especially *The Design of Everyday Things*, have been part of the core reading list for design students for decades.

## Industrial Design Students

|                   |                                                      |                                                  |
|-------------------|------------------------------------------------------|--------------------------------------------------|
| Solomija Bogusz   | Architectural Design                                 | University College London                        |
| Erin Carr         | Earthquake Engineering and Infrastructure Resilience | University of Bristol                            |
| Luisa Charles     | Global Innovation Design                             | Royal College of Art and Imperial College London |
| Jahan Daya        | Global Innovation Design                             | Royal College of Art and Imperial College London |
| Hemal Dias        | Innovation Design Engineering                        | Royal College of Art and Imperial College London |
| Alasdair Grant    | Global Innovation Design                             | Royal College of Art and Imperial College London |
| Daniel Hale       | Innovation Design Engineering                        | Royal College of Art and Imperial College London |
| Eden Harrison     | Innovation Design Engineering                        | Royal College of Art and Imperial College London |
| Samuel Jones      | Design Products                                      | Royal College of Art and Imperial College London |
| Georgia Mackenzie | Innovation Design Engineering                        | Royal College of Art and Imperial College London |
| Annie Tang        | Global Innovation Design                             | Royal College of Art and Imperial College London |

## Special Awards Granted

### *STEM education and outreach*

EDT – Virtual STEM work experience  
Royal Society of Chemistry – Steps into science  
In2ScienceUK – Engineering research module  
National Literacy Trust – Linking literacy and STEM careers  
Education and Training Foundation – Technical teaching fellowships  
Wellington Trust – Future maritime engineers project  
Kids Invent Stuff – Mini YouTube musical  
All Party Parliamentary Engineering Group – Meeting sponsorship  
STEM Learning – Involving fellows in primary STEM outreach

### *Support for legacy estate*

Royal College of Art – The empathetic engineer  
Royal Geographical Society – Upgrading 1 Kensington Gore  
Exhibition Road Cultural Group – South Kensington green trail

## Awards completed in 2021

### Research Fellows

#### Dr Stephen Cox

*Project:* Towards predicting the surface charge of electrolyte / solid interfaces

*University of Cambridge*

Interfaces between solids and electrolyte solutions (e.g., salt water) are of great fundamental and technological importance across a variety of fields. Examples include batteries, fuel cells, biological membranes, and colloids (e.g., paint).

Steve's project focused on advancing the latest techniques in molecular simulation to improve our understanding of solid/electrolyte interfaces, providing insight that is difficult to obtain experimentally. Steve showed how previously used "standard" methods give qualitatively incorrect results, and how a new theoretical framework can be used to correctly model these important systems. He also provided theoretical insight into how systems with short-ranged interactions respond to electric fields, which will be important for the application of machine learning approaches to describe intermolecular interactions more accurately. Steve now intends to use the advances made during his Fellowship to predict the surface structures of crystals in complex environments.

Steve published many high-profile papers during his Fellowship, including a single author contribution in *Proceedings of the National Academy of Sciences* and an experimental collaboration in *Physical Review Letters* as corresponding author. Steve was also awarded 2020 Best Paper by an Emerging Investigator by *Journal of Chemical Physics* for his article 'Macroscopic surface charges from microscopic simulations'. He is now a Royal Society University Research Fellow at the University of Cambridge.

#### Dr Paul Holloway

*Project:* A microfluidic model of the neurovascular unit for stroke research *University of Oxford*

This project aimed to develop a novel cellular model of the brain using 'Organ on chip' technologies to provide new investigational tools for stroke research. Protecting the brain following stroke has been a major therapeutic goal but despite over a thousand prospective neuro-protective treatments tested, none of these have been approved for clinical use. Methods to test drugs in human cells are, however, extremely limited and often rely on cells grown in a flat plastic dish, which fails to replicate brain form and function.

During his Fellowship, Paul set out to use 'Organ on Chip' techniques to develop a human cell culture system that mimics key elements of brain structure and function (from neuronal circuits to brain blood vessels) and can recreate the conditions of a stroke, to provide new methods to test drugs and understand disease mechanisms. During this project, Paul was able to develop two distinct models that are now being used to explore potential new therapies. One model guides cellular self-assembly in a 3D gel, to provide brain blood vessel mimics that can be blocked using micro-clots to explore the responses of the "neuro-vascular unit" in stroke, while the other creates living neuronal circuits that can be used to explore how cell damage can spread between connected regions of the brain following stroke.

During his Fellowship, Paul secured over £200k of research funding, became a member of the leadership team for the UK Organ on Chip Technology Network and Topic Editor at *Micromachines*, and published his work in *Lab on Chip* (2019 & 2020), *Cellular and Molecular Bioengineering* (2021) and a review in *The Journal of Neuroscience Research* (2021).

Paul is now utilising the technologies developed during his Fellowship to explore a new therapeutic approach as a post-doc at the University of Oxford in collaboration with the University of Cambridge and an Oxford-based biotech company.

### **Dr Davide Foffa**

*Project:* Elgin reptiles: the origins of the modern terrestrial fauna      *National Museums Scotland*

Davide's research focused on the Triassic 'Elgin Reptile' fauna, a series of understudied fossils closely related to the earliest ancestors of dinosaurs, pterosaurs, lizards, turtles and crocodilians. During his Fellowship, he adopted a digital approach (using computed tomography (CT) data) to circumvent destructive preparation of the specimens and reveal never-before-seen details of the skeletons of these animals. Davide created accurate digital reconstructions of these fossils which he used to study clues about their in-life behaviour and their positions in the reptile family tree. The results were pivotal to contributing to shedding light on long-standing questions in palaeontology (e.g., the origins of pterosaurs and the anatomy, biology and relationships of *Scleromochlus* and *Erpetosuchus*). Results of his research were published and more will be in due course.

This approach ultimately showed that the richness of the Elgin deposits may be greater than previously thought. For this reason, this project will survive the end of the Fellowship: unprocessed data will provide materials for training students and supervision experience for Davide's future career. A series of projects on the Permian 'Elgin Reptiles' has been started. Finally, the concluding outreach project will provide freely available learning materials and activities for schools worldwide.

Following the Fellowship, Davide has been awarded a Marie Skłodowska-Curie – Individual Fellowship – Global Fellowship to research the ecological effects of the Permian-Triassic mass extinction on terrestrial ecosystems. This post, which stemmed from fruitful collaborations during his project, will be based at the University of Birmingham with two years as a visiting researcher at Virginia Tech (USA).

### **Dr Jake Iles-Smith**

*Project:* Quantum control through photonic engineering

*University of Sheffield and University of Manchester*

Describing light-matter interactions in solid-state systems is a key barrier to developing photonic quantum technologies. Strong interactions between the electronic degrees of freedom of a solid-state emitter (SSE) and the vibrational modes of its host material, lead to complex dynamical and optical properties, and typically degrade an emitter's performance as a quantum technology. Standard theoretical methods in quantum optics assume an emitter is only weakly influenced by its environment and thus may be treated as a perturbation – a treatment that rapidly breaks down when used to describe SSEs. Therefore, in order for SSEs to reach their potential as a quantum technology, it is crucial that we have a versatile formalism capable of capturing emitter-environment interactions in the strong coupling regime.

During his fellowship, Jake developed techniques to describe the emission properties of SSE valid in regimes intractable to standard quantum optics methods. Two examples include: the collective coordinate approach, in which important environmental degrees of freedom are identified and incorporated into a new augmented system, effectively redrawing the boundary between the 'system' and 'environment'; and a numerically exact approach, which efficiently encodes system-environment correlations in a tensor network representation. These methods have been applied directly to realistic quantum emitters such as quantum dots and organic molecules, providing new insights into electron-phonon interactions in SSEs and how the optical properties of these emitters might be controlled through photonic structures. Furthermore, using the formalism as a basis, Jake has proposed quantum technologies that are robust against noise induced by environmental interactions, and even utilise this coupling to enhance their operation.

Jake is now a Presidential Fellow at the University of Manchester.



### **Dr Paul Knott**

*Project:* Employing computer algorithms to automate the engineering of quantum states

*University of Nottingham*

A requirement of any experiment involving quantum mechanics is that the quantum state of the system is engineered (i.e., designed, prepared and manipulated) with extreme precision and control. But the counter-intuitive nature of the quantum world, whilst enabling disruptive new technologies, also makes it particularly challenging to design quantum experiments that can engineer useful states – our usual intuitions can fail us here.

To overcome this, Paul pioneered an automated technique, the quantum state engineering algorithm, which in essence uses computer algorithms to design quantum experiments. This technique – which utilises methods from both genetic algorithms and machine learning – found numerous solutions that surpass the previous results in the literature whilst involving surprising experimental arrangements quite different from the human designs.

During the latter half of the Fellowship, Paul's future plans for the project became more ambitious. He now plans to develop an intelligent virtual laboratory, which will contain at its core a learning agent that learns from experience, utilises powerful search algorithms, can be trained by human experts, and can respond to human interaction and feedback in real time, ensuring the output satisfies the specific requirements of the user. This will have applications from quantum-enhanced precision metrology and quantum computing to quantum simulation and fundamental experimental tests. To develop the machine-learning expertise to enable him to complete this ambitious project, during his Fellowship Paul worked as a Visiting Scholar at the world-leading Berkeley Artificial Intelligence Research Lab. This experience gave him expertise in deep reinforcement learning and resulted in a publication on evaluating and improving the robustness of collaborative deep reinforcement learning agents.

Paul is now at the Centre on Long Term Risk where he researches the long-term risks associated with artificial intelligence.

### **Dr Emilio Martínez-Pañeda**

*Project:* Micromechanical modelling of rock fracture: towards energy-efficient mining

*University of Cambridge and Imperial College London*

Emilio's Fellowship aimed at developing a new generation of physically based models for rock fracture to optimise energy-intensive mining and construction technologies. Emilio worked on shedding new light into our understanding of rock fracture and also developed new bio-inspired techniques to manufacture rock-like materials with unique mechanical properties. He also worked on developing new mathematical methods that enabled simulating the nucleation and growth of multiple cracks for the first time. This allowed him to present pioneering models not only for rock fracture but also for predicting the failure of embrittled metals, advanced composites, and smart materials, as well as opening a new path for computational modelling of corrosion. Several of these fundamental models are now being used by industry to conduct "Virtual Testing" in applications and sectors where computer simulations had not been employed previously.

The Fellowship also provided a remarkable boost to Emilio's academic career. He went from being a postdoctoral research fellow at the University of Cambridge (2018) to a Lecturer (2019) and Senior Lecturer (2021) at Imperial College London. By the end of the Fellowship, Emilio led a group of five postdoctoral researchers and seven PhD students tackling mechanics of materials challenges that are the key to understanding physical phenomena such as corrosion or iceberg calving and are at the core of technologies such as Li-Ion batteries, offshore wind energy, and hydrogen storage.

Emilio has recently been awarded an UKRI Future Leaders Fellowship, which will support him and his team for seven years to continue tackling exciting material degradation challenges at the interface between mechanics and chemistry.

**Dr Konstantinos Meichanetzidis**

*Project:* Simulating compositional processes with tensor networks

*University of Oxford*

Konstantinos maintains that being awarded the Fellowship has been one of the most significant events, not only for his academic career but also for his personal development.

Having the Fellowship hosted by the Department of Computer Science at Oxford University with a three-year research horizon provided him with the priceless opportunity to independently and deeply think about his research interests while being surrounded by a variety of interesting and gifted researchers. Such breathing space allowed him to collaborate widely and connect seemingly disparate fields of study from formal graphical languages and complexity theory to quantum computing and artificial intelligence.

Following the Fellowship, he is joining a key player in the quantum computing industry, Cambridge Quantum, as a Senior Research Scientist, where he will be part of a diverse and interdisciplinary team envisioning applications of quantum computers to artificial intelligence.

**Dr Zahid Padamsey**

*Project:* Speed or precision? Dynamics of information flow in the brain

*University of Edinburgh*

Information processing in the brain is energetically expensive. Indeed, the brain consumes approximately 20% of our calorie intake despite comprising only 2% of our bodyweight. Much of this energy is spent on fuelling the rapid and precise transmission of information between neurons. Given the prohibitive costs of neuronal communication, how might information transmission change if caloric intake is reduced? One hypothesis is that the speed and/or precision of information transmission would decrease in order to save energy.

During his Fellowship, Zahid explored how information processing in the brain is impacted by a reduction in food intake in laboratory mice. He recorded neuronal activity in a region of the mouse brain responsible for vision. When food intake was reduced by 30%, he discovered that the precision with which neurons transmitted information was reduced. In effect, neurons were no longer transmitting precise details of the visual world, making it more difficult for mice to see clearly. However, whilst neurons were less apt at transmitting information, Zahid found that they were also using 30% less energy. These findings are the first to establish that the precision of information transmission is reduced in the mammalian brain to save energy when food availability is limited. This work has important implications for understanding how diet impacts cognition in humans.

Following his Fellowship, Zahid has been awarded a research grant by the Biotechnology and Biological Sciences Research Council (UK) to continue his line of work at the University of Edinburgh. He is now looking at the underlying molecular and genetic mechanisms that control how much energy neurons spend on information processing.

**Dr Matthew Pusey**

*Project:* Notions of non-classicality as sources of quantum advantages

*University of Oxford*

Quantum computation and quantum cryptography aim to exploit the unique features of quantum mechanics to achieve faster speeds and better security than is possible with current technology. But exactly which quantum features are responsible for each quantum advantage can be surprisingly difficult to pin down. A promising approach to these questions is via rigorous notions of non-classicality, the most important of which are quantum contextuality and quantum nonlocality. Because these notions provide a precise characterization of what makes quantum mechanics unusual, they offer the possibility to identify exactly what powers quantum advantages in computation and cryptography.

Matthew developed the theory of quantum contextuality, with a particular focus on making demonstrations of it more robust to various experimental imperfections. Since all experiments are imperfect, such robustness is important for doing convincing foundational experiments. This robustness is also important for any cryptographic applications where such imperfections could lead to security loopholes, and to make solid connections with quantum computation which always has to contend with noise. In particular, Matthew ensured the robustness of the connections between contextuality and another useful form of non-classicality known as “anomalous weak values”.

Matthew also worked on a structure theorem that makes it easier to identify and study contextuality by considering transformations alongside preparations and measurements. Most recently, he applied this theorem to give a full characterization of the contextuality of the “stabilizer subtheory”, which plays a key role in quantum computation. This characterization provides a very direct link between contextuality and certain forms of quantum computation.

Matthew is now a Lecturer in Quantum Information in the department of Mathematics at the University of York. His research is still in broadly the same areas: connections between quantum information and quantum foundations.

## Industrial Fellows

### Jasmine Bone

*Project:* Durability assessment and lifetime prediction of polymer composites under harsh marine environments

*Sponsor:* National Physical Laboratory

*University of Surrey*

Jasmine's research project focussed on the effects of accelerated ageing and moisture absorption in polymer composite materials. These materials are increasingly being used in marine and offshore environments where it is essential to understand the effects of the environment on degradation and material performance over time. The aim of this research was to use methods of accelerated ageing (increased severity test conditions) to correlate the absorption of water in the composites to reductions in material properties such as strength and stiffness.

Over the course of the Fellowship, Jasmine developed test methods to accelerate moisture uptake in the materials and vary exposure conditions with temperature, pressure and applied mechanical load. Different techniques were used to characterise the degradation occurring and diffusion modelling used to assist the understanding. This work provided the foundation for a capability to test and understand the degradation of composite materials due to moisture uptake and identified a relationship between the degree of water absorption and its location in the material to the degradation of material properties.

After completion of the EngD, Jasmine was employed full time by NPL in order to investigate the validity of the test work to industrial case study materials.

Jasmine is now a Research Fellow at the joint AWE and University of Surrey Centre of Excellence in Materials Ageing, Performance and Life Prediction.

### Laurence Devesse

*Project:* Investigation into the use of massively parallel sequencing in forensic genomics

*Sponsor:* Verogen

*King's College London*

Laurence's project was born out of a Knowledge Transfer Partnership between Verogen (the forensic genetics group at Illumina at the time of the award) and King's College London. As a new company, Verogen benefitted from the support of the forensic genetics community, and the partnership with King's Forensics helped establish the Verogen MiSeq FGx technology as a gold standard for massively parallel sequencing in forensic DNA typing. Laurence's research has proven that this technology is fully concordant with what forensic laboratories have been doing for the past 20 years and can be applied to forensic cases previously too complex to solve with less informative techniques. The results and databases made available through multiple publications during the Fellowship have facilitated uptake and implementation of the MiSeq FGx in laboratories world-wide, and already form part of the "Verogen story". Laurence's academic output is often utilised by the company, and her knowledge of the processes she applied and developed during her Fellowship is shared with Verogen customers on a regular basis.

Laurence remains a field application scientist with Verogen.

### **Mariastefania De Vido**

*Project:* Advanced gain materials for high energy, high average power laser systems

*Sponsor:* STFC Rutherford Appleton Laboratory

*Heriot-Watt University*

Stefania's Fellowship focussed on advancing DiPOLE, a world-leading high energy, high repetition rate nanosecond diode-pumped solid state laser amplifier architecture developed at the Central Laser Facility (CLF), part of the STFC Rutherford Appleton Laboratory.

She conducted wide-ranging experimental and numerical studies to address performance issues in existing systems and to open up routes to future increases in pulse energy and average power. Activities carried out during the Fellowship have yielded three first-author papers (with three more papers in preparation) and one patent application.

Stefania's contribution has allowed DiPOLE to remain a record holder in several categories, such as output energy, average power and system efficiency and facilitated the commissioning of a new DiPOLE system for the European Free Electron Laser (X-FEL) in Hamburg (Germany). This allowed CLF to remain at the forefront in the high energy high repetition rate laser field.

DiPOLE technology has been chosen to be at the heart of a new UK facility, the Extreme Photonics Applications Centre (EPAC), an £82m research centre currently under development at the CLF which will focus on the development and application of novel, laser-based accelerators and particle sources for sensing, medical and security applications. Stefania's research will contribute in making DiPOLE fit for purpose in terms of energy, efficiency and reliability performance.

Stefania's work allowed the development of next generation DiPOLE systems operating at 100 Hz repetition rate, 10 times the repetition rate of current DiPOLE lasers. Commissioning of a DiPOLE 100 Hz laser will open up new avenues in industrial applications of high energy, high repetition rate lasers and may be the first step towards the development of new high repetition rate facilities and the upgrade of existing ones.

Stefania continues to work at the CLF on the development of DiPOLE technology and on the development and commissioning of EPAC.

### **Christopher Magazzeni**

*Project:* Ultrasonic testing for jet engines

*Sponsor:* Rolls-Royce plc

*University of Oxford*

Aviation has become safer and more efficient, with every iteration of high-performing jet engine contributing to this change. A major source of improvement has come from a change in the way we manufacture the precise components in the engine: from shaping and cutting uniform blocks to friction-welding or 3D printing complex shapes. These new tools enable an enormous range of designs with significant performance benefits, from reducing the number of individual parts needed to bio-mimetic geometries.

However, these new tools also completely change the material structure, often at a micro-scale. In order to understand this, new tools for studying and qualifying these materials at a similar scale are needed: having refined our focus in the material with smaller and smaller features, we similarly need to downscale our testing methods.

Christopher's project delivered two novel methods to answer questions on material behaviour of these parts. The methods – applicable to any material, rich in data, and fast – have been developed on the case study of a friction weld in Rolls Royce plc jet engines. Exploring the weld-line, a region with higher strength, allowed for understanding the material behaviour of each individual link in the chain instead of just finding the weakest one. By combining new testing machines with advanced data analytics, these methods will cut down on the development cycle for the new manufacturing methods. The tools have been shared with the scientific community across the disciplines of aerospace, geology, and plastics, and have been incorporated in Rolls Royce's toolbox.

Christopher is now a Research Fellow with the European Space Agency.

**Shaun Mansfield**

*Project:* Manufacturing process for clinically relevant cord blood haematopoietic stem cells

*Sponsor:* Biovault Technical

*University College London*

Umbilical cord blood (UCB) is a source of haematopoietic stem and progenitor cells (HSPC) that have a proven clinical track record for the treatment of over 80 conditions. However, the finite number of cells within one unit, which limits the overall cellular dose available, ultimately limits its potential as a therapeutic, restricting the use of UCB to children and adolescents or requiring multiple units be transplanted in adults. To overcome this, expansion strategies to increase the overall number of HSPCs have been adopted. These strategies largely focus on the use of supplementation to promote proliferation whilst limiting differentiation. However, they rely on dated technologies, which are manual, laborious, inconsistent and lack the ability to scale.

For these expansion technologies to realise their full potential, manufacturing strategies are required that improve scalability and consistency whilst reducing overall cost and manual processing steps. The main aim of Shaun's project was to investigate the use of a bioreactor system for the expansion of HSPCs, which can address many of these challenges. Within the project it was demonstrated that agitating HSPC cultures improved the overall yield of cells, cell viability and their potency compared to a static control. In addition, specific process parameters were investigated, the dissolved oxygen concentration, cell seeding density and culture media pH. Investigating the design space for these parameters highlighted optimal operational parameters, which when applied to multiple donors, resulted in a further significant improvement in final cell yield, viability, and potency, whilst also decreasing the time required for manufacturing.

Biovault will be able to utilise the output from the research as a tool to secure more customers for their Umbilical Cord Blood storage service as well as new overseas partners. In addition, the research can be used to promote future collaborations between Biovault, academic institutions and other industry partners, building upon the outputs from this project either internally or with future collaborations.

Shaun is now working as a Research Scientist at Ori Biotech.

**Marta Ferran Marqués**

*Project:* Luminescent coatings for ultrahigh temperature measurements

*Sponsor:* Sensor Coating Systems

*Cranfield University*

Temperature is one of the most critical properties of thermal systems in power generation and aerospace. The extreme inlet temperatures influence the efficiency, reliability, and lifetime of an engine system. This demands accurate data concerning the thermal load on components. Current temperature sensors exhibit some limitations. Thermocouples and thermal crystals only provide point measurements making it difficult to reveal temperature gradients. Pyrometers require optical access and can be influenced by emissivity changes. Thermal paints deliver surface coverage, but they also present some challenges such as toxic chemicals, poor resolution, wide temperature data gaps, and poor durability.

To overcome some of these challenges, Sensor Coating Systems (SCS) has developed Thermal History Coating (THC) technology, able to measure temperature profiles in the 900 – 1600 °C range post-operation. THCs are phosphor thermometers synthesised via co-precipitation methods and deposited to form a coating via Atmospheric Plasma Spray (APS). This new offline temperature profiling technique uses optically active ions in a ceramic host material that phosphoresce once excited by light. After being exposed to high temperatures the host material irreversibly changes at the atomic level affecting the phosphorescence properties which are then related to temperature through calibration. The technique records the past maximum exposure temperature so that it can be determined once the component has already cooled down.

The data obtained during Marta's Fellowship has helped develop a more robust and reliable THC system for the 900 to 1600 °C temperature range. Firstly, a study on how the spray deposition parameters influence the microstructure, and thus the luminescence of the material, was carried out. The optimised and selected spray parameters are now used for all industrial projects at SCS. Secondly, several materials characterisation techniques, such as, X-ray diffraction, Raman spectroscopy and optical spectra, were used to reveal the different phase changes undergone by the THC material when exposed to high temperatures, providing a new calibration method. An in-depth characterisation of the decay kinetics undergone by the material was carried out, providing a better understanding of the underlying physics of the material. Lastly, engine and lab exposed samples were compared for the first time, revealing differences at the microstructure level and providing valuable results to SCS.

The findings throughout Marta's Fellowship will not only benefit design engineers in their race to achieve higher firing temperatures but will also help SCS in growing as a company and broaden its temperature range capabilities.

Marta continues to work at SCS.

**Elsa Noaks**

*Project:* An upstream manufacturing step to remove contaminating cell types from T-cells for immune oncology

*Sponsor:* Autolus

*University College London*

Chimeric antigen receptor (CAR) T-cell processing is a rapidly developing cancer therapy that can offer treatment for patients where traditional therapies have failed. Concerns regarding host rejection have resulted in the majority of CAR T-cell therapies using a patient's own cells, collected through a process called leukapheresis, and so manufacturing success is inextricably linked to starting material composition and quality.

Establishing the relationship between donor material composition and the success of CAR T processing stages is critical. The ability to predict how patient material will behave from its composition would allow manufacturers to adapt their processes, helping to prevent production of an ineffective product or failure to meet dosage. Reducing the chances of processing failure is especially important for CAR T-cell therapies, as their application is almost exclusively in refractory cancer patients who may not be able to wait for additional manufacturing cycles. Elsa's work found that depletion of specific cell groups from donor cells could significantly enhance the performance of key CAR T-cell production manufacturing steps.

Although widely implemented, replacing leukapheresis with an alternative starting material could be beneficial. The simplicity of blood collection makes it cheaper and more widely accessible to patients, which could be vital for those who may be too unwell to travel long distances to a specialist centre or undergo the procedure. However, much like leukapheresis, white blood cells (WBC) from whole blood also contain disruptive cell populations, such as monocytes, as well as a higher level of red blood cells. To examine the potential of using whole blood collections, Elsa's project reviewed how the CAR T-cell process cycle was affected by changing the WBC collection method.

Elsa has now taken up a position at Autolus as a Research Scientist.

**Alex O'Neill**

*Project:* Predicting tyre behaviour on different road surfaces

*Sponsor:* Jaguar Land Rover

*University of Surrey*

Alex's work has provided a solution to a long-standing, industry-wide problem that will directly benefit Jaguar Land Rover (JLR) by improving its tyre modelling capabilities. JLR aims to undertake a significant amount of its new vehicle development virtually. By using full-vehicle simulations to refine products as much as possible, the considerable costs associated with building expensive physical prototypes can be reduced substantially. The quality of simulations rests on the quality of the constituent models. Currently, tyre models often represent driving on sandpaper, diminishing correlation with physical tests conducted on asphalt and reducing the efficacy of the virtual engineering process.

Alex's work has successfully developed a process where tyre models can be reliably transferred from one surface to another (e.g., from sandpaper to asphalt). To do so, the complex frictional interaction that occurs between tyre rubber and different surfaces was captured experimentally. Then, the obtained frictional characteristics were used as an input to a tyre model. Results showed that changing the frictional characteristics in the model mirrored the changes seen in measured tyre forces on the different surfaces. Fundamentally, the results show the importance of capturing the frictional behaviour of the rubber.

Going forward, experimental tyre data obtained on sandpaper can now be 'scaled' to that of asphalt, in a reliable and physically meaningful way. Consequently, JLR's tyre models are more representative of reality, and, thus, the company's virtual engineering capability is improved. This allows more work to be done on the 'virtual' car and speeds up the process of bringing new products to market.

Following the Fellowship, Alex has secured a dream role with Siemens' tyre research group, who are industry-leading in their modelling capabilities.



### **Alexandre Raymond**

*Project:* Equipping autonomous surface vehicles with intelligent interaction capabilities

*Sponsor:* L3Harris ASV

*University of Cambridge*

During his Fellowship, Alex conducted a deep investigation into the open challenges of explaining the behaviour of autonomous vehicles. His research sets out a new paradigm of developing autonomous vehicles that are 'explainable by design.' These vehicles of the future can reason about their current state and justify their intentions to operators and other vehicles alike (manned or unmanned). As a result, he hopes to increase trust and speed up the regulatory hurdles in the indispensable adoption of this technology.

More specifically, Alex extended the concept of explanations not only for humans, but for other robots as well. He provided concrete answers to representative questions such as: how to explain intent according to the rules of the sea? How to optimise explanations and minimise potential conflicts of interest between vehicles? Can those explanations be used to improve the performance of AI algorithms?

For L3Harris ASV, Alex's work represents a competitive advantage in the form of a clear roadmap for designing technology that not only complies to regulations but can also exhibit awareness by explicitly reasoning about existing norms. The first player in the market who can demonstrate that their vehicles can coexist with humans will lead the way with the technology.

Following the Fellowship, Alex hopes to take on a technology leadership position in the autonomy domain at L3Harris ASV.

### **Jonathan Vince**

*Project:* Using ultrasound to enhance targeted radiotherapy

*Sponsor:* BTG Biocompatibles / Boston Scientific

*University of Oxford*

Jonathan's Fellowship has supported the development of a new method for delivering targeted radiotherapy to cancer patients using ultrasound and microbubbles. The technology has been specifically explored in the context of brain tumour treatment (glioblastoma multiforme), but also has the potential to treat other solid tumours with poor vascular access.

The use of ultrasound induced cavitation of commercially approved microbubble contrast agents, drastically extends the potential of selective internal radiation therapy (SIRT) as a modality for treatment of various cancers. It enables radioactive microspheres to be delivered into various tissues which do not have existing vasculature for intra-arterial microcatheter delivery and offers a new and exciting way to distribute selective internal radiotherapy within the body. The discoveries made possible by the Fellowship may pave the way to an improved standard of care for glioblastoma multiforme and transform the lives of patients suffering from this highly aggressive form of cancer.

A patent has been submitted between Oxford University Innovations and Boston Scientific with respect to the findings of this research and their commercially available radioactive product TheraSphere®. It is hoped that this new technology platform will improve the existing treatment of currently approved cancer indications and enable the use of radioactive microspheres for other indications. Two academic paper submissions are currently being written up summarising the findings and development of ultrasound mediated delivery of radioembolic microspheres.

Jonathan is now a Project Manager at Airfinity.

**Fergus Watson**

*Project:* The prevalence and relevance of hospital biofilms and their inactivation by H<sub>2</sub>O<sub>2</sub> vapour technology

*Sponsor:* Bioquell UK

*University of Southampton*

The aim of Fergus's Fellowship was to expand upon our understanding of the microbiome on dry surfaces within a hospital environment and utilise this to model the microbial challenge for in vitro efficacy testing of common disinfectants.

Environmental surfaces play a key role in the transmission of hospital-acquired infections (HAIs) and are believed to act as a reservoir to HAI-associated pathogens. Fergus's analysis of the clinical environment was able to support the limited literature for the presence of biofilm contamination on dry surfaces. Moreover, from his data he has been amongst the first to define the true levels of microbiome on dry surfaces using microbiologic culture techniques. He found the surface bioburden for hand-touch sites in patient wards was 10,000x higher than the current limits for cleanliness (5 CFU/cm<sup>2</sup>). Furthermore, by categorising his dataset into different types of surfaces he has been able to show which surfaces pose a greater risk to patients than others. Clinical equipment can often be missed during routine hospital cleaning yet was seen to harbour more clinically relevant pathogens such as *Acinetobacter* spp., whilst surfaces in closer proximity to the patient (e.g., bed rails, tables etc) were more abundant in environmental flora which are arguably less harmful yet are more frequently cleaned.

From this work Fergus has developed a novel in vitro model for emulating hospital microbiomes. There is a distinct lack of understanding of how biofilms grow on dry surfaces and Fergus postulates that patient bodily fluids transmitted through touch, such as sweat, are key contributors. Therefore, he developed his model to emulate the formation of dry surface biofilms via contact between a patient's 'hand' and clinical surfaces supplemented with a unique artificial sweat growth media. The resultant biofilms have been used for downstream efficacy testing of common disinfectants and will provide valuable information for clinicians when choosing Infection Prevention and Control (IPC) measures.

The information obtained during Fergus's Fellowship will be used to advance Bioquell's position within the healthcare industry and provide a comprehensive hygiene solution with multifaceted approaches to bioburden control. The techniques devised should enable Bioquell's clients to tailor their IPC approach to unique situations or facilities.

Following the Fellowship, Fergus has moved into a leadership role within the supply chain (production) division of Bioquell. He continues to provide input to on-going development work on Bioquell's biological products. He is also looking at areas within the global parent company, Ecolab, where his research and expertise can be utilised.

## Industrial Design Students

### Alex Dallman-Porter

*Course:* Innovation Design Engineering

*Royal College of Art / Imperial College London*

During his second year of IDE, Alex completed a group project with three peers, and a solo project. The former was concerned with the little known but significant environmental issues of clothes washing, which uses large volumes of fresh water, requires high energy input for heating and drying, and is overkill for how dirty most clothes are, which results in their frequent damage. Alex and his collaborators came up with a gentle waterless alternative that leaves clothes bacteria-free and smelling fresh.

Alex's solo project was originally inspired by rowing, and the feelings of calm many experience whilst out on the water. Through a lengthy development process, this resulted in his creation of a novel approach to mindfulness at home that incorporated gentle exercise, nature therapy and movement-responsive audio.

After graduation Alex has gone full time at the ex-IDE startup he'd been helping out with part time during his studies, Charco Neurotech. He works on a range of areas including product development, manufacturing and community support. Charco Neurotech recently launched their product the CUE1, a non-invasive wearable that alleviates the movement symptoms of Parkinson's.

### David Harris

*Course:* Global Innovation Design

*Royal College of Art / Imperial College London*

During his Studentship, David was driven by his desire to apply his background in product innovation and venture building to ideas with social impact. A central theme of his work was designing platforms, services and experiences that facilitate wellbeing and human connections.

During GID David spent a year living in Tokyo, where the widespread presence of daily rituals in Japanese culture inspired a research project into ritual design. The final concept presented was *Ritually*, a digital assistant for personal ritual creation that enables people to playfully establish new patterns of behaviour, for instance by designing ritual objects.

Whilst taking remote classes at Brooklyn's Pratt Institute, David explored the epidemic of urban loneliness and social isolation. In collaboration with residents of New York, he designed *Pal*, a fresh spin on traditional pen pal schemes aimed at building more meaningful human connections and cohesive communities in local neighbourhoods of large metropolitan areas.

David's final year project *NEXT* showcased a digital platform that connects people transitioning into retirement and enables them to find a new purpose in life by starting impactful community projects with others. *NEXT* followed a human-centred design approach, involving over 20 participant interviews, and built on the expressed needs for meaningful activity in retirement and opportunities to expand social connections.

David is now leading the product innovation team at a London-based software start-up where he works in partnership with the NHS and community organisations to address social determinants of health. His primary focus is on developing a digital ecosystem of wellbeing support and exploring the future of self-care pathways for citizens. He is part of the DigitalHealth.London accelerator programme for digital innovation in health and care.

### **Ella Hetherington**

*Course:* Bio-integrated Design

*University College London*

Ella's research focused on passive bioremediation of water using melanin, a natural pigment found in all biological kingdoms. In nature, melanin's function is often for protection from harmful environmental stresses. Melanin is capable of binding and absorbing many harmful pollutants such as heavy metals. Heavy metal pollutants are one of the most challenging substances to remove from our environment as they are bio accumulative. They can be costly and time consuming to remove using current physical and chemical methods.

Melanin is produced in-situ by bacteria that can express the pigment extracellularly. The bacteria are grown inside tiles of a hydrogel material made from seaweed that is both highly absorbent and biocompatible. Creating robotically printed lattices of these hydrogels maximises surface area for absorbance. The melanin can both permanently bind the metal or act as a reservoir which poses exciting prospects for the recovery and recycling of these metals.

Following her Studentship, Ella is continuing with the development of her project as a researcher at UCL with the aim of making a prototype for installation on a site. She is also a research assistant on a new project exploring the automation of construction of Cob (a sustainable natural building material made from sub soil, water and a fibrous aggregate like straw) with industrial robotics.

### **Sandeep Hoonjan**

*Course:* Innovation Design Engineering

*Royal College of Art / Imperial College London*

During his studentship, Sandeep focused on computational solutions to sustainable eating, physical communication, and longevity of electronics.

Sandeep's final group project, *Meal Engine*, was a system for generating customised food recipes in a way that fostered more sustainable and healthier practices for both the consumer and producer. The basis of this was a visual programming language Sandeep devised called EGlang, which condensed the complex act of cooking into simple classes. Sandeep and his team members devised methods for incorporating such a system into existing food systems now and far into the future.

His final solo project, *Computational Heirlooms*, created a manifesto for computational hardware that could last multiple human lifetimes. Sandeep took a hybrid approach of speculative design and physical prototype generation to create a vision of the future where our computational devices are cherished and enjoyed as life partners, rather than disposable tools.

One of his most notable first-year projects was entitled "Feel the Conversation", created in collaboration with Xianzhi Zhang. It consisted of a set of communication devices that translated multilingual conversations into a simple haptic movement. The project received global press and was included in a year-long exhibition at the Stedelijk Museum Amsterdam.

Since graduating, Sandeep has begun work as a designer and creative technologist, where much of his work focuses on future developments in digital communication.

**Daniel Karaj**

*Course:* Global Innovation Design

*Royal College of Art / Imperial College London*

During his Studentship Daniel focused on the relationship between digital and physical media, from exhibiting at a physical pixel art show in Japan, exploring the effect of technology on the future of music to more extensive projects focused on the application of technology to aid in physical and mental health care.

Developed in consultation with London based cellular agriculture start-up Hoxton Farms, Daniel's final project *Eggriculture* is a proposal in which cultured meat is incubated using household chickens in a consumer's garden. Unfertilised eggs are given transformation factors to induce pluripotent stem cells and then growth factors to guide the cells into producing a portion of steak, bacon or other meat following a three-week incubation period underneath a brooding hen. The proposal had three aims: humanising lab grown meat, reducing some of the economical concerns by leveraging experience design principles and aligning lab grown meat with the home-grown movement.

While on exchange in Japan, Daniel worked at the University of Tokyo with the DLX Design Lab on capillaroscopy research. Since graduation he has continued to take on software engineering and design projects including work with Nesta and the Scottish Government on the future of healthcare data and further collaborations with the DLX Design Lab, primarily focused on the future of autonomous transport.

**Roumyana Kotopanova**

*Course:* Manufacture and Commercialisation of Stem Cell and Gene Therapies

*University College London*

During her Master's year, Roumyana worked on a research project focussed on CAR-T cell therapy, one of the main advanced therapies for leukaemia based on genetically modified patient immune cells. The main limitation of CAR-T therapy is its high manufacturing cost of over £300,000 per patient, which is why her project explored different methods for cell activation. Activation is one of the steps of the production process that is a major cost driver, hence, she compared the use of four different activation methods and how each of them affects the quality of patient cells. Additionally, she explored the performance in three different donors, showing the significant difference that donor material makes for therapy production. She then produced a final report discussing the data she had generated and compared the four activation methods based on cost-efficiency. Roumyana's project highlighted the potential of some of the reagents to improve process efficiency and reduce production cost. It also brought to light the need for further research in the matter of cell activation as well as further innovation in the advanced therapy field.

Following her graduation, Roumyana is currently a cell and gene therapy scientist at GlaxoSmithKline as part of their Future Leaders Programme, a graduate programme consisting of three rotations within the Cell and Gene Therapy team in Stevenage. There she works on developing novel cell therapies in the oncology field and eventually bringing them to the commercial market, the main focus being improving patient quality of life.

**Max Medhurst**

*Course:* Innovation Design Engineering

*Royal College of Art / Imperial College London*

The IDE course gave Max the skills and experience to apply his existing mechanical engineering knowledge to the field of design and innovation, working on a range of projects from novel injection-mould making techniques for recycled plastics to bio-photovoltaic algae cultures that could one day provide electricity for settlements on Mars. These diverse projects enabled Max to explore his design practices, teaching him to combine technical knowledge with creative thinking, alongside learning to thrive in multi-disciplinary design teams.

After graduating from the course, Max started working as a freelance prototyping consultant, helping clients turn provisional ideas into working prototypes, minimum viable products, and proof-of-concept models. His clients have already included a cutting-edge sports technology start-up and Brompton Bicycles, the world-leading folding bicycle company. Through the skills he developed during the Studentship, he has been able to develop both the technical and user sides of these early concepts, experimenting through rapid prototyping to bring seemingly impossible ideas to life.

### Hugo Richardson

Course: Innovation Design Engineering

Royal College of Art / Imperial College London

Throughout his Master's degree, Hugo's roots in engineering and passion for design led him to take an interdisciplinary approach to the complex and nuanced challenges we face.

Today, over a million tons of tyre wear particles are produced annually across Europe. It is the second largest microplastic pollutant in our oceans, toxic to marine life, and a major contributor to airborne PM2.5. Hugo's final year group project, *The Tyre Collective*, developed the first retrofittable device to capture tyre wear at source, to prevent these harmful particles from entering our environment.

Thanks to the support of the Royal Commission, *The Tyre Collective* has gone from university project to fully fledged start up. They had the honour of winning the UK National James Dyson Award, Mayor's Entrepreneur Environment Award as well as Forbes 30U30 Honourees. This success, alongside a recent exhibition at the Design Museum, has helped to increase public awareness of tyre wear and prompt important conversations around the topic with policy makers and industry leaders.

Last September, Hugo and his team completed their first on-vehicle test alongside CEVT and Volvo. Over a period of 7 weeks, 3000km driven, the device successfully captured tyre wear and validated their core technology.

Without tackling tyre wear, transport will never be net-zero. Hugo and his colleagues are now exploring ways of reusing this captured material to create a closed loop system. Hugo wishes to thank the Commission for their ongoing support, without which this entire journey would not have been possible. Together, let's save our air from tyre wear!

### Joy Zhang

Course: Innovation Design Engineering

Royal College of Art / Imperial College London

As a student self-financing her master's education, Joy had considerable difficulty juggling the cost of living while also fielding the cost of course materials. This meant she took on part time jobs as she studied at the Royal College of Art and Imperial College London. When she received the Industrial Design Studentship in her second year, the newfound financial security gave her the opportunity to more freely invest in her final thesis project. Without the support of the Industrial Design Studentship, she feels she might not have had the courage to pursue a thesis topic in Web 3.0, which is a field far removed from her undergraduate mechanical engineering degree. Since then, her final thesis project has featured in the 2021 Global Graduate Show, has gathered advisors and collaborators, and is on its journey to becoming a funded start-up. Joy says: "I can't express how grateful I am to be pursuing work I love and believe in".

## Enterprise Fellows

### Alex Murdock

*Company:* Thermulon

*Technology:* Affordable nanoporous building insulation that is energy-efficient, fireproof and sustainable

Thermulon's nanoporous building insulation materials are engineered to tackle climate change and designed to make buildings energy efficient without compromising safety.

Aerogels are the most insulating materials in existence, but current production costs have made thermally efficient and fire safety-compliant products cost prohibitive for the construction sector.

Thermulon has developed an innovative production process utilising new continuous chemical pathways to produce an affordable aerogel without compromising on fire-safety or thermal performance.

The company is now aiming to scale up production to capitalise on its innovation as the global thermal insulation market is set to boom. The growth is being driven by net-zero targets mandating better home insulation to reduce CO2 emissions and safety factors including the need to replace cladding on many residential buildings across the UK following the Grenfell fire tragedy in 2017.

The company will initially target the UK retrofit market of solid-wall properties, which account for 25% of property building stock which equates to an estimated eight million dwellings. The UK high-rise building market, where combustible materials are banned, will become another key market focus and, longer term, Thermulon aims to extend its offering to the global thermal insulation market.

To date, Thermulon has attracted 878 investors. It has received a £750,000 grant from Innovate UK and recently raised £650,000 on CrowdCube.

### Matt Escott

*Company:* Protolaunch

*Technology:* Rocket engines that use a novel thermodynamic cycle to enable truly dedicated launch of Small Satellites

Protolaunch is a chemical propulsion company changing the way rocket engines are designed to enable future small launch vehicles.

Satellites are getting smaller while the rockets that launch them have not. A new generation of microlauncher vehicle is on the horizon targeting <1000kg payloads. Smaller rockets need smaller engines. Reducing the size of engines intended for much larger vehicles results in spiralling complexity and cost. Protolaunch is taking a different approach.

Protolaunch has taken a bottom-up design philosophy to propulsion development, designing specifically for small payloads from the outset. Their technology leverages a new thermodynamic cycle and system-level optimisations. This eliminates the need for complex pumps and turbomachinery, reducing manufacturing complexity and producing vehicle weight savings.

Positioned as an engine supplier, Protolaunch works with launch partners to bespoke standard propulsion units for particular customer use cases.

Protolaunch was recently awarded the Enabling Innovation award at Advanced Engineering.

**Bella-Trang Ngo**

*Company:* Brarista

*Technology:* AI-driven virtual bra fitting service

Brarista is working to democratise professional bra fitting. Their vision: a world where you can get fitted professionally from home using your phone's camera. Brarista brings together a team of professional bra fitters and computer vision scientists to solve one of the biggest problems of female well-being.

Brarista promotes convenience, accuracy and inclusivity, eliminating discomfort, saving time and reducing waste.

Brarista was recently awarded a development grant by Future Fashion Factory, an initiative funded by UKRI.

**Varun Sarwal**

*Company:* Hammer Missions

*Technology:* Versatile mission planning and data analysis for commercial drones

Hammer Missions helps clients collect and analyze quality drone data for asset mapping and inspection.

Their app allows clients to create automated flight plans, upload, annotate and share captured data with all stakeholders, all in 3D, and automatically upload and digitally maintain flight logs to ensure operations are efficient and compliant.

Hammer recently deployed with a reforestation business using drones to plant trees.

**Joseph Sherwood**

*Company:* FLIT

*Technology:* Lightweight folding e-bikes for urban commuters

Folding e-bikes open up the market to new customers as they can be easily stored or used with public transport. By developing a folding e-bike from scratch, and integrating the electrical system into the frame, FLIT's first product, the FLIT-16, is 30% lighter and smaller than a typical folding e-bike. FLIT-16s are available for purchase on-line.

FLIT is working on new models and hopes to trial a leasing scheme. In 2022 it hopes to expand into international markets in Europe and North America.

Joseph parted company with FLIT in 2021 and is now a Research and Development Engineer at Robert Bion & Co Ltd, an independent, UK-based metal and plastic perforating company.



## Alumni Awards, Honours and Achievements

A selection of the alumni appointments, publications, honours and awards notified to the Commission. The Commission encourages all alumni to keep their alumni profiles up to date so that their successes can be celebrated.

### Overseas Scholars

Professor Dawn Bazely (1984-1987)

- Awarded Minister's Teaching Excellence Award, Ontario Ministry of Colleges and Universities (for Future Proofing Students during the pandemic)

Professor John Boothroyd (1976-1979)

- Elected to the Governing Council of the U.S. National Academy of Sciences
- Winner, Alice and C.C. Wang Award in Molecular Parasitology, American Society of Biochemistry and Molecular Biology

Professor Crispin Gardiner (1965-1968)

- Published *Elements of Stochastic Methods*

Professor Shahina Ghazanfar (1977-1981)

- Became the first Pakistani and the first woman in Asia to be awarded the Linnean Medal in the field of Botany since the award was instituted in 1888

### Research Fellows

Dr Jo Ashbourn (2002-2004)

- Organised discussion panels on *Space Travel Across the Decades and Beyond* and *Searching for Extra-terrestrial Intelligence Across a Century*, and lectures by Professor Carlo Rovelli on *Scientific Thinking Across the Centuries and the Foundations of Physics* and by NASA's Chief Scientist on *The Martian – Science Fiction and Science Fact* at the St Cross Centre for the History and Philosophy of Physics

Dr Chris Bowman-Scargill (2013-2016)

- Awarded EPSRC Early Career Research Fellowship (£1.1m to work on *Tensor and wreath products of symmetric groups*)

Professor Byron Byrne (1999-2001)

- Elected Fellow of the Royal Academy of Engineering for developing new design methods for the foundations of offshore wind turbines, leading to the substantial cost savings that are now enabling the expansion of this green energy technology

Professor Amin Doostmohammadi (2017-2019)

- Awarded ERC Starting Grant (€1.5m to work on *Physics of collective cell decision-making*)
- Awarded New Exploratory Research & Discovery (NERD) Grant from Novo Nordisk Foundation (€1.5m to work on *Topography-mediated cellular sensing & communication*)
- Awarded Young Scientist Prize and Medal in Biophysics, The International Union of Pure and Applied Physics
- Awarded Lars Kann-Rasmussen Prize, Denmark

Dr Andrew Humphris (2002-2004)

- Appointed Honorary Professor, School of Physics, University of Bristol

Professor Apala Majumdar (2006-2008)

- Appointed Visiting Professor, Indian Institute of Technology, Bombay
- Appointed invited foreign expert, Institute of Responsive Soft Matter, Indian Institute of Technology, Madras
- Elected to the Executive Committee of the International Society for the Interaction of Mechanics and Mathematics
- Appointed to the Editorial Board of *Partial Differential Equations and their Applications*

Dr Alan W. McConnachie (2006-2008)

- Elected to the College of New Scholars, Artists and Scientists of the Royal Society of Canada

Dr Muhammad Nangrejo (2001-2003)

- Awarded Chartered Engineer status

Professor Edward Tate (1999-2001)

- Awarded CRUK Programme Grant (£1.9m to work on discovering and validating new drug targets in cancer)

Professor André Xuereb (2011-2013)

- Appointed Ambassador for Digital Affairs, Malta

## Industrial Fellows

Dr Andrew Anderson (2017-2020)

- Appointed Lead Research and Development Engineer at Plasma App Ltd

Professor Michael Clinch (1996-1999)

- Elected Vice-President, Institute of Materials, Minerals and Mining
- Appointed Visiting Professor, Materials Innovation and Sustainability, Loughborough University
- Awarded Chartered Engineer status

Dr Silvia Araguas Rodriguez (2014-2017)

- Appointed Technical Director, Sensor Coating Systems

Dr Ruth Sanderson (2009-2012)

- Founder of Full Matrix Ltd, which in 2021 was awarded a contract with UKAEA to study the feasibility of guided wave inspection for supply pipes in fusion reactors

## Industrial Design Students

Arthur Carabott (2015-2017)

- Winner, Core77 Design Education Initiative Award for *Intentional Interactions*, a module taught to students on the Global Innovation Design course at the Royal College of Art / Imperial College London

James Fraser (2017-2019) and James Wright (2012-2013)

- Launched *Sustainable Ventures Design*, a design studio offering services in new product development, design engineering and graphic design, exclusively for impact-led founders and organisations
- Successfully completed Project NEMO with the Royal College of Art, working on a custom marine observation camera fitted to Extreme E's vessel *St Helena* to monitor the surface of the world's oceans, providing data for scientists investigating environmental sustainability, plastic pollution, loss of marine habitats and new ocean economies

Yusuf Muhammad (2006-2008)

- Plumis won Active / Passive Fire Project of the Year, Security and Fire Excellence Awards
- Featured in Lord Winston's book *Inventors*

## Enterprise Fellows

Guillem Buxarrais (2017)

- Neurofenix was one of only 50 companies worldwide selected to participate in MedTech Innovator's Showcase and Accelerator Programme

Henrik Hagemann (2016)

- Puraffinity awarded a grant of £174,000 to successfully optimise a suite of adsorbent materials to treat broad spectrum Per and polyfluoroalkyl substances that can be adapted to a range of point of use systems

Ming Kong (2016)

- TGO secured a deal with French automotive supplier Novares for its smart 3D sensing material

Surakat Kudehinbu (2019)

- RAB-Microfluidics secured £1.2m investment
- Appointed Investment Executive, Green Angel Syndicate
- Appointed to Enterprise Fellowships Selection Panel

Ben Lakey (2019)

- Syndi Health launched integrated digital mental health platform with UNiDAYS, the world's largest student discount platform

Yang Lu (2016)

- Vivacity Labs secured a contract from the City of Port Philip, Australia, to install sensors to measure bike, pedestrian and motor vehicle movements, and to help the local council reduce congestion and increase sustainable transport

Rowan Minkley (2019)

- Secured £1m investment, allowing Chip[s]Board to relocate to Yorkshire and establish a pilot plant
- Secured contracts with Cubitts eyewear and bespoke button manufacture

Dr Atif Syed (2018)

- Secured £300m deal for WootZano with one of the country's leading pack-house conglomerates
- WootZano delivered first tomato packing robot
- WootZano received Made in the North East Award: Digital Engineering / Technology

George Wright (2017)

- Vochlea named one of TechRound's top 28 UK Music and Audio Tech companies

## Rome Scholars

Anne Desmet (1989)

- Designed the £5 coin launched by the Royal Mint in March 2021 to mark the 150th Anniversary of the Royal Albert Hall
- Curated and wrote the exhibition catalogue for the touring exhibition *Scene through Wood: A Century of Modern Wood Engraving* celebrating the centenary of the Society of Wood Engravers

Professor Mark Jones (1982)

- Elected Chair, Traditional Architecture Group
- Appointed Output Assessor for UK REF 2021

## Report by the Chairman of the Finance Committee

### *Executive summary*

The Board of Management has appointed the Finance Committee as a sub-committee to supervise the Commission's finances and investments; this Committee meets at least twice a year. Sir William Castell stepped down as a Commissioner and the Chairman of the Finance Committee in July. Over his tenure he reshaped the finances of the Commission and built an exceptional group of Committee members. He leaves the Commission's finances in excellent condition. I would like to thank all members of the Committee for their support as I transitioned into the role of Chair and for their ongoing valuable contribution in overseeing the Commission's finances.

During 2021 there were two formal meetings of the Committee. In the spring meeting we reviewed the annual accounts and met with the Commission's auditors. We also heard presentations from the investments managers. In the autumn meeting the Committee focused on reviewing the long-term investment objective and investment strategy for the Commission, recognising that the return of inflation and a less accommodative monetary environment would be challenging for markets. In view of the derecognition of RPI as a national statistic, the Committee recommended to the Commissioners that the investment objective be revised from 4% after RPI to 4% after CPI. Historically, CPI has tended to be somewhat lower than RPI, which should mean that this change has the advantage of making the investment objective more realistic in the new environment. During the year the Commissioners also appointed and onboarded a new property advisor, Daniel Watney LLP.

### *Highlights for the calendar year to 31 December 2021*

The Commission's income and gains derive primarily from its investment portfolio. For the 12-month period the investment portfolio generated combined income and gains of £17,086,913 (2020: £15,593,069). The total funds as of 31 December 2021 were £150,029,559 (2020: £138,125,545).

Expenditure on core Fellowships and Studentships increased from £3,245,516 to £3,839,642. Total expenditure on charitable activities of £4,538,642 was £640,019 less than the previous year. This primarily reflects an exceptional Special Award in 2020 of £1.2m for public realm improvements at the northern end of the Commission's estate.

Expenditure on raising funds – which primarily comprises investment and property management fees – decreased from £740,364 in 2020 to £643,883 in 2021.

### *Investment Policy*

Over the long term, the Commission aims to disburse 4% per annum of the trailing three-year average value of the portfolio. However, the Commission has few if any fixed liabilities and annual budgets include an allowance for Special Awards that can be adjusted without detriment to other programmes so this can vary from year to year depending on grant making opportunities and investment returns.

The investment objective is to generate a return of at least inflation plus 4% per annum over the long term, after expenses. This should allow the Commission to at least maintain and ideally grow the real value of the assets, whilst generating a stable and sustainable return to fund annual expenditure as set out above. The Finance Committee has determined that the inflation measure most relevant to the Commission's expenditure is the Consumer Price Index.

The Finance Committee is charged with agreeing a high-level asset allocation strategy with the investment managers, which is set so as to achieve the overall Commission investment objective. The Finance Committee will revisit the strategic asset allocation, and consider the need for tactical deviations from it, on at least an annual basis. The Finance Committee is responsible for identifying and monitoring investment managers and investment vehicles for the Commission.

The Commission's portfolio is invested by three investment managers: Schroder & Co. Ltd; Charles Stanley & Co. Ltd and JP Morgan Asset Management (UK) Ltd. The Commission also has direct property holdings on its legacy estate in South Kensington. The asset allocation of the combined portfolio as at 31 December was 75.4% in global equities, 3.1% in listed alternative assets, 8.8% in cash and bonds and 12.7% in the legacy estate (at the end of 2020 the proportions were 69.0%, 2.9%, 11.9% and 16.2% respectively).

Schroder & Co. Ltd and Charles Stanley invest globally, predominately in equities and returned 11.8% and 11.7% respectively (2020: 12.8% and 12.7% respectively). JP Morgan Asset Management (UK) Ltd manage a short duration bond account and returned 0.8% (2020: 6.2%). The directly held property returned 7.6% (2020: 11.6%) enjoying (predominantly unrealised revaluation) gains of £1,213,607 (2020: £1,975,082), the majority of the gains reflecting decreasing lease terms and the increasing impact of reversionary values. Income from property over the 12 months was £594,269 (2020: £1,300,782 including back rent of £665,000).

As at the balance sheet date, the Commission's main segregated equity portfolio had scope 1 and 2 carbon emissions that were 82% less than the MSCI World index (2020: 81% less than the MSCI World index). The carbon intensity of the Commission's combined equity portfolio (direct and indirect holdings), measured in tonnes of CO<sub>2</sub> emissions per million dollars of sales was a little over half that of the MSCI World index, broadly in line with the position the previous year.

#### *Long term performance vs investment objective*

The value of the investment portfolio – and the grant making it funds – has grown significantly in real terms over the last 10 years. The annualised real return achieved has been 8.0% for 10 years, 6.5% for 5 years and 9.3% for 3 years.

The Commission recognises this has been against a backdrop of high equity returns and central bank easing. As we move into a period of higher inflation and tightening monetary policy, the Commission recognises the “excess” real return enjoyed over the last decade is likely to reduce and so remains flexible in its disbursement policy.

#### *Reserves Policy*

The Commission's funds originated from the surplus arising from the Great Exhibition of 1851 and have been enhanced by careful stewardship of the assets invested over many years. They are technically unrestricted, giving the Commissioners the ability to spend the funds as they wish in fulfilment of the charitable objectives of the Commission. None of the funds are in assets that cannot readily be realised.

In order to balance the needs of current and potential future beneficiaries of the charity, the Commissioners recognise the need to maintain a strong capital base so as to deliver an appropriate level of return to enable the Commission to continue to fulfil its charitable objectives on a long-term basis. Accordingly, all of the Commission's funds are invested in line with the investment policy described above and normal expenditure commitments are set to match the assumed average return above inflation delivered by the portfolio.

Given the Commission's flexibility to spend capital if required, the Commissioners do not consider that there is any merit in identifying an optimum level of free reserves that might be readily available if required but will respond appropriately to spending needs identified as and when circumstances arise.

#### *The Commission's Auditor*

In 2008, Moore Kingston Smith LLP was appointed the Commission's auditor following a competitive tender. The audit partner meets with the Finance Committee at least once each year. In the interests of good governance, the audit manager changes at least every five years and the audit partner at least every ten years.

The Commission adopts a total return approach to investment, generating the investment return from income and capital gains or losses. Recognising the likely volatility of the capital, the Commission will typically aim to generate an overall income return of between 2% and 3% per annum to reduce the risk that losses will need to be crystallised to fund commitments.

The Commission recognizes that long term investment is subject to market, political, economic, counterparty and other risks, with financial instability in particular being a key risk. The Commission also recognizes inflation as a significant risk to the long-term sustainability of its activities and one that the investment policy should mitigate against.

The trustees are able to tolerate volatility of the capital value, as long as the Commission is able to meet its short-term grant making commitments through either income or liquid capital assets. To allow for volatility of capital values, the trustees wish to maintain at least £5m in cash or lower risk fixed income investments. Bearing in mind income generated by the portfolio and the flexibility to curtail Special Awards, this should allow three years' worth of Fellowships to be funded without needing to sell risk assets.

### *Ethical Investment Policy*

The Commission recognises that its investments have wider impacts and seeks to align its investment strategy with its aims, reflecting the views of its stakeholders and taking into account broader public benefit. The Commission expects its investment managers to integrate Environmental, Social and Governance (ESG) considerations into the normal investment process and to fulfil the requirements of the UK Stewardship Code, actively engaging with the companies in which they invest to promote best practice corporate behaviour and sustainable business practices. Given its limited staff resources, it is not practical for the Commission to engage directly with individual companies, but it does expect its investment managers to report annually on their engagement activities and results.

The Commission expects its investment managers to apply ESG considerations to both segregated holdings and pooled holdings, taking account of the extent to which suitable alternative investment vehicles are available and bearing in mind de minimis considerations. The Commission will only appoint managers who are signatories to the UN Principles of Responsible Investment (UN PRI) and will take into account the ranking assigned to those managers by the UN PRI.

The Commission may exclude certain stocks or sectors where these are seen to be in direct conflict with its objects and activities. Equally, where consistent with the financial objectives, the Commission seeks to invest in areas with positive environmental and / or social impact, such as clean energy and various areas of new technology.

The Commission recognises that climate change is a key challenge for the next decade and that limiting global temperature rises will require significant change in business, investment, technology development and fossil fuel use. The Commission monitors the carbon emissions of its main equity investment portfolio and through its investment managers seeks to reduce these emissions over time.

### *Investment Performance 2021*

2021 was another challenging year for investors. Key themes over the year included the emergence of the Omicron variant, ongoing supply chain disruptions, high inflation readouts and expectations for tightening monetary policy in the US and Europe. Despite this equity markets had a strong 2021 in aggregate, with the MSCI ACWI Index returning 19.6% across the year. Beneath this, however, there was a high degree of dispersion in returns across sectors and regions, with a significant amount of global equity performance driven by a small number of US technology stocks. Credit markets were weak in aggregate in 2021, particularly long duration bonds, in part linked to higher inflation and expectations of interest rate rises in a number of regions. The Bloomberg Barclays Global Aggregate Index was down -1.7% for the calendar year. Against this backdrop the Commission achieved a total return net of fees of approximately 10.2% (2020: 11.0%). CPI + 4% was 9.4% (2020: 4.6%).

## Statement of Commissioners' Responsibilities

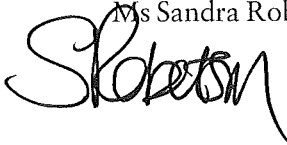
The Commissioners are responsible for preparing the Trustees' Report and the financial statements in accordance with applicable law and United Kingdom Accounting Standards (United Kingdom Generally Accepted Accounting Practice.)

The law applicable to charities in England and Wales requires the Commissioners to prepare financial statements for each financial year which give a true and fair view of the state of the affairs of the Commission and of the incoming resources and application of resources of the Commission for that period. In preparing these financial statements, the Commissioners are required to:

- select suitable accounting policies and then apply them consistently;
- observe the methods and principles in the Charities SORP;
- make judgements and estimates that are reasonable and prudent;
- state whether applicable accounting standards have been followed, subject to any material departures disclosed and explained in the financial statements;
- prepare the financial statements on the going concern basis unless it is inappropriate to presume that the Commission will continue in business.

The Commissioners are responsible for keeping proper accounting records that disclose with reasonable accuracy at any time the financial position of the Commission and enable them to ensure that the financial statements comply with the Charities Act 2011, the Charity (Accounts and Reports) Regulations 2008 and the provisions of the Royal Charter. They are also responsible for safeguarding the assets of the Commission and hence for taking reasonable steps for the prevention and detection of fraud and other irregularities.

The Annual Report on pages 1 to 45 and 50 to 77 was approved by the Commissioners on 6 July 2022.

Ms Sandra Robertson  


# Independent Auditor's Report to the Commissioners of Royal Commission for the Exhibition of 1851

## *Opinion*

We have audited the financial statements of the Royal Commission for the Exhibition of 1851 for the year ended 31 December 2021 which comprise the Statement of Financial Activities, the Summary Income and Expenditure Account, the Balance Sheet, the Cash Flow Statement and notes to the financial statements, including a summary of significant accounting policies. The financial reporting framework that has been applied in their preparation is applicable law and United Kingdom Accounting Standards, including FRS 102 'The Financial Reporting Standard Applicable in the UK and Republic of Ireland' (United Kingdom Generally Accepted Accounting Practice).

In our opinion the financial statements:

- give a true and fair view of the state of the charity's affairs as at 31 December 2021, and of its incoming resources and application of resources, for the year then ended;
- have been properly prepared in accordance with United Kingdom Generally Accepted Accounting Practice; and
- have been prepared in accordance with the requirements of the Charities Act 2011.

## *Basis for opinion*

We conducted our audit in accordance with International Standards on Auditing (UK) (ISAs (UK)) and applicable law. Our responsibilities under those standards are further described in the *Auditor's responsibilities for the audit of the financial statements* section of our report. We are independent of the charity in accordance with the ethical requirements that are relevant to our audit of the financial statements in the UK, including the FRC's Ethical Standard, and we have fulfilled our other ethical responsibilities in accordance with these requirements. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion.

## *Conclusions relating to going concern*

In auditing the financial statements, we have concluded that the Commissioners' use of the going concern basis of accounting in the preparation of the financial statements is appropriate.

Based on the work we have performed, we have not identified any material uncertainties relating to events or conditions that, individually or collectively, may cast significant doubt on the charity's ability to continue as a going concern for a period of at least twelve months from when the financial statements are authorised for issue.

Our responsibilities and the responsibilities of the Commissioners with respect to going concern are described in the relevant sections of this report.

## *Other information*

The other information comprises the information included in the annual report, other than the financial statements and our auditor's report thereon. The Commissioners are responsible for the other information. Our opinion on the financial statements does not cover the other information and, except to the extent otherwise explicitly stated in our report, we do not express any form of assurance conclusion thereon.



## Independent Auditor's Report to the Commissioners of Royal Commission for the Exhibition of 1851 (continued)

In connection with our audit of the financial statements, our responsibility is to read the other information and, in doing so, consider whether the other information is materially inconsistent with the financial statements or our knowledge obtained in the audit or otherwise appears to be materially misstated. If we identify such material inconsistencies or apparent material misstatements, we are required to determine whether there is a material misstatement in the financial statements or a material misstatement of the other information. If, based on the work we have performed, we conclude that there is a material misstatement of this other information, we are required to report that fact.

We have nothing to report in this regard.

### *Matters on which we are required to report by exception*

We have nothing to report in respect of the following matters where the Charities Act 2011 requires us to report to you if, in our opinion:

- the information given in the Commissioners' Annual Report is inconsistent in any material respect with the financial statements; or
- the charity has not kept adequate accounting records; or
- the financial statements are not in agreement with the accounting records and returns; or
- we have not received all the information and explanations we required for our audit.

### *Responsibilities of Commissioners*

As explained more fully in the Commissioners' responsibilities statement set out on page 45, the Commissioners are responsible for the preparation of the financial statements and for being satisfied that they give a true and fair view, and for such internal control as the Commissioners determine is necessary to enable the preparation of financial statements that are free from material misstatement, whether due to fraud or error.

In preparing the financial statements, the Commissioners are responsible for assessing the charity's ability to continue as a going concern, disclosing, as applicable, matters related to going concern and using the going concern basis of accounting unless the Commissioners either intend to liquidate the charity or to cease operations, or have no realistic alternative but to do so.

### *Auditor's responsibilities for the audit of the financial statements*

We have been appointed as auditor under section 144 of the Charities Act 2011 and report in accordance with regulations made under section 154 of that Act.

Our objectives are to obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is a high level of assurance but is not a guarantee that an audit conducted in accordance with ISAs (UK) will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements.

Irregularities, including fraud, are instances of non-compliance with laws and regulations. We design procedures in line with our responsibilities, outlined above, to detect material misstatements in respect of irregularities, including fraud. The extent to which our procedures are capable of detecting irregularities, including fraud is detailed below.

## Independent Auditor's Report to the Commissioners of Royal Commission for the Exhibition of 1851 (continued)

### *Explanation as to what extent the audit was considered capable of detecting irregularities, including fraud*

The objectives of our audit in respect of fraud, are: to identify and assess the risks of material misstatement of the financial statements due to fraud; to obtain sufficient appropriate audit evidence regarding the assessed risks of material misstatement due to fraud, through designing and implementing appropriate responses to those assessed risks; and to respond appropriately to instances of fraud or suspected fraud identified during the audit. However, the primary responsibility for the prevention and detection of fraud rests with both management and those charged with governance of the charity.

Our approach was as follows:

- We obtained an understanding of the legal and regulatory requirements applicable to the charity and considered that the most significant are the Charities Act 2011, the Charity SORP, and UK financial reporting standards as issued by the Financial Reporting Council.
- We obtained an understanding of how the charity complies with these requirements by discussions with management.
- We assessed the risk of material misstatement of the financial statements, including the risk of material misstatement due to fraud and how it might occur, by holding discussions with management.
- We inquired of management and those charged with governance as to any known instances of non-compliance or suspected non-compliance with laws and regulations.
- Based on this understanding, we designed specific appropriate audit procedures to identify instances of non-compliance with laws and regulations. This included making enquiries of management and obtaining additional corroborative evidence as required.

As part of an audit in accordance with ISAs (UK) we exercise professional judgement and maintain professional scepticism throughout the audit. We also:

- Identify and assess the risks of material misstatement of the financial statements, whether due to fraud or error; design and perform audit procedures responsive to those risks, and obtain audit evidence that is sufficient and appropriate to provide a basis for our opinion. The risk of not detecting a material misstatement resulting from fraud is higher than for one resulting from error, as fraud may involve collusion, forgery, intentional omissions, misrepresentations, or the override of internal control.
- Obtain an understanding of internal control relevant to the audit in order to design audit procedures that are appropriate in the circumstances, but not for the purposes of expressing an opinion on the effectiveness of the charity's internal control.
- Evaluate the appropriateness of accounting policies used and the reasonableness of accounting estimates and related disclosures made by the Commissioners.
- Conclude on the appropriateness of the Commissioners' use of the going concern basis of accounting and, based on the audit evidence obtained, whether a material uncertainty exists related to events or conditions that may cast significant doubt on the charity's ability to continue as a going concern. If we conclude that a material uncertainty exists, we are required to draw attention in our auditor's report to the related disclosures in the financial statements or, if such disclosures are inadequate, to modify our opinion. Our conclusions are based on the audit evidence obtained up to the date of our auditor's report. However, future events or conditions may cause the charity to cease to continue as a going concern.
- Evaluate the overall presentation, structure and content of the financial statements, including the disclosures, and whether the financial statements represent the underlying transactions and events in a manner that achieves fair presentation.

## Independent Auditor's Report to the Commissioners of Royal Commission for the Exhibition of 1851 (continued)

We communicate with those charged with governance regarding, among other matters, the planned scope and timing of the audit and significant audit findings, including any significant deficiencies in internal control that we identify during our audit.

### *Use of our report*

This report is made solely to the charity's Commissioners, as a body, in accordance with Chapter 3 of Part 8 of the Charities Act 2011. Our audit work has been undertaken so that we might state to the charity's Commissioners those matters we are required to state to them in an auditor's report and for no other purpose. To the fullest extent permitted by law, we do not accept or assume responsibility to any party other than the charity and charity's Commissioners as a body, for our audit work, for this report, or for the opinion we have formed.

*Moore Kingston Smith LLP*

Statutory Auditor

2 Appold Street  
London  
EC2A 2AP

Moore Kingston Smith LLP is eligible to act as auditor in terms of Section 1212 of the Companies Act 2006.

*7/7/2022*

# Royal Commission for the Exhibition of 1851

## Statement of Financial Activities for the Year Ended 31 December 2021

|                                                                   | Notes | Unrestricted<br>Funds<br>2021<br>£ | Unrestricted<br>Funds<br>2020<br>£ |
|-------------------------------------------------------------------|-------|------------------------------------|------------------------------------|
| <b>Income from:</b>                                               |       |                                    |                                    |
| Donations                                                         | 4     | 3,000                              | 71,107                             |
| Investments                                                       | 5     | 2,256,608                          | 2,715,229                          |
| Other                                                             | 6     | 58                                 | 925                                |
| <b>Total income</b>                                               |       | <u>2,259,666</u>                   | <u>2,787,261</u>                   |
| <b>Expenditure on:</b>                                            |       |                                    |                                    |
| Raising funds                                                     | 7     | 643,883                            | 740,364                            |
| Charitable activities                                             | 8     | 4,538,642                          | 5,178,661                          |
| <b>Total expenditure</b>                                          |       | <u>5,182,525</u>                   | <u>5,919,025</u>                   |
| <b>Net expenditure before gains and losses<br/>on investments</b> |       | (2,922,859)                        | (3,131,764)                        |
| <b>Net gains on investments</b>                                   |       |                                    |                                    |
| Gains on property                                                 |       | 1,213,607                          | 1,975,082                          |
| Gains on investments                                              |       | 13,616,698                         | 10,902,758                         |
| <b>Total of net gains on investments</b>                          |       | <u>14,830,305</u>                  | <u>12,877,840</u>                  |
| <b>Net income</b>                                                 |       | <u>11,907,446</u>                  | <u>9,746,076</u>                   |
| <b>Other recognised gains and losses</b>                          |       |                                    |                                    |
| Actuarial losses on defined<br>benefit pension scheme             | 14    | (3,432)                            | (23,626)                           |
| <b>Net movement in funds</b>                                      |       | <u>11,904,014</u>                  | <u>9,722,450</u>                   |
| <b>Reconciliation of funds</b>                                    |       |                                    |                                    |
| Total funds brought forward                                       |       | 138,125,545                        | 128,403,095                        |
| Net movement in funds                                             |       | 11,904,014                         | 9,722,450                          |
| <b>Total funds carried forward</b>                                |       | <u>150,029,559</u>                 | <u>138,125,545</u>                 |

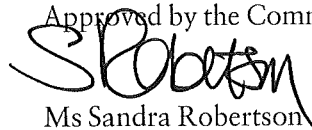
The notes on pages 53 to 71 form part of these accounts. Notes 1-2 provide details of the Commission's objectives and accounting policies.

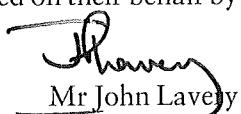
# Royal Commission for the Exhibition of 1851

## Balance Sheet as at 31 December 2021

|                                                         | Notes | Total<br>Funds<br>2021<br>£ | Total<br>Funds<br>2020<br>£ |
|---------------------------------------------------------|-------|-----------------------------|-----------------------------|
| <b>Fixed asset investments</b>                          |       |                             |                             |
| Investment properties                                   | 15    | 20,940,350                  | 23,345,382                  |
| Listed investments                                      | 16    | 133,023,295                 | 119,307,960                 |
| Cash held as part of the investment portfolio           |       | 1,501,182                   | 1,017,499                   |
|                                                         |       | <u>155,464,827</u>          | <u>143,670,841</u>          |
| <b>Current assets</b>                                   |       |                             |                             |
| Debtors                                                 | 17    | 404,829                     | 1,140,855                   |
| Cash at bank and in hand                                |       | 1,577,788                   | 1,103,335                   |
|                                                         |       | <u>1,982,617</u>            | <u>2,244,190</u>            |
| <b>Liabilities</b>                                      |       |                             |                             |
| Creditors: Amounts falling due within one year          | 18    | (4,070,791)                 | (4,580,884)                 |
| <b>Net current liabilities</b>                          |       | <u>(2,088,174)</u>          | <u>(2,336,694)</u>          |
| <b>Total assets less current liabilities</b>            |       | 153,376,653                 | 141,334,147                 |
| Creditors: Amounts falling due after more than one year | 18    | (2,948,094)                 | (2,783,602)                 |
| <b>Net assets excluding pension liability</b>           |       | <u>150,428,559</u>          | <u>138,550,545</u>          |
| Defined benefit pension scheme liability                | 14    | (399,000)                   | (425,000)                   |
| <b>Net assets</b>                                       |       | <u><u>150,029,559</u></u>   | <u><u>138,125,545</u></u>   |
| <b>The funds of the Charity:</b>                        |       |                             |                             |
| <b>Capital Funds</b>                                    |       |                             |                             |
| Balance as at 1 January                                 |       | 138,125,545                 | 128,403,095                 |
| Movement in year                                        |       | 11,904,014                  | 9,722,450                   |
| <b>Balance as at 31 December</b>                        |       | <u><u>150,029,559</u></u>   | <u><u>138,125,545</u></u>   |

Approved by the Commissioners on 6 July 2022 and signed on their behalf by:

  
Ms Sandra Robertson  
Chairman, Finance Committee

  
Mr John Lavery  
Secretary

The notes on pages 53 to 71 form part of these accounts.

# Royal Commission for the Exhibition of 1851

## Statement of Cash Flows for the Year Ended 31 December 2021

|                                                                    | Total<br>Funds<br>2021<br>£ | Total<br>Funds<br>2020<br>£ |
|--------------------------------------------------------------------|-----------------------------|-----------------------------|
| <b>Cash flows from operating activities</b>                        |                             |                             |
| Donations received (excluding donations in kind)                   | 3,000                       | 71,107                      |
| Grants and award paid                                              | (4,310,580)                 | (3,460,087)                 |
| Payments to suppliers                                              | (1,030,464)                 | (885,401)                   |
| Payments in respect of employees                                   | (324,198)                   | (312,540)                   |
| Other payments                                                     | (24,570)                    | (22,214)                    |
| <b>Cash used in operating activities</b>                           | <b>(5,686,812)</b>          | <b>(4,609,135)</b>          |
| <b>Cash flows from investing activities</b>                        |                             |                             |
| Dividends, interest and rent from investments                      | 3,063,600                   | 1,756,794                   |
| Proceeds from sale of investments                                  | 24,220,420                  | 60,431,106                  |
| Purchase of investments                                            | (20,639,072)                | (58,065,375)                |
| <b>Net cash provided by investing activities</b>                   | <b>6,644,948</b>            | <b>4,122,525</b>            |
| <b>Change in cash and cash equivalents in the reporting period</b> | <b>958,136</b>              | <b>(486,610)</b>            |
| Cash and cash equivalents brought forward                          | 2,120,834                   | 2,607,444                   |
| <b>Cash and cash equivalents carried forward</b>                   | <b>3,078,970</b>            | <b>2,120,834</b>            |
| <b>Disclosed as:</b>                                               |                             |                             |
| Cash held as part of the investment portfolio                      | 1,501,182                   | 1,017,499                   |
| Cash at bank and in hand                                           | 1,577,788                   | 1,103,335                   |
|                                                                    | <b>3,078,970</b>            | <b>2,120,834</b>            |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2021

### 1. STATUS AND OBJECTIVES

The Commission for the Exhibition of 1851 was set up by Royal Charter in 1850 to plan and promote the Exhibition of Works of Industry of all Nations, which was to be held in London in 1851. When the affairs of the Great Exhibition had eventually been wound up, the Commissioners were appointed, under a Supplemental Charter, as a permanent body to administer the surplus funds at their disposal. These were to be applied in order to “increase the means of industrial education and extend the influence of science and art upon productive industry”.

### 2. ACCOUNTING POLICIES

The accounts are prepared under the historic cost convention, modified by the revaluation from time to time of certain fixed assets, and in accordance with the Financial Reporting Standard applicable in the UK and Republic of Ireland (effective January 2015) (FRS102), Accounting and Reporting by Charities: Statement of Recommended Practice applicable to charities preparing their accounts in accordance with the Financial Reporting Standard applicable in the UK and Republic of Ireland (effective January 2019) (SORP) and the Charities Act 2011.

In the estimation of the trustees (the Commissioners), there are no material uncertainties that call into doubt the Commission’s ability to continue and the accounts have therefore been prepared on a going concern basis.

The Commission, like every other organisation, has been impacted by the pandemic; many events had to be cancelled and some programmes moved on-line. In terms of its core grant-making activity, however, the Commission has largely been able to continue as planned.

As soon as the possibility of a pandemic became clear, the Finance Committee acted to ensure that there were sufficient cash or near cash assets in place to fund at least three years’ expenditure in full. This gave confidence that the Commission would be able to ride out the immediate disruption and need not curtail any of its programmes. Investment markets have, to be sure, been much more volatile and the day-to-day value of the Commission’s portfolio has inevitably reflected that. The Commission is a long-term investor, however, and Commissioners remain confident in the underlying strength of the portfolio; they see no evidence at this stage of any permanent loss of value. Indeed, the value of the Commission’s portfolio has risen over the year.

Similarly, while some of the Commission’s tenants have asked for and received temporary support with deferred rent demands and the like, there is not considered to be any risk to the long-term value of the estate. That is not to say of course that some of our legacy institutions have not been severely impacted.

The Commission had robust business continuity plans in place and Commissioners, Committee members and staff have adapted relatively straightforwardly to the need for remote working. The 2020 and 2021 award rounds for all the Commission’s Fellowships and Studentships have gone ahead as planned with a full complement of awards made. A majority of existing award holders have been able to adapt their workflow patterns to fit the unusual circumstances imposed by lockdowns etc. Where this has not been possible, the Commission has granted extensions and provided the necessary financial support.

All in all, Commissioners are confident that whatever the short-term disruptions, the pandemic should not have any material, long-term impact on the Commission’s work.

The Commission meets the definition of a public benefit entity under FRS102.

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2021

### 2. ACCOUNTING POLICIES (continued)

The financial statements are presented in sterling which is the functional currency of the charity. Monetary amounts are rounded to the nearest pound.

#### (a) Investments

- (i) Are shown in the balance sheet at market value; any unrealised gain over original cost is shown in the statement of financial activities.
- (ii) Income on investments is included in the accounts when receivable.
- (iii) Cash held as part of the investment portfolio includes short-term deposits held temporarily with the company's bankers pending re-investment.

#### (b) Donations, legacies and similar income

Donations, legacies and similar income are included in the year in which they are receivable, that is, when the Commission becomes entitled to the income. Donations received for general purposes are included as unrestricted funds. Where the wishes of the donor are legally binding on Commissioners, donations are accounted for as Restricted Funds with their use limited to that defined by the donor.

#### (c) Fixed Assets and Depreciation

All purchases of capital items under £10,000 are written off in the year of purchase. Capital items over £10,000 are depreciated over their estimated useful economic lives. Currently no items are being depreciated.

#### (d) Investment Properties

All the Commission's properties are let to provide an income on a full repairing lease. All properties are inspected regularly by the Commission's Surveyors and revalued by them from time to time. The last full revaluation was undertaken at 31 December 2019 and was based on the existing use and occupation of the land, and the duration of leases at ground rents and rack rents. These valuations are reviewed and adjusted annually as described in note 15.

#### (e) Realised and Unrealised Gains on Investments

Gains and losses on investments and assets held for the Commission's use are treated in accordance with the Statement of Recommended Practice. They are recognised in the statement of financial activities for the year in which they occur.

#### (f) Cash and cash equivalents

Cash and cash equivalents include cash in hand, deposits held at call with banks, other short-term liquid investments with original maturities of three months or less, and bank overdrafts. Cash held on capital account pending investment by the charity's investment managers, together with cash for investment in transit between investment managers, is disclosed within fixed asset investments; all other cash and cash equivalents is disclosed within current asset investments.



# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2021

### 2. ACCOUNTING POLICIES (continued)

#### (g) Lease premiums and licences

Premiums received for lease extensions are treated as capital receipts and included within gains / (losses) on property transactions. Certain other premiums received which do not materially affect the underlying value of the Commission's investment are treated as income receipts.

#### (h) Charitable activities

The primary charitable activity is the making of grants and awards. Grants and awards payable are accounted for on an accruals basis. Multi-year grants are accounted for in full in the year that the grant is awarded. The Commission recognises future liabilities discounted to their present value where material.

The majority of grants and awards are made to individuals who have been granted Fellowships or Studentships by the Commission. A limited number of awards are made to Institutions in furtherance of their educational needs. Some support is also provided to the legacy institutions on the Commission's South Kensington estate and to organisations facilitating access to the Commission's archives. A full analysis is shown in note 9.

The Commission also undertakes some direct charitable activities, in particular networking and educational events organised for the Commission's Fellows, Students, Alumni and the general public. Further details are shown in note 10.

#### (i) Allocation of support costs

Support costs are allocated on the basis of board or staff time as appropriate.

#### (j) Financial instruments

The Commission has elected to apply the provisions of Section 11 *Basic Financial Instruments* and Section 12 *Other Financial Instruments Issues* of FRS 102 to all of its financial instruments.

Financial instruments are recognised in the Commission's balance sheet when the Commission becomes party to the contractual provisions of the instrument.

##### *Basic financial assets*

Basic financial assets, which include trade and other debtors and cash and bank balances, are initially measured at transaction price including transaction costs and are subsequently carried at amortised cost using the effective interest method unless the arrangement constitutes a financing transaction, where the transaction is measured at the present value of the future receipts discounted at a market rate of interest.

##### *Other financial assets*

Other financial assets, including investments in equity instruments which are not subsidiaries, associates or joint ventures, are initially measured at fair value, which is normally the transaction price. Such assets are subsequently carried at fair value and the changes in fair value are recognised in the statement of financial activities, except that investments in equity instruments that are not publicly traded and whose fair values cannot be measured reliably are measured at cost less impairment.

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2021

### 2. ACCOUNTING POLICIES (continued)

#### (j) Financial instruments (continued)

Trade debtors, loans and other debtors that have fixed or determinable payments that are not quoted in an active market are classified as 'loans and receivables'. Loans and receivables are measured at amortised cost using the effective interest method, less any impairment.

##### Basic financial liabilities

Basic financial liabilities, including trade and other creditors, are initially recognised at transaction price unless the arrangement constitutes a financing transaction, where the debt instrument is measured at the present value of the future payments discounted at a market rate of interest.

Debt instruments are subsequently carried at amortised cost, using the effective interest rate method.

Trade creditors are obligations to pay for goods or services that have been acquired in the ordinary course of business from suppliers. Accounts payable are classified as current liabilities if payment is due within one year or less. If not, they are presented as non-current liabilities. Trade creditors are recognised initially at transaction price and subsequently measured at amortised cost using the effective interest method.

##### Other financial liabilities

Derivatives, including interest rate swaps and forward foreign exchange contracts, are not basic financial instruments. Derivatives are initially recognised at fair value on the date a derivative contract is entered into and are subsequently re-measured at their fair value. Changes in the fair value of derivatives are recognised in the statement of financial activities in finance costs or finance income as appropriate, unless they are included in a hedging arrangement.

#### (k) Retirement benefits

Payments to defined contribution retirement benefit schemes are charged as an expense as they fall due.

The cost of providing benefits under defined benefit plans is determined separately for each plan using the projected unit credit method and is based on actuarial advice.

The net interest element is determined by multiplying the net defined benefit liability by the discount rate, taking into account any changes in the net defined benefit liability during the period as a result of contribution and benefit payments. The net interest is recognised in the statement of financial activities.

Remeasurement changes comprise actuarial gains and losses and the return on the net defined benefit liability excluding amounts included in net interest. These are recognised immediately in the statement of financial activities in the period in which they occur.

The defined net benefit pension liability in the balance sheet comprises the total of the present value of the defined benefit obligation (using a discount rate based on high quality corporate bonds).

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2021

### 2. ACCOUNTING POLICIES (continued)

#### (l) Significant judgements and key sources of estimation uncertainty

In the application of the charity's accounting policies, Commissioners are required to make judgements, estimates and assumptions about the carrying value of assets and liabilities that are not readily apparent from other sources. The estimates are based on historical experience and other factors that are considered to be relevant. Actual results may differ from these estimates. The key sources of estimation uncertainty that have a significant effect on the amount recognised in the accounts are:

- the valuation of investment properties, which are stated at their estimated fair value based on professional valuations as disclosed in Note 15;
- the valuation of multi-year grant commitments, which take into account estimates of future inflation, early withdrawal rates, claim rates and other factors affecting the final amount payable; in this context, and given current interest rates and grant periods, discounting for the time value of money is not considered material;
- the valuation of the defined benefit pension scheme liability, which is based on actuarial assumptions and a professional valuation as set out in Note 14;
- the valuation of future minimum lease payments under non-cancellable operating leases, which are discounted for inflation in accordance with Bank of England targets and ignore the potential effects of leasehold enfranchisements, as set out in Note 15.

### 3. FUNDS

All the Commission's income and capital is expendable at the discretion of the Commissioners and is therefore shown as a single unrestricted fund. The Commissioners have designated part of the unrestricted fund as a Special Projects Fund. It is anticipated this will primarily be used to fund activities in connection with the 175th Anniversary of the Great Exhibition in 2026 and the transition to net zero. Movements on the designated fund are disclosed in Note 20.

### 4. DONATIONS

The Commission received donations from The Bugatti Trust, The Faculty of Royal Designers for Industry and The Royal Academy of Engineering. In each case the donation is for the general charitable purposes of the Commission but with an expressed wish that it be used to support the activities of the Sir Misha Black Awards Committee. The donations were used to part fund the ceremony held on 19 October 2021 at which the 2020 and 2021 Medals and Awards were presented. The Commissioners are very grateful to each of the donors for their support.

### 5. INVESTMENT INCOME

|                                  | 2021<br>£        | 2020<br>£        |
|----------------------------------|------------------|------------------|
| Rental income from UK properties | 594,269          | 1,300,782        |
| Income from managed investments  | 1,642,026        | 1,379,063        |
| Interest on rent arrears         | —                | 32,995           |
| Interest on cash deposits        | 20,313           | 2,389            |
|                                  | <u>2,256,608</u> | <u>2,715,229</u> |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2021

### 6. OTHER INCOME

|                | 2021      | 2020       |
|----------------|-----------|------------|
|                | £         | £          |
| Licence income | 58        | 925        |
|                | <u>58</u> | <u>925</u> |

### 7. COST OF RAISING FUNDS

|                                   | 2021           | 2020           |
|-----------------------------------|----------------|----------------|
|                                   | £              | £              |
| Investment management fees        | 549,091        | 507,244        |
| Property management fees          | 33,130         | 66,434         |
| Legal fees                        | 8,226          | 60,255         |
| Provisions                        | —              | 53,333         |
| Allocated support costs (note 11) | 53,436         | 53,098         |
|                                   | <u>643,883</u> | <u>740,364</u> |

### 8. CHARITABLE ACTIVITIES

|                               | Grants<br>(note 9) | Direct<br>costs<br>(note 10) | Allocated<br>support<br>costs<br>(note 11) | 2021             | 2020             |
|-------------------------------|--------------------|------------------------------|--------------------------------------------|------------------|------------------|
|                               | £                  | £                            | £                                          | £                | £                |
| Fellowships and studentships  | 3,554,841          | 126,189                      | 158,612                                    | 3,839,642        | 3,245,516        |
| STEM education and outreach   | 199,839            | 72,814                       | 59,831                                     | 332,484          | 410,790          |
| Support for legacy estate     | 195,700            | 38,819                       | 59,832                                     | 294,351          | 1,425,547        |
| Archives and alumni relations | (1,593)            | 11,683                       | 62,075                                     | 72,165           | 96,808           |
|                               | <u>3,948,787</u>   | <u>249,505</u>               | <u>340,350</u>                             | <u>4,538,642</u> | <u>5,178,661</u> |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2021

### 9. GRANTS AWARDED

#### (a) Fellowships and studentships

|                                  | 2021<br>No. | 2021<br>£        | 2020<br>No. | 2020<br>£        |
|----------------------------------|-------------|------------------|-------------|------------------|
| Research Fellowships             | 10          | 1,490,400        | 10          | 1,707,647        |
| Industrial Fellowships           | 13          | 1,165,435        | 10          | 494,982          |
| Industrial Design Studentships   | 11          | 466,506          | 10          | 412,192          |
| Built Environment Fellowship     | 1           | 100,000          | –           | –                |
| Design Fellowship                | –           | –                | 1           | 90,000           |
| Enterprise Fellowships           | 6           | 312,500          | 5           | 312,500          |
| Great Exhibition Scholarships    | –           | –                | –           | (9,000)          |
| Sir Misha Black Awards Bursaries | 2           | 20,000           | –           | –                |
|                                  | <u>43</u>   | <u>3,554,841</u> | <u>36</u>   | <u>3,008,321</u> |

All of the fellowships and studentships were awarded to individuals. The Annual Report includes more information on the awards granted, including where relevant details of each of the institutions at which individual recipients are carrying out their studies / research.

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2021

### 9. GRANTS AWARDED (continued)

#### (b) STEM education and outreach

|                                                                    | 2021<br>£ | 2020<br>£ |
|--------------------------------------------------------------------|-----------|-----------|
| EDT – Virtual STEM work experience                                 | 10,186    | –         |
| Royal Society of Chemistry – Steps into Science                    | 15,000    | –         |
| National Literacy Trust – Linking literacy and STEM careers        | 18,648    | –         |
| Education and Training Foundation – Technical Teaching Fellowships | 112,500   | –         |
| Wellington Trust – Future maritime engineers                       | 15,460    | –         |
| Kids Invent Stuff – Mini YouTube STEM musical                      | 5,000     | –         |
| All Party Parliamentary Engineering Group – Meeting sponsorship    | 5,000     | –         |
| STEM Learning – Involving 1851 Fellows in primary STEM outreach    | 14,875    | –         |
| SmartSTEMs – Digital portal                                        | –         | 14,850    |
| Ruth Mountford – They Made It podcasts                             | –         | 5,000     |
| Fun Kids Radio – How's That Made?                                  | –         | 10,000    |
| Physics Partners – Physics videos                                  | –         | 9,800     |
| Primary Engineer – Leaders award podcasts                          | –         | 10,160    |
| In2ScienceUK – Engineering research module / Alumni programme      | 7,850     | 14,750    |
| RedR UK – Engineering in emergencies                               | –         | 5,000     |
| London Transport Museum – Engineering your neighbourhood           | –         | 20,602    |
| Cranfield University – National flying laboratory centre           | –         | 197,000   |
|                                                                    | <hr/>     | <hr/>     |
|                                                                    | 204,519   | 287,162   |
| Less: Past awards written back where not utilised in full          | (4,680)   | (1,952)   |
|                                                                    | <hr/>     | <hr/>     |
|                                                                    | 199,839   | 285,210   |
|                                                                    | <hr/>     | <hr/>     |

All of the STEM education and outreach grants were awarded to institutions (2020: all of the STEM education and outreach grants were awarded to institutions except for one awarded to an individual).

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2021

### 9. GRANTS AWARDED (continued)

#### (c) Support for legacy estate

|                                                           | 2021<br>£      | 2020<br>£        |
|-----------------------------------------------------------|----------------|------------------|
| Royal Geographical Society – Upgrading 1 Kensington Gore  | 155,200        | –                |
| Royal College of Art – The empathetic engineer            | 13,500         | –                |
| Royal Albert Hall – Public realm project                  | –              | 1,225,000        |
| National Railway Museum – The Great Machine               | –              | 105,050          |
| Exhibition Road Culture Group – South Kensington          |                |                  |
| Green Trail / Covid Culture Shock event                   | 30,000         | 2,500            |
|                                                           | <u>198,700</u> | <u>1,332,550</u> |
| Less: Past awards written back where not utilised in full | (3,000)        | –                |
|                                                           | <u>195,700</u> | <u>1,332,550</u> |

All of the grants in support of the legacy estate in both 2021 and 2020 were awarded to institutions.

#### (d) Archives and alumni relations

|                                                                | 2021<br>£      | 2020<br>£     |
|----------------------------------------------------------------|----------------|---------------|
| University of Oxford – Digitising Albert                       | –              | 26,500        |
| Royal Collection Trust – Queen’s Bindery Apprenticeship Scheme | –              | 1,500         |
|                                                                | <u>–</u>       | <u>28,000</u> |
| Less: Past awards written back where not utilised in full      | (1,593)        | (6,702)       |
|                                                                | <u>(1,593)</u> | <u>21,298</u> |

All of the grants in support of archives and alumni relations in 2021 and 2020 were awarded to institutions.

In total, 12 grants were made to institutions and 43 to individuals (2020: 13 grants to institutions and 37 to individuals).

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2021

### 10. DIRECT COSTS

|                                         | 2021                  | 2020                  |  |
|-----------------------------------------|-----------------------|-----------------------|--|
|                                         | £                     | £                     |  |
| Promotion and selection costs           | 85,323                | 83,148                |  |
| Networking and educational events       | 40,866                | 77,635                |  |
| Estate memberships, projects and advice | -                     | 35,193                |  |
| Archive supplies and acquisitions       | -                     | 7,487                 |  |
| Alumni website and expenses             | -                     | 7,080                 |  |
|                                         | <u>126,189</u>        | <u>210,543</u>        |  |
|                                         | <u><u>126,189</u></u> | <u><u>210,543</u></u> |  |
| Fellowships and studentships            | 85,323                | 85,323                |  |
| STEM education and outreach             | 72,814                | 116,506               |  |
| Support for legacy estate               | 2,826                 | 35,993                |  |
| Archives and alumni relations           | -                     | 4,898                 |  |
|                                         | <u>38,819</u>         | <u>6,785</u>          |  |
|                                         | <u><u>38,819</u></u>  | <u><u>6,785</u></u>   |  |
|                                         | <u><u>38,819</u></u>  | <u><u>6,785</u></u>   |  |



# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2021

### 11. SUPPORT COSTS

|                             | Cost of raising funds<br>£ | Fellowships and studentships<br>£ | STEM education and outreach<br>£ | Support for legacy estate<br>£ | Archives and alumni relations<br>£ | 2021<br>£      | 2020<br>£      | Basis of allocation |
|-----------------------------|----------------------------|-----------------------------------|----------------------------------|--------------------------------|------------------------------------|----------------|----------------|---------------------|
| Governance costs (note 12)  | 7,081                      | 7,081                             | 5,664                            | 5,665                          | 2,832                              | 28,323         | 47,519         | Board time          |
| Staff costs (note 13)       | 36,024                     | 117,761                           | 42,095                           | 42,095                         | 46,040                             | 284,015        | 272,543        | Staff time          |
| Retired staff pension costs | 678                        | 2,215                             | 792                              | 792                            | 866                                | 5,343          | 8,202          | Staff time          |
| Facility costs              | 1,563                      | 5,109                             | 1,826                            | 1,826                          | 1,997                              | 12,321         | 12,322         | Staff time          |
| Office refurbishment        | 23                         | 74                                | 27                               | 27                             | 29                                 | 180            | –              | Staff time          |
| Office costs                | 3,866                      | 12,640                            | 4,518                            | 4,518                          | 4,942                              | 30,484         | 20,210         | Staff time          |
| Legal and professional fees | 3,746                      | 12,245                            | 4,377                            | 4,377                          | 4,787                              | 29,532         | 11,393         | Staff time          |
| Travel and entertaining     | 455                        | 1,487                             | 532                              | 532                            | 582                                | 3,588          | 1,648          | Staff time          |
|                             | <u>53,436</u>              | <u>158,612</u>                    | <u>59,831</u>                    | <u>59,832</u>                  | <u>62,075</u>                      | <u>393,786</u> | <u>373,837</u> |                     |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2021

### 12. GOVERNANCE COSTS

|                                     | 2021          | 2020          |
|-------------------------------------|---------------|---------------|
|                                     | £             | £             |
| Audit fees (including VAT)          |               |               |
| – Current year                      | 11,000        | 10,200        |
| – Prior year under / (over) accrual | 480           | (100)         |
| Actuarial fees                      | 1,800         | 1,900         |
| Annual report                       | 1,801         | 769           |
| Meeting costs                       | 13,242        | 190           |
| Commissioner recruitment costs      | –             | 34,560        |
|                                     | <u>28,323</u> | <u>47,519</u> |

### 13. STAFF COSTS AND RELATED PARTY TRANSACTIONS

|                                       | 2021           | 2020           |
|---------------------------------------|----------------|----------------|
|                                       | £              | £              |
| Salaries (including benefits in kind) | 232,682        | 221,203        |
| Employers NI                          | 21,874         | 20,330         |
| Pension contributions                 | 25,649         | 30,148         |
| Staff recruitment                     | 2,956          | –              |
| Training and development              | 854            | 862            |
|                                       | <u>284,015</u> | <u>272,543</u> |

The average number of employees during the year analysed by function was:

|                            | 2021       | 2020       |
|----------------------------|------------|------------|
|                            | No.        | No.        |
| Support and administration | 4.0        | 4.0        |
| Archive                    | 1.0        | 1.0        |
|                            | <u>5.0</u> | <u>5.0</u> |

The full time equivalent number of employees during the year analysed by function was:

|                            | 2021       | 2020       |
|----------------------------|------------|------------|
|                            | No.        | No.        |
| Support and administration | 2.8        | 2.8        |
| Archive                    | 0.4        | 0.4        |
|                            | <u>3.2</u> | <u>3.2</u> |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2021

### 13. STAFF COSTS AND RELATED PARTY TRANSACTIONS (continued)

One employee earned between £100,000 and £110,000 (2020: one employee earned between £90,000 and £100,000). No pension contributions were paid in respect of this employee (2020: no pension contributions were paid in respect of this employee).

Commissioners do not receive remuneration. During the year re-imbursements were made to five Commissioners in respect of travelling and other expenses totalling £1,512 (2020: to two Commissioners totalling £601).

The total amount paid in respect of key management personnel (i.e., the Secretary and Finance Director), including employer's national insurance and employer pension contributions, was £180,236 (2020: £175,003).

There were no other related party transactions during the year (2020: none).

### 14. PENSIONS AND OTHER LONG-TERM EMPLOYEE BENEFITS

All current and new members of staff are eligible to join a personal pension scheme of their choice with the Commission contributing 15% of salary (2020: 15% of salary). There is no requirement for employee contributions. Staff may opt to sacrifice some of their salary in return for an additional employer contribution. Employer contributions of £25,649 (2020: £30,148) were made in the year of which £781 (2020: £nil) were outstanding at the year-end. There were no prepaid contributions at the year-end (2020: £nil).

All current and new members of staff also benefit from an unfunded / uninsured death in service scheme under which the Commissioners (at their absolute discretion) may pay a nominated beneficiary a lump sum equivalent to 18 months' salary if an employee dies while employed by the Commission. No liability for the scheme is recognised in the accounts as Commissioners do not believe there is any sensible way to estimate the liability. Actuarial calculations based on assumptions comparable to those used in valuing the defined benefit pension liability (see below) suggest that any liability in respect of the death in service scheme would in any case be immaterial.

All current and new members of staff also benefit from a Group Income Protection policy with Canada Life which covers basic salary and pension contributions for staff unable to work due to long term illness.

The Commission operates an unfunded pension scheme in the UK (the 'Scheme'). The Scheme is an unregistered, non-contributory defined benefit scheme. As the Scheme is unfunded, no contributions are paid by the Commission, other than to meet benefits as they fall due. As no triennial valuations are carried out, a valuation is carried out at the balance sheet date each year by an independent qualified actuary.

The Scheme was closed to new members on 14 July 2004. As at 31 December 2021, all six remaining members of the Scheme are receiving a pension and there is no further accrual of benefits. There is therefore no service cost for the year. The amount recognised in arriving at net expenditure for the year is an expense of £5,343 (2020: £8,202) which is fully in respect of net interest on the net liability.

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2021

### 14. PENSIONS AND OTHER LONG-TERM EMPLOYEE BENEFITS (continued)

As regards the unfunded, defined benefit pension scheme:

*The principal assumptions used by the actuary were:*

|                                       | FRS102<br>Valuation<br>2021<br>(% p.a.) | FRS102<br>Valuation<br>2020<br>(% p.a.) |
|---------------------------------------|-----------------------------------------|-----------------------------------------|
| <i>Financial assumptions</i>          |                                         |                                         |
| Gross investment return               |                                         |                                         |
| In-service members                    |                                         |                                         |
| Pre-retirement                        | N/A                                     | N/A                                     |
| Post-retirement                       | N/A                                     | N/A                                     |
| Current pensioners                    | 1.9%                                    | 1.4%                                    |
| Pensionable earnings increases        | N/A                                     | N/A                                     |
| Price inflation                       | 3.6%                                    | 3.0%                                    |
| Pension increases                     | 3.6%                                    | 3.0%                                    |
| Allowance for administration expenses | 0.0%                                    | 0.0%                                    |
| <i>Demographic assumptions</i>        |                                         |                                         |
| Mortality                             |                                         |                                         |
| Pre-retirement                        | N/A                                     | N/A                                     |
| Post-retirement                       | S3PA                                    | S3PA                                    |
|                                       | CMI 2020 1%                             | CMI 2019 1%                             |
| Withdrawal allowance                  | No allowance                            | No allowance                            |
| Early retirement allowance            | No allowance                            | No allowance                            |
| Proportion married                    | 90%                                     | 90%                                     |
| Wife's age                            | 3 years younger<br>than husband         | 3 years younger<br>than husband         |

The assumptions used by the actuary are best estimates chosen from a range of possible actuarial assumptions which, due to the timescale covered, may not necessarily be borne out in practice.

*Value of Scheme assets and liabilities:*

|                                     | 2021<br>£ | 2020<br>£ |
|-------------------------------------|-----------|-----------|
| Market value of Scheme assets       | —         | —         |
| Present value of Scheme liabilities | (399,000) | (425,000) |
| Scheme deficit                      | (399,000) | (425,000) |
| Related deferred tax asset          | —         | —         |
| Net liability                       | (399,000) | (425,000) |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2021

### 14. PENSIONS AND OTHER LONG-TERM EMPLOYEE BENEFITS (continued)

#### *Movements in the year:*

|                                     | 2021<br>£        | 2020<br>£        |
|-------------------------------------|------------------|------------------|
| Scheme deficit at beginning of year | (425,000)        | (427,000)        |
| Current service cost                | –                | –                |
| Interest on obligation              | (5,343)          | (8,202)          |
| Actuarial loss on liabilities       | (3,432)          | (23,626)         |
| Benefits paid directly by employer  | 34,775           | 33,828           |
|                                     | <u>(399,000)</u> | <u>(425,000)</u> |
| Scheme deficit at end of year       |                  |                  |

The interest on obligation of £5,343 (2020: £8,202) is disclosed within Support costs (note 11) while the actuarial loss on liabilities of £3,432 (2020: £23,626) is disclosed within Other recognised gains and losses on the face of the SOFA.

### 15. INVESTMENT PROPERTIES AND OPERATING LEASES

|                                                        | 2021<br>£         | 2020<br>£         |
|--------------------------------------------------------|-------------------|-------------------|
| (a) <i>Movements in value of investment properties</i> |                   |                   |
| Balance at 1 January                                   | 23,345,382        | 21,370,300        |
| Sales during the year                                  | (3,680,032)       | –                 |
| Unrealised gain on year-end revaluation                | 1,275,000         | 1,975,082         |
|                                                        | <u>20,940,350</u> | <u>23,345,382</u> |
| Valuation at 31 December                               |                   |                   |

The valuation as at 31 December 2021 shown above resulted from a full revaluation of the properties at 31 December 2019, undertaken by Cluttons LLP, Chartered Surveyors and Property Consultants. The valuation was carried out on an open market value basis in accordance with the RICS Appraisal and Valuation Manual and is based on existing usage and occupation of the land, and the duration of leases at ground and rack rents. In reaching the 31 December 2021 valuation, the value at 31 December 2019 has been adjusted, based on advice from Daniel Watney LLP, to take into account movements in local property market indices, changes in estimated rental values, the decreasing length of leases and lease extension / leasehold enfranchisement claims received. All of the investment properties are located in the UK.

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2021

### 15. INVESTMENT PROPERTIES AND OPERATING LEASES (continued)

#### (b) *Operating leases – lessor*

The Commission is entitled as landlord to income from investment properties under operating leases. Future minimum lease payments under non-cancellable operating leases, discounted for inflation, for each of the following periods are as follows:

|                                                   | 2021<br>£        | 2020<br>£         |
|---------------------------------------------------|------------------|-------------------|
| Not later than one year                           | 94,538           | 175,788           |
| Later than one year and not later than five years | –                | –                 |
| Later than five years                             | 9,800,137        | 9,996,587         |
|                                                   | <u>9,894,675</u> | <u>10,172,375</u> |

The Commission's investment properties are let for periods ranging up to 999 years. All leases are on full repairing and insuring terms. Leases of residential property are potentially subject to leasehold enfranchisement; this has been ignored in arriving at the above figures.

### 16. INVESTMENTS

|                                            | 2021<br>£          | 2020<br>£          |
|--------------------------------------------|--------------------|--------------------|
| (a) <i>Movements in listed investments</i> |                    |                    |
| Market value 1 January                     | 119,307,960        | 110,771,099        |
| Acquisitions at cost                       | 20,645,106         | 58,063,652         |
| Disposals at carrying value                | (15,820,788)       | (52,976,767)       |
| Net gains on revaluation                   | 8,891,017          | 3,449,976          |
|                                            | <u>133,023,295</u> | <u>119,307,960</u> |
| Market value 31 December                   |                    |                    |
| Value at cost 31 December                  | 94,413,971         | 89,589,653         |

#### (b) *Geographic breakdown*

|                | 2021<br>£             | 2021<br>£        | 2020<br>£             | 2020<br>£        |
|----------------|-----------------------|------------------|-----------------------|------------------|
|                | Listed<br>investments | Cash             | Listed<br>investments | Cash             |
| In the UK      | 64,605,641            | 1,501,182        | 61,560,772            | 902,632          |
| Outside the UK | 68,417,654            | –                | 57,747,188            | 114,867          |
|                | <u>133,023,295</u>    | <u>1,501,182</u> | <u>119,307,960</u>    | <u>1,017,499</u> |

All investments are listed on a recognised stock exchange.

There were no individual holdings the market value of which is considered to be material in the context of the portfolio as a whole.

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2021

### 17. DEBTORS

|                         | 2021<br>£      | 2020<br>£        |
|-------------------------|----------------|------------------|
| Rents receivable        |                |                  |
| – in hands of surveyors | 36,978         | 250,079          |
| – in arrears            | 318,667        | 822,536          |
|                         | <u>355,645</u> | <u>1,072,615</u> |
| Other debtors           | 9,844          | 8,585            |
| Prepayments             | 28,871         | 26,655           |
| Accrued income          | 10,469         | 33,000           |
|                         | <u>404,829</u> | <u>1,140,855</u> |

### 18. CREDITORS

|                                     | 2021<br>£        | 2020<br>£        |
|-------------------------------------|------------------|------------------|
| Amounts falling due within one year |                  |                  |
| Grants payable                      | 3,895,445        | 4,418,496        |
| Other creditors                     | 175,346          | 162,388          |
|                                     | <u>4,070,791</u> | <u>4,580,884</u> |

|                                   | 2021<br>£      | 2020<br>£      |
|-----------------------------------|----------------|----------------|
| Analysis of other creditors       |                |                |
| Investment management fees        | 106,558        | 131,814        |
| Property management fees          | 19,733         | 5,700          |
| Audit fees                        | 11,000         | 10,200         |
| Other legal and professional fees | 9,309          | 3,400          |
| Others                            | 28,746         | 11,274         |
|                                   | <u>175,346</u> | <u>162,388</u> |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2021

### 18. CREDITORS (continued)

|                                                     | 2021<br>£        | 2020<br>£        |
|-----------------------------------------------------|------------------|------------------|
| <b>Amounts falling due after more than one year</b> |                  |                  |
| Grants payable                                      | 2,948,094        | 2,783,602        |
| Due in one to two years                             | 2,040,027        | 1,821,110        |
| Due within two to five years                        | 908,067          | 962,492          |
|                                                     | <u>2,948,094</u> | <u>2,783,602</u> |

The analysis of grants payable by award is as follows

| Award                             | Period of<br>commitment | 2021<br>£        | 2020<br>£        |
|-----------------------------------|-------------------------|------------------|------------------|
| Fellowships and studentships      |                         |                  |                  |
| – Research Fellowships            | 3 years                 | 3,130,514        | 3,099,479        |
| – Industrial Fellowships          | 3 years                 | 2,128,343        | 1,595,090        |
| – Industrial Design Studentships  | 2 years                 | 428,850          | 339,645          |
| – Built Environment Fellowships   | 2 years                 | 122,807          | 58,402           |
| – Design Fellowships              | 2 years                 | 110,000          | 142,500          |
| – Enterprise Fellowships          | 1 year                  | 125,000          | 187,500          |
| – Sir Misha Black Award Bursaries | 1 year                  | 11,000           | –                |
| STEM education and outreach       | 1 year                  | 171,775          | 342,932          |
| Support for legacy estate         | 3 years                 | 615,250          | 1,410,050        |
| Archives and alumni relations     | 1 year                  | –                | 26,500           |
|                                   |                         | <u>6,843,539</u> | <u>7,202,098</u> |

### 19. FINANCIAL INSTRUMENTS

|                                                                                | 2021<br>£        | 2020<br>£        |
|--------------------------------------------------------------------------------|------------------|------------------|
| <b>Carrying amount of financial assets</b>                                     |                  |                  |
| Debt instruments measured at amortised cost<br>(debtors excluding prepayments) | 375,958          | 1,114,200        |
|                                                                                | <u>375,958</u>   | <u>1,114,200</u> |
| <b>Carrying amount of financial liabilities</b>                                |                  |                  |
| Measured at amortised cost                                                     | 7,018,885        | 7,364,486        |
|                                                                                | <u>7,018,885</u> | <u>7,364,486</u> |



# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2021

### 20. FUNDS

|                                  | At 1 January<br>£  | Income<br>£      | Expenditure<br>£   | Gains<br>£        | Transfers<br>£ | At 31 December<br>£ |
|----------------------------------|--------------------|------------------|--------------------|-------------------|----------------|---------------------|
| Unrestricted<br>General          | 138,125,545        | 2,259,666        | (5,182,525)        | 14,826,873        | (2,285,737)    | 147,743,822         |
| Designated<br>– Special Projects | –                  | –                | –                  | –                 | 2,285,737      | 2,285,737           |
|                                  | <u>138,125,545</u> | <u>2,259,666</u> | <u>(5,182,525)</u> | <u>14,826,873</u> | <u>–</u>       | <u>150,029,559</u>  |

During the year, the Commissioners set up a designated Special Projects Fund. It is anticipated that this will be used to fund activities in connection with the 175th Anniversary of the Great Exhibition in 2026 and perhaps also to fund activities around the transition to net zero, although Commissioners retain the discretion to direct alternative uses and remain mindful of the desirability of maintaining disbursements through periods of inferior market return. The designated fund comprises listed investments. It is administered as part of the unrestricted fund.

## Administrative Information

### Structure, Governance and Management

The Commission is constituted as a limited company incorporated by Royal Charter. Its governing documents are the original Charter dated 3 January 1850 and a Supplemental Charter dated 2 December 1851.

The Commission may have up to twelve trustees, known as Royal Commissioners, at any one time, who together constitute the Board of Management, which meets formally twice a year. Commissioners are chosen to bring wide experience in areas relevant to the Commission's work – science, engineering, industry, design, architecture and finance. To maintain an appropriate balance of skills, Commissioners normally serve for 10 years, and Commissioners themselves identify possible successors, who may serve on a committee prior to election. Following election by the Board of Management, Commissioners are only appointed with the approval of the President.

All other committees are advisory in remit, are subordinate to the Board of Management and report to it, and all committee Chairmen are Commissioners. *Ad hoc* committees may be formed for limited periods and specific purposes. Any committee other than the Board of Management may have non-Commissioners as members subject to the wishes of the Chairman of that committee. All committees, except *ad hoc* committees, meet at least once annually. All committees are serviced by the Secretary and, where appropriate, by the Finance Director.

The Secretary also provides full briefing and induction programmes for all new Commissioners and committee members when appointed. As part of this introduction Commissioners are provided with a Governance Book containing full details of the Commission's history, role, strategy, procedures and Commissioners' responsibilities, as well as the relevant Charity Commission guidance for trustees. During their tenure, further opportunities for Commissioners to develop their knowledge of areas relevant to the Commission's activities are provided as appropriate.

Day to day running of the Commission is delegated to the Secretary, assisted by a small staff team. Matters of strategy, and all grants greater than £5,000, are decided by Commissioners.

Full details of Commissioners and Committee members in post during the year, as well as the small staff team, are provided on pages 74 to 76. Details of the Commission's professional advisers are provided on page 77.

### Remuneration

Commissioners are not remunerated in their role as trustees of the charity and do not receive benefits other than reimbursement of expenses incurred in attending meetings.

In order to maximise funds available for grant making, Commissioners are determined to keep staff numbers and associated office costs to a minimum. To attract and retain experienced staff of the right calibre, however, Commissioners recognise the need to set salaries in line with those for other grant-making charities in the London area, based on sector benchmarks and other publicly available data.

Salaries for all staff, including key management personnel, are reviewed annually by the Chairman of the Board and the Chairman of the Finance Committee as part of the performance appraisal process. Pay awards are dependent on performance and set based on increases in the cost of living and average salary increases for the sector. There are no automatic increments and no bonus scheme.

Commissioners recognise the importance of helping employees make adequate provision for retirement. All employees are therefore eligible to receive a 15% employer pension contribution to the pension scheme established for auto-enrolment purposes or a personal pension of their choice. All employees also benefit from a Group Income Protection policy that will cover basic salary and pension contributions if they are unable to work due to long-term illness. At their absolute discretion,

Commissioners may pay a nominated beneficiary a lump sum equivalent to 18 months' salary if an employee dies while employed by the Commission. All employees are also entitled to an interest free season ticket loan. All of the above benefits are available to all employees, including key management personnel. Employees do not receive any other benefits.

## Risk Policy

In discharging their responsibilities for the management of risk, it is the policy of the Commissioners to identify, analyse and seek to manage any risks to the ability of the Commission to carry out its role effectively and meet the obligations of its Royal Charter.

To this effect the Commissioners have given consideration to the major risks to which the Commission is, or may be, exposed. A full risk register has been drawn up, which is reviewed regularly. Insurance brokers have been appointed to advise on areas where risk can be effectively mitigated through insurance. Compliance risks are mitigated through taking and following appropriate professional advice.

The main remaining areas of strategic and operational risk and the steps taken to address them are summarised below. Actions taken to mitigate the impact of COVID-19 are described on page 11 above.

### *Investments: security, performance, liquidity*

The Commission has a diversified portfolio, both in terms of investments held and managers appointed. It has adopted investment and disbursement policies designed to maintain the real value of the portfolio over time and hence the support available to current and future beneficiaries. Sufficient liquidity is held outside the portfolio to meet short term commitments. Commissioners have delegated review of investment performance to a Finance Committee comprising individuals with relevant expertise.

### *Grant making: applications, assessment, administration*

Commissioners have appointed specialist committees to review fellowship applications, work closely with other organisations active in the STEM arena to avoid unnecessary duplication or administrative effort and have appointed a communications company to assist with marketing of the awards to ensure they are brought to the attention of eligible recipients. Commissioners regularly seek feedback from potential applicants and other stakeholders to ensure the awards remain relevant.

### *Legacy estate: character, experience, relevance*

Commissioners take an active interest in the estate, seek to facilitate relevant initiatives across legacy institutions and provide financial support where possible to ensure the estate remains a beacon of excellence and inspiration in the worlds of science, engineering and design.

## Commissioners and Committee Members

### President

HRH The Princess Royal

### Commissioners (and Board of Management)

Mr Bernard Taylor CBE DL FRSC *Chairman, Board of Management*

Professor Jim Al-Khalili CBE FRS FInstP

Professor Dame Kay Davies DBE FRS FMedSci

Professor Dame Ann Dowling OM DBE FREng FRS

Mr Jim Eyre OBE

Professor Sir Andrew Hopper CBE FRS FREng FIET

Professor Lord Mair CBE HonDSc FREng FICE FRS

Dame Alison Nimmo DBE MRTPI FRICS HonFRIBA FICE

Ms Sandra Robertson

Professor Dame Carol Robinson DBE FRS FRSC FMedSci

Professor Chris Wise RDI FREng FICE MStructE HonFRIBA FRSA

Professor Jim Al-Khalili was appointed to the Board on 8 December 2021

Professor Dame Carol Robinson was appointed to the Board on 7 July 2021

Sir William Castell retired from the Board on 7 July 2021

Mr Stuart Corbyn retired from the Board on 7 July 2021

Sir John O'Reilly retired from the Board on 8 December 2021

### Ex Officio Commissioners

The Lord President of the Council

The First Lord of the Treasury

The Chancellor of the Exchequer

The Secretary of State for Business, Energy and Industrial Strategy

The Secretary of State for the Environment, Food and Rural Affairs

The President of the Institution of Civil Engineers

The President of the Geological Society

### Finance Committee

Ms Sandra Robertson *Chairman*

Ms Sarah Arkle

Professor Sir Andrew Hopper CBE FRS FREng FIET

Mr Nicholas Moakes CFA

Dame Alison Nimmo DBE MRTPI FRICS HonFRIBA FICE

Sir William Castell retired from the Committee on 7 July 2021

Mr Stuart Corbyn retired from the Committee on 7 July 2021

## Science and Engineering Fellowships Committee

Professor Dame Kay Davies DBE FRS FMedSci *Chairman*  
Professor Jim Al-Khalili CBE FRS FInstP  
Professor Gillian Bates FRS FMedSci  
Professor Mike Benton FRS FRSE  
Professor Martin Bridson FRS  
Professor Andrew Briggs  
Professor Neil Champness FRSC FLSW  
Professor Anne Dell CBE FRS FMedSci  
Professor John Dewey FRS  
Professor Cyril Hilsum CBE FREng FRS  
Professor Patrick Keogh FREng  
Professor Jane Langdale CBE FRS  
Professor Stephen Muggleton FREng  
Professor Rachel O'Reilly FRSC  
Professor Sheena Radford OBE FRS FMedSci  
Professor Dame Carol Robinson DBE FRS FRSC FMedSci  
Dr Dame Frances Saunders DBE CB FREng FInstP  
Professor Trevor Stuart FIC FRS  
Professor Christopher Tout  
Professor Stuart West  
Professor John Wood CBE FREng

Professor Jim Al-Khalili was appointed to the Committee on 8 December 2021  
Professor Patrick Keogh was appointed to the Committee on 30 April 2021  
Professor Dame Carol Robinson was appointed to the Committee on 7 July 2021  
Dr Dame Frances Saunders was appointed to the Committee on 21 July 2021  
Professor Christopher Tout was appointed to the Committee 25 June 2021  
Professor Stuart West was appointed to the Committee on 28 April 2021  
Professor David Ewins retired from the Committee on 27 April 2021  
Professor James Feast retired from the Committee on 1 January 2021  
Professor Douglas Gough retired from the Committee on 27 April 2021  
Professor Maurice Skolnick retired from the Committee on 27 April 2021

## Brunel Fellowships Sub-Committee

Professor Dame Kay Davies DBE FRS FMedSci *Chairman*  
Professor Dame Anne Dowling OM DBE FREng FRS  
Professor David Ewins DSc FREng FRS  
Professor William Powrie FREng FICE  
Professor John Wood CBE FREng

## Industry and Engineering Committee

Professor Dame Ann Dowling OM DBE FRS FREng *Chairman*  
Professor John Clarkson FREng  
Ms Naomi Climer CBE FREng FIET  
Dr Nicholas de León  
Professor Lord Mair CBE HonDSc FREng FICE FRS  
Professor Ron Pethig  
Dr Malcolm Skingle CBE DSc  
Professor Eleanor Stride OBE

Sir John O'Reilly retired from the Committee on 8 December 2021

## Built Environment and Design Fellowships Committee

Mr Jim Eyre OBE *Chairman*  
Professor Rachel Cooper OBE  
Dame Alison Nimmo DBE MRTPI FRICS HonFRIBA FICE  
Dr Andrea Siodmok EMPP FRSA HonDCL  
Professor Chris Wise RDI FREng FICE MStructE HonFRIBA FRSA

Mr Robin Levien retired from the Committee on 1 January 2021

## Sir Misha Black Awards Committee

Ms Mary Mullin *Chairman*  
Professor Chris Wise RDI FREng FICE MStructE HonFRIBA FRSA  
Professor Peter Childs  
Dr Nicholas de León  
Professor Sir Christopher Frayling FCSD FRSA FRIBA  
Professor Malcolm Garrett MBE RDI FISTD  
Professor Geoff Kirk RDI FREng

## Staff

|                            |                                      |
|----------------------------|--------------------------------------|
| Mr Nigel Williams LVO CEng | Secretary (to 25 May 2022)           |
| Mr John Lavery             | Secretary (from 25 May 2022)         |
| Mr Amahl Smith ACA         | Finance Director                     |
| Mrs Helen Harris           | Fellowship Programme Manager         |
| Mrs Angela Kenny RMARA     | Archivist and Alumni Relations       |
| Ms Kat O'Dea               | Office Manager / Executive Assistant |

## Professional Advisers

### Bankers

The Royal Bank of Scotland plc  
London Drummonds (B) Branch  
49 Charing Cross  
London SW1A 2DX

### Investment Managers

Schroder & Co. Limited  
1 London Wall Place  
London EC2Y 5AU

### Surveyors

Daniel Watney LLP  
165 Fleet Street  
London EC4A 2DW

Charles Stanley & Co. Ltd  
55 Bishopsgate  
London EC2N 3AS

### Auditor

Moore Kingston Smith LLP  
9 Appold Street  
London EC2A 2AP

JP Morgan Asset Management (UK) Ltd  
20 Finsbury Street  
London EC2Y 9AQ

### Actuaries

XPS Pensions  
Albion  
Fishponds Road  
Wokingham RG41 2QE

### Insurance Brokers

Aston Lark Ltd  
9th Floor, Colman House  
King Street  
Maidstone  
Kent ME14 1DN

### Legal Advisers

Farrer & Co LLP  
66 Lincoln's Inn Fields  
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## Royal Commission for the Exhibition of 1851

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# Accounts

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# Royal Commission for the Exhibition of 1851

Annual Report and Accounts

For the year ended 31 December 2020



## The Aims of the Royal Commission

The 1851 Royal Commission's governing document is its Supplemental Charter of 1851, which requires the Commission to *"increase the means of industrial education and extend the influence of science and art upon productive industry"*.

This was originally interpreted as a requirement to create a centre of intellectual excellence, which resulted in the acquisition of the South Kensington estate and its subsequent development with museums, academic establishments and a Central Hall of Arts and Sciences (the Royal Albert Hall).

Later, in 1890, the emphasis was switched to the support of individuals, starting with the award of Science Research Scholarships from 1891.

Today the Commission runs its own schemes for:

Research Fellowships  
Industrial Fellowships  
Industrial Design Studentships  
Built Environment Fellowships  
Fellowships in Design

In partnership with others it supports:

Great Exhibition Scholarships  
Enterprise Fellowships

It also supports worthy individuals and appropriate organisations by Special Awards.

The total number of individuals being supported in 2020 was 148

## Contents

|                                                 |       |
|-------------------------------------------------|-------|
| Chairman's Report                               | 1-2   |
| Secretary's Report                              | 2     |
| The Work of the 1851 Royal Commission           | 3     |
| Public Benefit                                  | 3     |
| Grant-making Policies                           | 4-5   |
| Achievements in 2020                            | 5-9   |
| COVID-19                                        | 10    |
| Post balance sheet event – Brexit               | 10    |
| Future Plans                                    | 11    |
| Awards Granted in 2020                          | 12-18 |
| Awards Completed in 2020                        | 19-33 |
| Alumni Awards, Honours and Achievements         | 34-35 |
| Report by the Chairman of the Finance Committee | 36-38 |
| Statement of Commissioners' Responsibilities    | 39    |
| Independent Auditor's Report                    | 40-43 |
| Statement of Financial Activities               | 44    |
| Balance Sheet                                   | 45    |
| Cash Flow Statement                             | 46    |
| Notes to the Financial Statements               | 47-64 |
| Administrative Information                      | 65-66 |
| Commissioners, Committee Members and Staff      | 67-69 |
| Professional Advisers                           | 70    |

# Chairman's Report

Bernard Taylor, Chairman of the Board of Management

In common with the rest of the world in 2020 the 1851 Royal Commission saw significant impact from the Covid 19 pandemic: a year which started with great plans, not least for a second Great Exhibition Road Festival even better than the first, came to a crashing halt in March with the commencement of the first lock down. An early casualty was the Fellows' Reception with The Princess Royal, cancelled at three days' notice, and the 1851 'family' has not gathered since, thereby depriving our award holders of one of their greatest benefits: the opportunity to meet and exchange ideas. However our setbacks are a mere inconvenience compared to the devastating impact on the institutions on our legacy estate, particularly the museums and the Royal Albert Hall; we can only admire their irrepressible spirit and determination to make the best of a truly terrible situation, absorbing the blows of one setback after another and continuing to provide inspiration to all through online content. Prince Albert would surely have been proud.

Notwithstanding the above, there is plenty of positive news to report. Prescient action by the Finance Committee in February in liquidating sufficient assets to cover three years of costs, meant we were well prepared to weather any storm without having to cut back on programmes. The Committee also started, and maintained up until the autumn, three-weekly management meetings with our investment managers to actively manage the risk as markets and economies around the world responded to the imposition of the various pandemic management measures. This close attention and the skilful work of our investment managers led us to finish the year on another record high – I thank the Finance Committee and their advisers for all their work to achieve this remarkable result.

Our fellowship committees quickly adjusted to virtual meetings and we were able to achieve a full complement of awards. At the same time we reassured current award holders who were impacted by the pandemic that we would look favourably on requests for extensions and, to date, 25 have been granted at a cost of £266,000. Our programmes have continued to grow, with our Graduate Enterprise Fellowships, in partnership with the Royal Academy of Engineering, set to increase to six by next year. This year also saw completion of the first Technical Teaching Fellowships, a two-year programme in partnership with the Education and Training Foundation, aimed at improved teaching standards in the Further Education sector. The scheme shows much promise and the Board has agreed to extend the pilot phase until at least 2022 to allow a fuller evaluation of its impact.

2020 also saw us take on the administration of the Sir Misha Black Medal and Awards. The Medal honours those who have given distinguished services to design education: it was the first, and is the only, international award to do so. The Award for Innovation in Design Education salutes innovation in design education in the United Kingdom. The Awards commemorate the work and life of the designer and architect, Professor Sir Misha Black, whose pioneering work played a crucial role in the development of design in Britain. They are a close fit with the 1851 objectives and we are delighted to give them our support.

While the Great Exhibition Road Festival could not go ahead as planned, we were still able to stage the fifth of our annual series *The Engineers* with the BBC World Service, albeit on a virtual platform rather than at the Festival site. This was the first time the BBC had brought together a 'live' audience on Zoom: drawn from every continent, it was a mix of members of the public and engineers from the Royal Academy of Engineering's global network who were able to participate in a united audio loop specially created for the programme. The planned theme was changed from 'Climate Engineering' to 'Re-engineering the Future' and four engineers engaged in combating coronavirus – including the British CPAP success story represented by Professor Rebecca Shipley – took part in a panel discussion chaired by Kevin Fong. We were proud to be one of the pioneers of this audio format, now commonplace, which attracted a maximum capacity global audience on the night. It was broadcast a week later to the BBC World Service English audience, which now tops 97 million listeners per week, and attracted very positive reviews. At our request, the BBC also produced a video of the programme which was put up on the Great Exhibition Road Festival website and is currently available on the Royal Commission website.

It has been customary to run a schools' competition in conjunction with *The Engineers* with virtual school visits by the panellists as part of the prizes. The intention this year was to expand this in conjunction with the Festival and the 'Great Exhibition in Schools' challenge was on the verge of launching when the pandemic struck. Our partners, the Big Ideas Company swiftly transformed it into the 'Great Exhibition at Home' which was picked up by major media outlets, including Sky News, the Sunday Times and Forbes Magazine, and recommended as an excellent initiative for home schooling. There were over 6,000 downloads of the free resources and some truly innovative entries at the end of the twelve-week run. In the course of the year the Commission has also supported other home schooling initiatives including a Fun Kids radio project and a series of videos to assist physics teachers, as part of the effort to overcome some of the immense challenges posed by the closure of schools.

We have long had an ambition to see improvements to the public realm around the Royal Albert Hall to place it in a more appropriate setting and better connect it to the Albert Memorial to the north. Architect Deborah Saunt, an 1851 Built Environment Fellow in 2009, laid the groundwork and urgency was injected by the need to improve security arrangements following the terrorist attacks in London in 2019 and 2020. Westminster City Council and Transport for London have now agreed to fund elements of the road improvements and the Commission will support the scheme with a substantial Special Award. Work is due to start early next year and the result will be a significantly more elegant, as well as a safer, approach to this iconic building.

I have touched on some of the highlights of this extraordinary year but of course that is not the whole story. As the reports that follow show, our Fellows and our alumni continue to do exceptional work and it is supporting our current award holders that, quite rightly, absorbs the bulk of our expenditure each year. Helping the brightest and the best to achieve great things and extending the influence of science and art on productive industry remains our focus and this report shows that our work continues undiminished in this respect. This could not happen without the hard work of our loyal staff and the Commissioners and committee members who are so generous with their time. I am very grateful to them all for helping us so successfully through a uniquely difficult year; I hope to be able to report on a more normal one in twelve months' time.

Bernard Taylor CBE DL FRSC

## Secretary's Report

We had barely had time to welcome our two new members of staff, Helen Harris, Fellowship Programme Manager and Kat O'Dea, Office Manager and Executive Assistant, before the office closed in mid-March and we have been working from home ever since. On the whole this has gone very well but we are all looking forward to returning to South Kensington at the earliest opportunity. Despite the fact that they have spent more time working in isolation at home than together in the office, our new recruits have had a great impact. The additional resource has enabled us to do more to promote our awards, particularly Industrial Fellowships and allowed us to strengthen our relationship with our media consultants AprilSix. Much effort has gone into a new website, with improved utility and a fresh look, which launched in early 2021. Engagement with award holders, who have been denied our usual run of social events, has suffered as a result of the pandemic but increasing activity on social media and efforts to feature work on the website have gone some way to alleviate this. We are poised to restart a live programme as soon as restrictions are lifted.

Notwithstanding the shortcomings of living in a two-dimensional world much has been achieved by our award holders and our alumni: a clear demonstration of the continuing reach of the '1851'. I hope you enjoy reading about the impact they are making across an extraordinary breadth in the pages that follow.

Nigel Williams CEng

## The Work of the 1851 Royal Commission

The Commission's aim is to 'make a difference' by providing educational fellowships and studentships to the very best early career scientists, engineers and designers. Success is hard to measure within the confines of a single year but looked at over the longer term the Commission's achievement is evident, with 13 Nobel Prize winners and over 150 Fellows of the Royal Society among its previous award winners. The case studies of completing fellows and summaries of alumni achievements later in this report also bear witness to the Commission's success.

In addition to its core fellowship schemes, the Commission also provides special awards to its legacy institutions, to other organisations working to encourage STEM (science, technology, engineering and mathematics) education and to organisations that can help facilitate access to its incredible archives. Details of some of these awards and the impact they have made can also be found later in this report.

As well as the grants that it makes, the Commission also itself organises a number of educational and networking events for the benefit of its award holders, alumni, legacy institutions and the general public, which together make a significant contribution to STEM education.

The Commission was originally established by Royal Charter in 1850 under the Presidency of Prince Albert, to organise and stage the Great Exhibition. Held in the spectacular Crystal Palace, constructed in Hyde Park, it was the first ever World Fair, and the most successful. With over 6 million visitors, it also made a substantial profit.

Consolidated by Supplemental Charter, and enjoined to invest the surplus from the Great Exhibition *strictly in accordance with the ends of the Exhibition...[to] increase the means of industrial education and extend the influence of science and art upon productive industry* the Commission purchased 87 acres of land in South Kensington and helped establish its three great museums, the Royal Albert Hall and renowned institutions of learning, including Imperial College and the Royal Colleges of Art and Music.

When this huge undertaking was complete, there remained sufficient funds for the Commission to initiate, in 1891, a programme of fellowships and studentships to support pure research in science and engineering, applied research in industry, industrial design and other projects.

The Commission continues its work to this day, both managing its freehold estate and awarding over £4m a year in research fellowships, design studentships and other grants. The provision of long leases to the legacy colleges and the Royal Albert Hall also makes a very substantial contribution to scientific, engineering and artistic education.

## Public Benefit

The Royal Commission ensures that its work is for the public benefit and takes full account of the published Charity Commission guidance. The Royal Commission's events and awards programmes and support of the legacy institutions represent identifiable benefits and are available to all eligible members of the public. They satisfy the primary charitable purpose of the advancement of education.

## Grant-making Policies

The Commission primarily pursues its charitable purposes through the award of grants to individuals and organisations. The Commission awards grants under a number of defined programmes. Full details of the terms and conditions for each programme, including application forms and deadlines where appropriate, are provided on the Commission's website. A brief summary of the major programmes which the Commission supports is provided below:

### **Schemes administered by the Commission:**

#### *Post-doctoral Research Fellowships in Science or Engineering*

These are intended to give early career scientists or engineers of exceptional promise the opportunity to conduct a research project of their own instigation; an ultimate objective is to contribute to the knowledge base required for a healthy and innovative national culture. Around eight to ten awards are made each year, including one or more Brunel Fellowships for engineering projects addressing the primary infrastructure needs of modern society. The awards are for up to three years, subject to annual review and encompass an annual stipend and some support for travel and other expenses.

#### *Industrial Fellowships*

These are intended to encourage profitable innovation and creativity in British industry. Projects in any science or engineering discipline will be considered. A variable number of awards – usually around ten to fifteen – is available each year depending on the financial value of individual awards granted. An ERA Foundation Fellowship for the electro-technology sector is awarded as part of the scheme. Fellowships are awarded to selected exceptional graduates with the potential to make an outstanding contribution to industry, for a programme of research, supported by their employing / sponsoring company, leading to a patent, product or process improvement in conjunction with a higher academic award. Awards are for up to three years, subject to annual review, and include a contribution towards living costs, a travel allowance, an honorarium for the host university and in appropriate cases a contribution towards university fees or towards the cost of enhancing the research project.

#### *Industrial Design Studentships*

These are intended to stimulate industrial design capability among the country's most able science and engineering graduates. Around eight to ten awards are offered each year for outstanding engineers or scientists who wish to develop their capabilities in industrial design by taking a recognised Master's course and who aspire to become leading designers in British industry. The award is for up to two years and includes a stipend, materials allowance, travel allowance and contribution towards tuition fees.

#### *Fellowships in Design and the Built Environment*

Awarded in alternate years, these Fellowships each provide a stipend for up to two years to enable those at a more advanced stage in their career to explore important current issues, selected by the Commission.

### **Schemes administered by other organisations:**

#### *Enterprise Fellowships*

Awarded through the Royal Academy of Engineering (RAEng), these fellowships are open to outstanding UK-resident engineering graduates seeking entrepreneurial success. A package of tailored mentoring, training and grant funding will enable recipients to pursue commercialisation of their technological ideas. Originally three fellowships a year were available, but this is being increased to six a year by 2021.



### *Great Exhibition Scholarships*

The Commission's 5-year commitment to this scheme ended in 2018 when ten scholarships were awarded. These scholars will graduate in 2022. Awarded through The Institution of Engineering and Technology (IET), these scholarships were open to UK residents who achieved 3 A grades or above at 'A' level or equivalent joining an IET accredited undergraduate degree. Up to ten scholarships a year were available. Scholars receive an annual stipend. Similar scholarships continue to be available through the IET.

### **Special Awards:**

Although the educational programmes described above represent the lion's share of its grant giving, the Commission also responds to all those requests for funding that commend themselves through the Special Awards procedure. Here the aim is to assist worthy individuals, organisations or projects whose aims in the broadest sense align to the Commission's, and all applications are carefully scrutinised at an appropriate level according to the amount of support requested. Grants range from a few hundred pounds to over a hundred thousand pounds. While Commissioners retain considerable flexibility in principle, in practice a majority of special awards are made either to institutions on the Commission's legacy estate or for educational outreach work by like-minded organisations seeking to draw the attention of the young to the opportunities presented by science, engineering and design. A small number of grants are also made to facilitate access to the Commission's archives.

In addition to the above schemes, the Commission also administers, in conjunction with the Sir Misha Black Awards Committee, two awards in the field of design education, for which nominations are sought each year. Full details are available on the Commission's website but in brief these are:

#### *Sir Misha Black Medal for Distinguished Services to Design Education*

Global in reach the Medal acknowledges the important contribution of individuals to the teaching of design at all levels, from anywhere in the world – as designers, as champions, as mentors and as educators.

#### *Sir Misha Black Awards for Innovation in Design Education*

Salutes educators from across the United Kingdom and celebrates the innovative achievements of institutions and individuals.

Together the Sir Misha Black Medal and Awards recognise those who by innovation, vision and contribution to theory or practice have measurably improved the education of designers and enhanced the profile of design education.

## Achievements in 2020

The core activity – and primary achievement – of the Commission is identifying early career science and engineering graduates of exceptional promise and supporting their work with its prestigious fellowships and studentships. Full details of the awards made during the year are given on pages 12 to 18.

The true impact of the Commission's award holders will only emerge over time, but many show ample indications of their future promise during their Fellowships. To take some examples at random:

- 2018 Research Fellow Emilio Martínez-Pañeda was awarded the Simó Prize by the Spanish Society for Numerical Methods in Engineering and the Prestige Award for Risk Reduction in Mechanical Engineering by the Institution of Mechanical Engineers
- 2018 Industrial Fellow Maristefania De Vido was awarded the MacFarlane Prize by Heriot-Watt University and has been selected to be part of The Foundation for Science and Technology "Future Leaders 2021" programme



- 2018 Industrial Fellow Adam McKenzie was awarded a Postgraduate Prize by the Institute of Engineering and Technology
- 2019 Industrial Fellow Alex O'Neill was awarded the Young Scientist of the Year prize at the Tire Technology Expo

More evidence of the success of the various programmes can be gleaned from the achievements of those Fellows who completed their awards during the year and the positions they go on to secure. A representative sample of case studies is provided on pages 19 to 33. Many completing Fellows comment quite explicitly on the importance of their Fellowship to their success:

*As a young CEO who moved to the UK in 2017, the Fellowship's support provided me with much needed access to a network of like-minded entrepreneurs and experienced professionals to learn from. Learning from other's success, and more importantly, their challenges, has enabled me to rapidly expand the leadership and management skills that are required to build an ambitious and close-knit team to build impactful products.*

Ben Lakey, Enterprise Fellow 2019

*The support provided by the Industrial Fellowship has significantly increased the potential of my DPhil by enabling generation of high-quality experimental data. As I am based in the department of statistics, it was difficult for me to obtain my own biological data. The resources provided by the Industrial Fellowship have enabled me to build a strong collaboration with a research group in Zürich, Switzerland. I visited them to use their state-of-the-art experimental setups to generate my own biological data as well as to exchange scientific expertise. This data is currently being actively studied in preparation for multiple peer-review article submissions.*

*The Industrial Fellowship has had a notable impact on my career prospects. The Fellowship provided a truly unique and exceptional opportunity which made me a highly skilled interdisciplinary researcher. The CEO of a London based biotech company (and my future employer), LabGenius, directly headhunted me to join their company more than one year before the official end of my DPhil.*

Aleksandr Kovaltsuk, Industrial Fellow 2018

For some, it is clear that without the award from the Commission, their project would not have gone ahead:

*I originally proposed my project to my employer 12 months prior to applying to the 1851 before I knew it existed and although my manager told me he liked it and it was a good idea he said we could not allocate any time or resources to work on it. I can say that without the support of the Commission this project would not have gone ahead. I am grateful that it did as this project has allowed me to develop a process and product from the initial concept through to lab scale testing, something I don't believe I would have been able to do at this stage in my career without the support of the Commission. Doing this has allowed me to gain a wide range of engineering skills I would have never developed as a chemist on my previous career trajectory. I have learned how to weld as well as how to code, I have become a qualified refrigeration and ATEX engineer and I have been awarded membership of the Institute of Chemical Engineers. This has positioned me within the company as the go between for the chemical and engineering departments. The support from the Commission I believe has been very valuable, especially to a small company. To be able to train a PhD in the company's core subject matter is something that most SMEs would not be able to do without external support.*

Andrew Anderson, Industrial Fellow 2017

Academic and Industrial Supervisors are also very complimentary about the Commission's Fellowships:

*In my opinion, the support provided by the Royal Commission through their Industrial Fellowships is fantastic. It provides a fantastic platform for bright young individuals to develop their independent careers. I am very grateful for the support offered to Iestyn and our research and as such make it*

*a point to ensure that I continually promote the scheme to my network, not only the Industrial Fellowship but all of the generous awards offered by the Commission. I have found the process of being a supervisor of an Industrial Fellow most fulfilling. As an academic engineer, and Whitworth Scholar, I think it is so essential that schemes such as this fellowship continue to facilitate the engagement of academia and industry and it is only through schemes such as this that creativity and innovation in British industry will continue to propagate.*

Professor Karl Dearn, University of Birmingham

*The Fellowship allowed a small start-up (3 people when the Fellowship first started) to give the Fellow the potential to develop a completely new product range from scratch and increase his knowledge and future capability. This would not have been possible without the support of the Fellowship during the period.*

Dr Alex Reip, Oxford nanoSystems

A more complete picture of the impact of the Commission's awards comes from the honours and awards bestowed on more senior alumni – some highlights are given on pages 34-35. Many of our alumni tell us that their Fellowship has made a decisive difference to their career:

*The 1851 Fellowship gave me an invaluable platform and recognition as an independent researcher. It was a fantastic opportunity to do cutting-edge research, meet new colleagues and friends and build networks for a lifetime.*

Dr Apala Majumdar, Research Fellow 2006

*I had the great fortune of being granted an 1851 award that I used to support my first post-doctoral position at the Plant Breeding Institute in 1984. Subsequently I spent the next 35 years in research at CSIRO and then the Australian National University where I am currently a professor in the Plant Science Division of the Research School of Biology. The 1851 gave me the chance to develop independent research in the UK and was a wonderful opportunity at the start of my career. I have spent my career investigating photosynthesis and most recently have been trying to apply this towards increasing crop yield. I was elected fellow of the Australian Academy of Science in 2013 and last year was recognised with a Highly Cited Researcher in Plant and Animal Sciences award by Web of Science.*

Professor John Evans, Overseas Scholar 1984

*Getting the Rome Scholarship in Painting from the Royal Commission of 1851 changed my life. It sent me to the British School at Rome in 1979, where I had a year to paint with total support and during that year my professional future opened up and I was awarded a Fulbright fellowship to the USA. I've never looked back. I'm represented by a NY gallery and my paintings are in major collections including The Metropolitan Museum of Art and the V&A Museum London.*

Carole Robb, Rome Scholar 1979

*It's 28 years since I first visited Imperial College London (ICL) for my Royal Commission for the Exhibition of 1851 Industrial Fellowship interview at the Sherfield building and was ecstatic to be told that I had been successful! The award enabled me to travel around the UK (and the World) to visit eminent academics, engineers and industrialists, who gave me their time, experience and advice willingly. This was invaluable in my formative engineering development and has provided life-long career contacts.*

*So, in 2017, it was with great pride that I took on the role of Royal Academy of Engineering (RAEng) Visiting Professor of Robotic Systems Architectures at ICL. This scheme aims to get senior industrialists to contribute to undergraduate teaching and was my opportunity to 'give back' to academia and engineering. Primarily, my approach was to link the students' academic taught work to the Dyson 360Heurist, a robotic vacuum cleaner for which I was the Product Technical Lead.*

*With the support of Dyson, I was able to extend the aim of the scheme and provide teaching at other institutions. Over the three-year tenure of the award I supported 18 Universities, 34 unique cohorts, and engaged with 1136 students covering England, Wales, Ireland and Scotland. In addition, with the help of the teaching staff at ICL I achieved Fellowship of the Higher Education Academy (FHEA). I have now joined the RAEng Visiting Professor Management group to assist with the strategy, development and running of the scheme. Further, I will continue to provide Industrial Teaching to help the development of the next generation of engineers.*

Dr Robert Deaves, Industrial Fellow 1994-1997

For some, a Fellowship does much more than just enable a successful career:

*As a recipient of an 1851 Royal Commission Fellowship I can say that this set me on the path to becoming a successful academic, and, importantly for me, also to having a family. For anyone wanting to be a professional scientist/academic, i.e. continuing after the PhD, your career requires you to move, branch out and fight hardest to stay in the game typically in your late 20's to 30's and this is exactly the same time, especially for women, that the 'biological clock ticks loud'. The freedom provided by the two year-fellowship comes at a crucial time and is invaluable because it provides:*

- (i) endorsement to me and the world that you are on-track to becoming an independent scientist (what employers are looking for)*
- (ii) flexibility to control where you are in a critical phase of your life: staying with a partner / moving away from a partner can be make-or-break for women continuing their careers and I think this is a big reason why we lose so many good female scientists from the PhD to postdoc and higher rank phases – they don't necessarily want to relocate where a partner cannot follow (or does not want to) at that stage in their lives (if they want a family).*

*My fellowship allowed me to find a solution that allowed my partner and I to be in a place where we both had fulfilling work in the same town. Always a challenge for ambitious couples.*

*After my Royal Commission Fellowship came a second success – my good start resulted in me obtaining a 5-year Royal Society University Research Fellowship, which allowed me to continue the independence and flexibility.*

*20 years later, I am now doing really well as a Senior Lecturer at Stockholm University working in the field of palaeoclimate research, AND have a teenage family, in part because of the great start my Royal Commission fellowship gave me. Thank you, Royal Commission, for investing in me! Plus I will never forget the incredible dinner and evening at the Royal Armoury when I was sitting opposite HRH Prince Philip, Duke of Edinburgh, with the Director of the Natural History Museum on my side (inspiring conversation), and on occasions, experiencing wonderful performances of music and dance at the Royal Albert Hall. What a package of privileges!*

Dr Helen Coxall, Research Fellow 2000

The work of our alumni also has tremendous real-world impact. To take one topical example, the intelligent cameras for better transport planning developed by 2016 Enterprise Fellow Yang Lu and his company Vivacity Labs have really come into their own during the pandemic. The company now has more than 1,000 sensors installed across the UK, in cities including London, Manchester, Oxford, Cambridge and Nottingham, the data from which is fed back to Government to inform Covid policy. In addition, Vivacity Labs' technology has been adopted by more than 30 UK councils, following the recent £250m government funding awarded for regions to develop 'Active Travel' schemes, which encourage people to avoid public transport or their cars and instead walk or cycle to get around. The company has also recently secured a partnership with Transport for Greater Manchester to control traffic across 25% of the central Manchester area.

As well as its core fellowships and studentships, the Commission also runs a very successful Special Awards programme, supporting individuals and institutions with similar aims to the Commission. As in previous years, many of the awards reflect the Commission's continuing commitment to raising the awareness of the young to the opportunities presented by science and engineering. They include awards to Physics Partners, to produce a series of videos for teachers giving tips on how to

teach key topics; to Fun Kids Radio, for a series of audio programmes on great British inventors; to Primary Engineer, for a series of podcasts aimed at young people, featuring engaging engineers; to SmartSTEMs, for development of an online platform and event package kit to facilitate STEM outreach events aimed at young people from disadvantaged backgrounds; and to In2ScienceUK to provide information, mentoring and skills workshops to help young people from low income and underrepresented backgrounds move into STEM careers.

As the examples above illustrate, the Commission funds a wide range of innovative STEM initiatives at varying scales, recognising that not all will achieve huge success, but in the hope that most will transform individual lives, and some will go on to have considerable reach. Feedback from grant recipients suggests the programme is largely achieving its aims. To take a couple of recent examples:

In 2016, The South Downs National Park became the world's latest International Dark Sky Reserve, with 66% of the Park having Bronze Level Skies. The South Downs Dark Night Skies Festival was launched to celebrate this designation and help people experience the joy of witnessing and understanding dark night skies.

The Commission's support enabled the introduction of Virtual Reality technology that furnished those attending the event on a cloudy night or in areas suffering from light pollution with the opportunity to virtually experience a true dark night sky, inspiring them to go out and seek the real thing. The VR experience has since been used at school science events and other outreach programmes, where it has proved universally popular.

To take another example, Kids Invent Stuff is an initiative by two former Young Engineers of the Year to establish a YouTube channel to get primary school children inventing things – which are then built by real engineers. They do this to give more primary school kids the chance to engage with real engineering projects. The Commission first supported their Big Inventor, Little Inventor Challenge in which the presenters, Ruth Amos and Shawn Brown, brought to life a different kid's invention every month, with often hilarious consequences. Inventions brought to life so far include a robot shopping trolley and the world's first sneeze-activated flamethrower. Their work has been featured on Tomorrow's World Live, BBC News Online as well as major US TV news outlets. More recently, the Commission supported their Giant Rube Goldberg Machine Challenge which saw them build a giant chain reaction machine from 60 kids' invention ideas, setting a new world record and securing a live invention demo on BBC's *The One Show*. Together it is estimated that these projects have reached over 6 million people through national media, views and mail outs.

Needless to say, not all Special Awards proceed completely smoothly, and many recent awards are suffering significant delays in implementation as a result of the pandemic. Nevertheless, anecdotal evidence suggests that it is interventions such as these that can make all the difference in stimulating young people to become the scientists and engineers of tomorrow and the Commission remains committed to doing what it can.

In recent years, the Special Awards Programme has been complemented by an increasing focus on the Commission's own educational initiatives, including, in 2020, the Great Exhibition at Home, which challenged schoolchildren to produce a video at home showing their ideas for addressing the impact of climate change. This was enthusiastically received and achieved excellent press coverage. It is estimated that around 10,000 children engaged directly or indirectly with the programme and the quality of the final entries was excellent. The programme won many plaudits for providing a constructive way for parents to entertain children stuck at home while their schools were closed.

As well as promoting STEM outreach, the Commission also makes Special Awards focused on continuing to develop South Kensington as the premier destination for those interested in science, engineering, art and design. This year, as mentioned in the Chairman's report, they included a major award to improve the public realm around the Royal Albert Hall.

Finally, the Commission sometimes makes Special Awards to facilitate access to its own archives and in 2020 gave a grant to the University of Oxford to support the work of Dr Andrew Cusworth, who is seeking to enhance access to and understanding of material relating to Prince Albert's legacy, including the Great Exhibition.



## COVID-19

As made clear in the Chairman's Report, the Commission, like every other organisation, has been impacted by the pandemic; many events had to be cancelled and some programmes moved on-line. In terms of its core grant-making activity, however, the Commission has largely been able to continue as planned and Commissioners do not believe that any adjustments to the accounts are required.

As soon as the possibility of a pandemic became clear, the Finance Committee acted to ensure that there were sufficient cash or near cash assets in place to fund at least three years' expenditure in full. This gave confidence that the Commission would be able to ride out the immediate disruption and need not curtail any of its programmes. The Committee also met regularly with the investment managers to monitor the position. Investment markets have to be sure been much more volatile and the day to day value of the Commission's portfolio has inevitably reflected that. The Commission is a long-term investor, however, and Commissioners remain confident in the underlying strength of the portfolio; they see no evidence at this stage of any permanent loss of value. Indeed, the value of the Commission's portfolio has risen over the year.

Similarly, while some of the Commission's tenants have asked for and received temporary support with deferred rent demands and the like, there is not considered to be any risk to the long-term value of the estate. That is not to say of course that some of our legacy institutions have not been severely impacted.

The Commission had robust business continuity plans in place and Commissioners, Committee members and staff have adapted relatively straightforwardly to the need for remote working. The 2020 and 2021 award rounds for all the Commission's Fellowships and Studentships have gone ahead as planned with a full complement of awards made. A majority of existing award holders have been able to adapt their workflow patterns to fit the unusual circumstances imposed by lockdowns etc. Where this has not been possible, the Commission has granted extensions and provided the necessary financial support. Commissioners have also been pleased to provide 'paid sabbaticals' where award holders' specialist skills have enabled them to support the fight against COVID-19, whether through testing, modelling or other means.

All in all, Commissioners are confident that whatever the short-term disruptions, the pandemic should not have any material, long-term impact on the Commission's work.

## Post balance sheet event – Brexit

The Commission does not import or export significant goods or services from the EU and does not currently employ any staff from the EU; to date there has been relatively little direct impact from Brexit therefore.

The Commission's alumni system is hosted in the EU and the Commission may therefore be impacted by changes to data protection regulations arising from Brexit, particularly if an adequacy decision is not forthcoming. However, the Commission has taken relevant legal advice and remains confident that it should be possible to meet any new requirements through proper contractual arrangements.

Although none of the eligibility criteria for the Commission's various awards have changed as a result of Brexit, Commissioners accept that there may nonetheless be some impact on the number of Fellowship applications the Commission receives from EU citizens and this will be monitored over time. So far, however, application numbers appear to be holding up well.

## Future Plans

The Commission has long recognised the need to ensure a future pipeline of applicants for its awards by raising awareness amongst the young of the excitement and importance of STEM, something it does primarily through its Special Awards programme. Over the past 15 years the Commission has awarded grants totalling £2m to a variety of organisations adopting a wide spectrum of different approaches. Commissioners would like to develop a strategy for STEM interventions more clearly focused on long term impact with hard to reach groups and will be examining how this might be possible. Commissioners will also be exploring how to move beyond raising awareness to facilitating access to STEM careers, building on Special Awards such as that to In2ScienceUK mentioned earlier in this report and the Technical Teaching Fellowship programme mentioned by the Chairman.

In recent years the Commission's Special Awards programme has been complemented by its own educational initiatives, including in particular the inaugural Great Exhibition Road Festival and 2020's Great Exhibition at Home. The enforced closure of the Albertopolis institutions in response to the pandemic makes it difficult to say with certainty when large scale public events in South Kensington will be possible again, but the Commission stands ready to play its part in helping Albertopolis to thrive again as the premier destination for those interested in science, engineering, art and design.

Another ongoing priority for the Commission is to increase awareness of its award programmes and the opportunities they provide to the brightest and the best. The pandemic has restricted opportunities to implement marketing campaigns and ambassadorial networks, but the Commission remains committed to moving forward with new initiatives as soon as possible. The Commission is particularly keen to raise awareness amongst the UK's black and minority ethnic populations and amongst young female scientists, engineers and designers. The Commission is looking at how it best works with its alumni, universities and others to increase the diversity and inclusivity of its awards.

As well as raising awareness of its awards, and their impact, the Commission will as always be reviewing the value they add and ways in which they can be improved and made more attractive to potential applicants. Commissioners will also be looking at new ways in which the Commission's objects can be promoted beyond its award holders. With the incorporation of the Sir Misha Black Awards into the Commission's portfolio, Commissioners are particularly focused on exploring ways in which the Commission can positively influence design education in the UK and extend its support beyond those fortunate enough to win its Industrial Design Studentships.

## Awards Granted in 2020

### Research Fellows

#### **Dr Claudia Bonfio**

*Subject:* Exchange of chemical messages between primitive cells *University of Cambridge*  
Drawing upon the principles of supramolecular chemistry, lipid self-assembly and peptide biochemistry, this project aims to build functionalised primitive cells capable of molecular transport and signalling, ultimately leading to cell-to-cell communication. The research will thus provide a more complete picture of the transition from prebiotic chemistry to early life.

#### **Dr Matthew Gleeson**

*Subject:* Decoding the crystal record of volcanic eruptions *Cardiff University*  
It is now becoming clear that magmatic systems beneath volcanoes are vertically extensive and predominantly crystal rich. These crystals preserve an important, but understudied, record of pre-eruptive magma system dynamics. This project will explore this record using state-of-the-art geochemical techniques to identify the primary process of melt transport within crystal-rich magma reservoirs.

#### **Dr Xianxin Guo**

*Subject:* End-to-end optical training of neural networks *University of Oxford*  
This project aims to realize the first optically trained neural network with an end-to-end optical backpropagation scheme. Constructed with simple linear optical elements and atomic vapor cells, such an optical neural network can offer significant computation speedup and remarkable power reduction as compared to its electronic counterparts.

#### **Dr Harry Miller**

*Subject:* Geometric approach to optimisation in quantum thermodynamics *University of Manchester*  
One crucial obstacle for designing reliable quantum devices stems from the influence of unwanted fluctuations that can damage thermodynamic performance. This project will devise powerful methods for optimising the control of realistic quantum systems using techniques from differential geometry, with an aim to guide the development of improved quantum technologies.

#### **Dr Alex Plajer**

*Subject:* Mechanistic catalyst control in CO<sub>2</sub>/epoxide copolymerization *University of Oxford*  
This project will explore mechanistically guided ligand design for CO<sub>2</sub>/epoxide copolymerization to target the co-catalyst copolymerization and free block-copolymerization and challenging epoxide monomers such as propyleneoxide and limonenoxide.

#### **Dr Adam Smith**

*Subject:* Understanding strongly correlated matter using quantum computers *University of Nottingham*  
This project offers new approaches to further our understanding of currently perplexing strongly correlated quantum materials and address fundamental open questions in condensed matter physics. It will develop new quantum algorithms to tackle these questions that are tailored for the new quantum computing technology that has emerged in recent years.

#### **Dr Patrick Stowell**

*Subject:* Cosmic ray neutron detectors for smart agriculture / civil engineering monitors *Durham University*  
This project will develop novel, low cost, soil sensors that use background radiation to map soil moisture with enhanced resolution over existing measurement techniques. These sensors will enable new methods to autonomously monitor moisture variation over time to extract valuable information on the hydrological properties of large areas of land.

**Dr Hannah Wauchope**

*Subject:* Understanding the biodiversity of the past to predict the future

*University of Exeter*

As the Earth's climate emergency worsens, understanding how species' distributions will shift is key to effective conservation. Using the past 17,000 years of climate change as a natural experiment, this project will identify what traits helped species track suitable habitat, to help predict the distribution of biodiversity on a future Earth.

**Dr Niclas Westerberg**

*Subject:* Reshaping the quantum vacuum for photon sources

*University of Glasgow*

As photon sources get smaller, their shape and the nature of their surroundings increasingly affect the quantum fields inside them. This project will bridge the theory gap between photon generation and quantum vacuum effects at these scales, which will enable nano-optic devices, and advance fundamental studies of the quantum vacuum.

## Brunel Fellow

**Dr Edward Hart**

*Subject:* Advancing main bearing science for wind and tidal turbines

*University of Strathclyde*

Wind turbine main bearings are failing with much greater frequency than expected, with associated costs running into the hundreds of millions. This project looks to significantly reduce these costs and the failure risks associated with main bearings in wind and tidal turbines by establishing a detailed scientific understanding of this component.

## Industrial Fellows

**Maral Bayarra**

*Subject:* Satellite-enabled early warning system for geotechnical structures

*Sponsor:* Satellite Applications Catapult

*University of Oxford*

Interferometric Synthetic-Aperture Radar analysis allow the detection of mm-precision ground motion from space. This enables large-scale monitoring of geotechnical structures such as tailings dams which have an unacceptably high failure rate. This project will develop AI-embedded remote monitoring tools with early warning capabilities.

**Sam Bourne**

*Subject:* Characterising genetic variants associated with pain to improve the clinical translation of novel therapies

*Sponsor:* LifeArc

*University of Kent*

This project will address the poor clinical translation of pain therapies, which are urgently required. Genetic variants within ion channels linked to pain will be interrogated and characterised. Novel therapeutic candidates identified at LifeArc will then be screened to improve the translation of first-in-class therapies and stratify patient populations.

**Daniella Cheang**

*Subject:* Can we keep borrowing from future generations? A green, biomimetic method for controlling chirality

*Sponsor:* AstraZeneca

*University of Oxford*

Hydrogen borrowing provides an elegant alternative to Nature's carbon-carbon bond synthesis. This proposal outlines a strategy for developing a sustainable, biomimetic, enantioconvergent method for converting racemic feedstock alcohols into enantiopure biologically relevant molecules. Producing water as the sole by-product, this method has extensive potential for industrial use.



**Sophie Duong**

*Subject:* Metal to ceramic interfacial engineering for armour applications

*Sponsor:* Dstl

*University of Surrey*

The international defence scene is ever-changing and threat levels are increasing. Armour development is necessary to protect our Armed Forces to ensure they are best equipped to protect us. This project proposes a novel approach to bonding metals with ceramics to better protect soldiers from new and existing ballistic threats.

**Jack Kay**

*Subject:* Discovery of novel antimicrobial peptides to combat current and emerging superbugs

*Sponsor:* Ingenza

*University of Plymouth*

Antimicrobial resistance is a growing global health threat. Antimicrobial peptides have therapeutic value and Ingenza plan to use their knowledge, experience and relationships with academic leaders to discover novel peptides for tackling emerging superbugs. This project will support the development of new and improved methodologies and tools to this effect.

**Joseph Lawton**

*Subject:* Remote plasma sputtering of high-quality thermochromic thin films for energy conservation

*Sponsor:* Plasma Quest

*University of Surrey*

Improving windows' energy efficiency and controlling solar infrared radiation heating is crucial for reducing future global energy consumption for cooling buildings. Vanadium dioxide technology promises smart energy-efficient windows but requires high temperature processes. Utilising a novel, scalable technique, a visibly transparent, infrared radiation-regulating, vanadium dioxide window coating is targeted.

**Poppy Oldroyd**

*Subject:* Conducting polymer electrodes for interfacing with the brain

*Sponsor:* Johnson Matthey

*University of Cambridge*

Conducting polymer-based electrodes are being used for recording and stimulating the central and peripheral nervous system in order to understand and treat neurological disease. The aim of this project is to understand how the fundamental properties of these electrodes determine recording / stimulation efficiency and device lifetime.

**Euan Rodgers**

*Subject:* Development of a permanently installed monitoring system using guided waves for safety critical nuclear components

*Sponsor:* Rolls-Royce

*Imperial College London*

The inspection of safety-critical nuclear components is essential but is often difficult and costly. This project will develop a novel permanently installed monitoring system using guided waves, allowing the inspection of large geometries from a single position with increased sensitivity and reduced cost when compared with currently used ultrasonic methods.

**Thomas Waddell**

*Subject:* Causal modelling of type 2 diabetes and multi-organ dysfunction through quantitative magnetic resonance imaging: applying Bayesian networks

*Sponsor:* Perspectum Diagnostics

*University of Oxford*

Obesity is associated with multi-organ dysfunction and poor health outcomes. This project aims to develop a computational model of obesity utilising Bayesian-network methodology that incorporates quantitative MRI metrics of multiple organs and bioinformatics. This model will allow the prediction of future patient health outcomes and the provision of targeted interventions.

**Declan Williams**

*Subject:* Flow versus batch chemistry in the safe manufacture of explosives

*Sponsor:* QinetiQ

*University of Birmingham*

Flow chemistry methods offer adaptable, greener processes with a higher level of control compared to traditional batch reactions. This project will investigate the synthesis of both qualified and unqualified military explosives through the use of microreactors, and how their chemical and physical properties vary when compared to batch processing.

## Enterprise Fellows

**Lewis Hornby**

*Company:* Jelly Drops

Many people with dementia are no longer aware of thirst, do not equate drinking with quenching thirst and do not recognise cups for what they are. Eating is often easier than drinking, even still, it's difficult to encourage them to eat. One way to overcome this is to offer a treat! This format excites people with dementia, they instantly recognise it and know how to interact with it. Jelly Drops are hydrating treats that enable people with dementia to hydrate more often and independently.

**Alex Murdock**

*Company:* Thermulon

Thermulon has designed a novel continuous chemical process to synthesise complex nanoporous insulation materials at scale by combining new techniques coming out of academia with scalable industrial production. The process comes from discussions with over 40 players in the construction space (Mace, ARUP, Kingspan etc.) to define their insulation problem, combined with discussions with over 30 world leading academics in nanoporous materials. In combination with reading over 130 research papers, multiple product iterations were devised to develop a building material that could be processed in a way to directly match the industry defined criteria of energy-efficiency, fire-safety, sustainability and price.

**Matt Escott**

*Company:* Protolaunch

Protolaunch reduces the cost of access-to-space for small payloads by enabling a small launch vehicle that can disrupt ridesharing services by facilitating dedicated launch for small payloads. A bottom-up design approach to propulsion enables an engine specifically designed for <100kg payloads from the outset rather than miniaturising technology from larger vehicles. Protolaunch's engine implements a novel thermodynamic cycle utilising phase changes of cryogenic nitrogen within the engine cooling jacket to provide performance and cost advantages. Such a vehicle can deploy satellites exactly where and when required, extending their onboard fuel supplies so customer satellites can generate revenue sooner and for longer.

**Bella-Trang Ngo**

*Company:* Brarista

Brarista is a B2B2C software that replicates fully the process of professional bra-fitting. It makes it possible for women to shop and get fitted properly and accurately from home, using any digital camera. Via their favourite retailers, by wearing a tight vest top and taking several photos of their upper body, consumers can use the software to work out exactly what bra size to buy in the right bra styles that work for their breast shapes and fashion needs. To achieve the highest level of accuracy, Brarista's unique computer-vision algorithm is trained on an ever-expanding proprietary data set of real-life women.

### **Varun Sarwal**

*Company:* Hammer

Hammer is the world's first *adaptive* flight automation software for unmanned aerial vehicles. It is highly versatile in that it supports many different types of flight automation, and yet extremely simple to use. Using artificial intelligence and modular software architecture, the software morphs itself based on the task at hand. This allows operators to use the same software for a number of different flights, eliminating the need to learn new software all the time. Moreover, with features such as Terrain-follow, 3D Views, in-built simulator and multi-mission automation, it can be used to automate flights even in the most complex environments.

### **Joseph Sherwood**

*Company:* Flit [Financially supported by the ERA Foundation]

Flit's e-bike uses a novel fold with the battery and other electrical components built into the top tube, and the motor built into the rear hub. By using a new design, we are able to select lightweight electrical and mechanical components to minimise the weight of the bike. This allows for a clean looking e-bike that is specifically designed to be easy to carry and, at 14 kg, is 30% lighter than a typical folding e-bike. This is not possible with existing designs which have evolved to work with a specific subset of components.

## **Design Fellow**

### **Aran Dasan**

*Subject:* "Enki" – Technology for Resilient Biodiverse Oceans

*Mentor:* Professor Michel Kaiser, Heriot-Watt University

The ocean is under intense environmental and societal pressure from the twin effects of climate change and human fishing activity, forcing humanity to rethink our relationship with marine ecosystems. In the meantime, we struggle to source healthy protein for a growing population (currently, around 20% of the global population relies on ocean protein). The ocean can be a source of this sustainable 'blue' protein, but fishing fleets require smarter tools to fish better.

Enki is a new technology for 'Precision Fishing', a concept analogous to movements in Precision Agriculture and Internet of Things. It is an idea for highly targeted fishing that is based on frequent and spatially dense observation and measurement of the oceans, in response to impending scarcity of marine resources. Enki exploits the ubiquitous nature of global fishing operations: aiming to turn fishing gears into ocean sensors and fishing vessels into scientific platforms, to measure the ocean densely and cheaply on a similarly massive scale, returning benefits to fishermen and their stakeholders in fisheries management, as well as scientific and policy communities.

Enki is a toolkit of devices that attaches to and converts fishing nets into these ocean sensors. By measuring key oceanographic variables (temperature, salinity) at-depth, at the same time as measuring fishing outcomes (fishing type, catch amounts, location, duration), Enki aims to create a rich dataset to support dynamic fisheries management decision-making, on-the-spot fishing sustainable decisions by skippers, and enhanced climate change modelling and weather prediction.

## **Sir Misha Black Medal for Distinguished Services to Design Education**

### **Professor Birgit Mager**

*Professor of Service Design*

*University of Applied Sciences, Cologne, Germany*

Since her appointment in 1995, Professor Mager has developed the theory, methodology and practice of Service Design. Her lectures, projects and publications have led to a new understanding of the economical, ecological and social function of design in the provision of public and private services.

## Sir Misha Black Awards for Innovation in Design Education

### **Professor Oliver Broadbent**

*Founder and Director*

*Constructivist Ltd*

Professor Broadbent has dedicated his career to injecting creativity into university-based engineering design education. In the last decade he has led the way in ensuring that the climate emergency is a central driver in engineering design and in advocating that the creative response of engineers must be central to ensuring positive change in the built environment.

### **Professor Daniel Charny**

**Ms Dee Halligan**

*Founders*

*FixEd*

Professor Charny and Ms Halligan founded FixEd as a ‘think and do tank’ working with schools, colleges and universities to foster design skills for a changing world. Their aim is to put social and environmental matters at the heart of practice across disciplines under the banner of ‘applied creativity’.

## Industrial Design Students

|                     |                                                                      |                                                     |
|---------------------|----------------------------------------------------------------------|-----------------------------------------------------|
| Alex Dallman-Porter | Innovation Design Engineering                                        | Royal College of Art and<br>Imperial College London |
| Daniel Ellis        | Industrial Design                                                    | Central Saint Martins                               |
| Sean Fisher         | Contextual Design                                                    | Design Academy Eindhoven                            |
| David Harris        | Global Innovation Design                                             | Royal College of Art and<br>Imperial College London |
| Ella Hetherington   | Bio-integrated Design                                                | University College London                           |
| Daniel Karaj        | Global Innovation Design                                             | Royal College of Art and<br>Imperial College London |
| Roumyana Kotopanova | Manufacture and Commercialisation<br>of Stem Cell and Gene Therapies | University College London                           |
| Tahira Resalat      | Innovation Design Engineering                                        | Royal College of Art and<br>Imperial College London |
| James Stirrat       | Innovation Design Engineering                                        | Royal College of Art and<br>Imperial College London |
| Joy Zhang           | Innovation Design Engineering                                        | Royal College of Art and<br>Imperial College London |

## Special Awards Granted

### *STEM education and outreach*

Smart STEMs – Digital portal

Ruth Mountford – They Made It podcasts

Fun Kids Radio – How's that Made?

Physics Partners – Physics videos

Primary Engineer – Leaders Award podcasts

In2ScienceUK – Alumni programme

RedR UK – Engineering in emergencies

London Transport Museum – Engineering your neighbourhood

Cranfield University – National flying laboratory centre

### *Support for legacy estate*

Science Museum Group – National Railway Museum's Great Machine

Royal Albert Hall – Public realm project

Exhibition Road Cultural Group – Covid Culture Shock event

### *Archives and Alumni Relations*

University of Oxford – Digitizing Albert Research Fellowship

Royal Collection Trust – Queen's Bindery Apprenticeship Scheme

## Awards completed in 2020

### Research Fellows

#### **Dr Claire McIlroy**

*Project:* Semi-crystalline materials in additive manufacturing

*University of Nottingham*

Additive manufacturing is a disruptive polymer processing technology, offering mass customization and personalization that is unavailable via traditional manufacturing techniques. Compared to other methods, filament-extrusion 3D printing is considerably cheaper and has the ability to process durable high-performance thermoplastics for high-end applications. However, weakness along the welds that join the extruded filaments is a crucial factor limiting advanced application. Recently, the use of semi-crystalline polymers in 3D printing has sparked much interest for numerous reasons, including increased mechanical strength and biodegradability, which is particularly important for tissue-engineering applications. During her fellowship, Claire developed the first molecularly aware model of the printing process that couples flow, rheology and crystallization kinetics under typical non-isothermal conditions. Using this model, she was able to gain a fundamental understanding of how semi-crystalline polymers behave during printing, and how different conditions may affect the final properties of a printed part.

By collaborating with experimental teams at the University of Nottingham, NIST, University of Bradford, and the University of Genoa (funded by a Royal Society Exchange Scheme), she was able to validate the model predictions: flow through the nozzle can align the polymer molecules and subsequent rapid solidification can 'freeze-in' this molecular structure leading to the notorious weak spots along the welds. On the other hand, this flow-induced polymer alignment can alter the crystallization kinetics leading to smaller, stronger crystal structures localised to the weld region. Thus, this research fellowship has opened new avenues for controlling printed properties via molecular design.

In September 2020, Claire transitioned to a Lecturer position in the School of Mathematics and Physics at the University of Lincoln, where she will continue her research in polymers used for additive manufacturing applications; in particular with her collaborators at Lincoln she will investigate 3D printed personalised pharmaceutical tablets via multi-scale computational modelling. Claire has recently been appointed as the Secretary for the British Society of Rheology and as an Associate Editor for the *Additive Manufacturing* journal.

**Dr Guillaume Nataf**

*Project:* Colossal barocaloric effects in liquid crystals

*University of Cambridge*

Cooling is essential for perishable food, medicine, buildings and electronics. Current cooling technologies exploit large thermal changes that occur in fluids when driving liquid to gas phase transitions with pressure. However, these vapour-compression technologies are harmful to the environment and display low energy efficiencies. By contrast, cooling based on pressure-driven thermal changes in solids, i.e. barocaloric effects, promise novel environmentally friendly cooling technologies with high energy efficiencies. While several major breakthroughs have been recently reported, solid barocaloric materials are still in their infancy, and they all operate at solid-solid phase transitions.

During his fellowship, Guillaume investigated (baro)caloric effects in liquid crystals. Liquid crystals have properties between those of conventional liquids and those of solid crystals. For instance, a liquid crystal may flow like a liquid, but its molecules may be oriented in a crystal-like way. Guillaume demonstrated that both lyotropic and thermotropic liquid crystals exhibit outstanding barocaloric responses due to their large thermally driven changes in entropy, small thermal hystereses and extremely large shifts of their transition temperatures with pressure.

During the project, Guillaume established strong national and international collaborations (e.g. with the University of Luxembourg, the University of Barcelona and the University of Ljubljana), published six articles in international peer-reviewed journals (e.g. Nature Reviews Physics) and was awarded a Junior Research Fellowship by Wolfson College Cambridge. At the end of the second year of his fellowship, Guillaume was appointed Researcher at the French National Centre for Scientific Research (CNRS). Based in the laboratory GREMAN, in Tours, he is now investigating how ferroic oxides can be used to obtain dynamic heat flow controls in large temperature ranges.



**Dr Mark Puttick**

*Project:* Biodiversity and the sixth mass extinction: lessons from the past *University of Bath*

Mass extinctions are large-scale events in which a huge proportion of standing life goes extinct in a short space of time. Probably the most famous mass extinction is the Cretaceous-Palaeogene crisis 66 million years ago that wiped out the non-avian dinosaurs. Mass extinctions are fascinating in their own right: by destroying swathes of diversity (diversity is the number of species that exist at a point in time) these mass extinctions have altered the course of evolution. Large scale loss of lineages allows surviving clades to prosper and radiate.

During his fellowship, Mark addressed major questions related to mass extinctions: (1) how did these mass extinction events alter major patterns of trait evolution? (2) and what methodological approaches are available to study these events? To answer these questions it is vital to turn to the fossil record, as well as develop approaches and models to clarify the impacts of extinctions.

Mark used a simulation approach to understand patterns of evolution of continuous measures of biology, such as body size, through mass extinction events. He found that in response to mass extinctions changes in body size are inherently variable even under simple patterns of change and understanding the ‘selectivity’ of these events is difficult with current statistical approaches. Furthermore, even extinction events in deep time can leave ‘traces’ of the mass extinction in the distribution of body traits in living species.

Mark also wrote new approaches for studying mass extinctions in the R package *motmot* that contains extensive code to examine trait evolution and mass extinction selectivity. Using this code (<https://cran.r-project.org/web/packages/motmot/index.html>), he found that the mass extinction 66 million years ago was followed by 10 million years of rapid evolution in body size of mammals as they exploited available ecological space vacated by the extinction of dinosaurs.

In addition to these main studies, Mark has written code and published a paper for preparing and analysing molecular clock studies to date events in the history of life, including mass extinctions. He also published a Masters project for which he was the main supervisor on the selectivity of extinction during a major extinction, the Triassic-Jurassic extinction around 200 million years ago. He has also contributed novel R code incorporated on the CRAN database in the package *disparity* (<https://cran.r-project.org/web/packages/disparity/index.html>).

Following the fellowship, Mark is now a Senior Analyst at the Office for Students.

**Dr Andy Kah Ping Tay**

*Project:* Magneto-mechanical biomedicine for pain modulation and immune engineering *Imperial College London*

Andy’s research focuses on delivery of DNA into immune ‘soldier’ cells to engineer them into ‘super-soldiers’ to eliminate cancer. As a result of the pandemic, Andy has decided to cut short his fellowship after only a year and relocate to be closer to his family, accepting a position as Assistant Professor at the National University of Singapore.

Despite his limited tenure, Andy’s research made significant progress and he hopes to file a patent in the next year. Andy has also received a number of prestigious awards including: BrightSpark Top 30 Young Engineers in the UK; Imperial College London President’s Award for Research Excellence: Outstanding Early Career Researcher (one of only four); World Economic Forum Young Scientist (one of only 25 selected globally in 2020); Alessandro Chiabrera Award for Excellence in Bioelectromagnetics.

Andy writes: “I am extremely grateful to the Commission for nurturing me and providing me with financial and administrative support. It was only through the support of the Commission that I was able to accomplish so much during this short period. As a beneficiary of the Commission, I hope to represent the organisation as an alumnus, sharing my fellowship experiences and enhancing research ties between Singapore and the UK.”



**Dr Matthew Wallace**

*Project:* Elucidation of carbohydrate dissolution and gelation using NMR imaging techniques

*University of East Anglia*

The ability to measure the properties of molecules quickly and accurately is fundamental to modern science. Whether it is a new drug, a material or a cosmetic ingredient it will have faced a battery of analytical tests throughout its development. Nuclear magnetic resonance (NMR) can provide the 3D structures of molecules with unparalleled efficiency and is one of the most important analytical techniques in the chemical and biological sciences. However, two serious drawbacks of conventional NMR are the slow speed of analysis and the high cost of the equipment. An NMR spectrometer, which costs more than £500k, is only able to process one sample at a time with analysis taking anything from a few minutes to several hours. In this project, Matthew has developed a fundamentally new approach to NMR that enables multiple analyses to be condensed into just a single NMR experiment, thereby providing substantial savings in time, labour and cost. Using controlled chemical concentration gradients, Matthew's methods enable molecular systems to be analysed under a range of conditions without the requirement to prepare and analyse a large number of separate samples. For example, the pH-dependent properties of a drug molecule can now be measured in 20 minutes rather than the several hours of tedious sample preparation and analysis required by the conventional procedure. Matthew's methods also provide greater insight into the processing of next-generation sustainable ingredients for personal care and medical products. Matthew has published eight papers during the fellowship, three as first author, and has recently been awarded a UKRI Future Leaders Fellowship to continue his research in NMR method development at the University of East Anglia.

## Industrial Fellows

**Andrew Anderson**

*Project:* Manufacturing enhanced heat transfer surfaces on commercial heat exchangers

*Sponsor:* Oxford nanoSystems

*University College London*

Over the course of the fellowship Andrew developed a novel coating process which allows for the rapid, large-scale micromachining of non-flat surfaces over the range of 50-500µm+ which can be integrated into the current product offering at Oxford nanoSystems and increases the range of applications for the technology. Andrew also designed, built and heavily modified a heat transfer test rig which is capable of performing experiments with every refrigerant available on the market including CO<sub>2</sub>, propane and ammonia, over a wide heat flux range, something which hadn't been previously achieved in any company or academic institution. This will allow the technology to be tested in the widest range of possible applications even on refrigerants which aren't on the market yet to keep the company at the forefront of technology and allowing the company to create quick proof of concepts in each area which would normally require a new rig for each application. This allows the company to significantly reduce development and process optimisation timescales. Now that the fellowship has ended, Andrew is continuing work at Oxford nanoSystems on the new coating process as well as building a database of the different factors which affect heat transfer and a model which will accelerate the company's development time further.

**Timur Avkiran**

*Project:* Discovery of novel small molecule drugs for the treatment of tuberculosis

*Sponsor:* LifeArc

*University of Warwick*

Timur's project targeted antibiotic resistance in the hope of developing novel cures for some of the world's toughest diseases. During his fellowship, he was able to progress a number of drug targets from early stage screening hits to the point of in vivo testing. All of the compounds he produced were tested in a biochemical assay to test for potency against the isolated target protein. Compounds of interest were then selected for more thorough ADME (absorption, distribution, metabolism and excretion) testing, to test the compounds solubility, stability and permeability. Compounds with a promising profile were subsequently tested for antimicrobial activity against Mycobacterium Tuberculosis and Mycobacterium Bovis and showed evidence of antimicrobial activity. It is hoped that these compounds may yet lead to novel therapeutics for targeting TB. Timur's work was greatly assisted by the travel budget associated with the fellowship which allowed him to attend relevant international conferences and have meetings with leading academics in the TB field. The feedback and ideas gained from these opportunities were then used to help guide his research further. Timur is continuing his research at LifeArc and is delighted that a fellow LifeArc employee has been appointed an Industrial Fellow this year.

**David Dearlove**

*Project:* The regulatory and downstream effects of supplemental ketosis

*Sponsor:* TdeltaS Ltd

*University of Oxford*

Ketones are molecules produced by our body during starvation that have profound effects on metabolism (that is, the way our body uses and stores energy). TdeltaS Ltd. Has developed a ketone-containing drink, which may be used to enhance human physical performance and potentially as an adjunctive treatment for some diseases. Across three studies recruiting 39 healthy participants, David's work has provided novel insights into the effects of this drink on human physiology, metabolism and physical capacity. This includes understanding: the optimal dosing of the ketone drink; determining ketone oxidation rates (that is, how much of the ketone ingested is "burnt" to create energy) and how this is affected by energy demand (that is, the rate at which the body must "burn" fuels to create energy); which individuals may benefit most from consuming the drink (based on the molecular characteristics of their skeletal muscle fibres); and determining the effects of repeated dosing (three times daily for 10 days) of the drink on carbohydrate and fat metabolism. As the company expands its global operations (<https://www.tdeltas.global>) this basic science is essential to determine how to most effectively utilise the ketone drink to enhance human performance and health. To date, David's work has led to 4 publications in peer-reviewed journals with more expected and, of course, a doctoral degree. David will continue this work as a post-doctoral researcher at the University of Oxford with TdeltaS Ltd., building upon the learning and experience he gained during his DPhil.

**Carlos Julià**

*Project:* Development of an automated bioreactor for suspension and adherent cell expansion for cell therapy manufacture

*Sponsor:* Aglaris Ltd

*University College London*

This project focused on developing a better bioreactor for cell therapy manufacture. Significant progress was made, particularly in respect of the process control system.

Carlos is now a Process Development Scientist at GammaDelta Therapeutics.

### **Aleksandr Kovaltsuk**

*Project:* Using antibody next generation sequencing data to aid antibody engineering

*Sponsor:* UCB Pharma

*University of Oxford*

Aleksandr's project was conducted in collaboration with UCB Pharma, a biopharmaceutical company based in Slough. During his fellowship, Aleksandr studied the human adaptive immune system and how it can be leveraged in therapeutic antibody engineering. More specifically, he interrogated snapshots of natural human antibody repertoire diversities generated by next-generation sequencing (NGS) technologies. He developed multiple open-source software packages to enable scientists to interrogate the entirety of antibody repertoires using structural information for the first time. These tools were published in peer-review journals. UCB Pharma actively uses these software packages in their antibody discovery pipelines.

A significant number of studies have made their antibody repertoire data publicly available. However, these outputs are fragmented across repositories and tend to be presented as raw nucleotide reads, which means non-trivial effort is required to reuse the data for analysis. To address this issue, Aleksandr developed the first database that curates more than 1.9 billion sequences from 85 studies. This knowledge is of high significance in guiding therapeutic antibody development by referencing to the sequence space accessible to naturally observed human antibodies. This database was also made open-access and published in a peer-review journal.

Lastly, Aleksandr helped the scientific community in the global COVID-19 research effort. He co-authored the development of the first database that collates all known antibody binders against SARS-CoV-2. Each of these binders holds a valuable piece of molecular descriptor information about SARS-CoV-2 complementarity. One of the immediate applications of this database is the assessment of the adaptive immune response elicited by COVID-19 vaccine candidates and natural infections. A unified enrichment of the known neutralising sequences in antibody repertoires across all post-vaccinated human donors would be indicative of an effective and protective immune response.

Following his fellowship, Aleksandr will be joining a London based biotech company, LabGenius, as a Data Scientist.

### **Iestyn Stead**

*Project:* Reduction of parasitic losses in zero emissions liquid air engines

*Sponsor:* Dearman

*University of Birmingham*

Iestyn's research focussed on reducing losses found in a zero-emission cryogenic engine – the Dearman Engine – operating in conditions that allow for the introduction of innovative technologies: the introduction of polymers, biomimetic lubricants and improved analysis methods.

The first area analysed identified the potential for frictional reduction that replacing metal engine components with polymers can provide: increasing the efficiency of the engine, reducing the mass and the cost of manufacture. The second investigation developed novel lubricants based on natural sources. These lubricants have the potential to drastically change the nature of the Dearman Engine, reducing the need for auxiliary components and the number of fluids within the engine. The key to the efficiency of the engine and what separates it from other cryogenic engines is the presence of a heat exchange fluid (HEF); the fluids that were developed will lubricate and have the potential to also operate as a HEF.

The final area of research was based on how the collection and analysis of frictional data are done. Polymers and biological compounds have mechanical properties that are dependent on the frequency and time of loading; Iestyn's work exposed the impact of this on the friction and wear properties and the benefit of using high sample rate monitoring in the determination of these.

Following the completion of his fellowship, Iestyn will be remaining at the University of Birmingham as a Research Fellow researching other environmentally focussed technologies.

### **Chris Towell**

*Project:* Smart mixing – artificial intelligence in live music mixing systems

*Sponsor:* Allen & Heath Ltd

*University of Plymouth*

Allen & Heath is seeking to develop intelligent automatic mixing systems both to aid experienced audio engineers and to enable inexperienced users to improve audio quality in live events.

As a tool for automatic music mixing, Chris has developed a neural network based musical instrument recognition model that is on a par with the state of the art in academia and industry. This has saved the company a considerable sum of money as the company was previously in talks to purchase such a model for circa \$150,000. This model is due to be incorporated into an upcoming product which is expected to be the first in a line of intelligent mixing consoles.

Chris has also developed a novel technique for automatic mixing using information theory that together with techniques developed to overcome the lack of training data will form the basis for the company's future work on automatic mixing, enabling the company to maintain a competitive edge over its international competitors.

Following the completion of his fellowship, Chris will remain at Allen & Heath, working to continue integrating machine learning models into their products and engaging in further collaborations with the University of Plymouth. Having been awarded the fellowship through an unusual route, Chris has only partially completed his PhD and hopes to resume studies in August 2021.

### **Ed Williamson**

*Project:* New ceramic coatings for small modular reactors

*Sponsor:* Rolls-Royce plc

*University of Surrey*

Ed's Fellowship focused on the development of new coating materials for components in small modular reactors (SMRs), a type of factory-built fission reactor, currently revolutionising the nuclear industry. Components in nuclear environments have to withstand high levels of irradiation, wear and corrosion so coatings are vital for component longevity.

Current components in reactors are typically coated in hard chrome plating using electrodeposition, but this process creates carcinogens. Around the world, governments are creating regulations to curb the levels of chemical pollution from industrial processes. The new coatings developed have provided alternatives with reduced environmental impact.

From the coatings identified and tested, the  $\text{Cr}_2\text{O}_3$  thermal spray coating had the best overall performance in irradiation and wear testing but there were concerns over its corrosion performance. The  $\text{Cr}_3\text{C}_2$ -NiCr coating was shown to offer comparable irradiation and corrosion performance to Hexagonal Close Packed structure (HCP) and could be considered for use in applications where wear performance is not as critical. The study also highlighted key factors for future testing in this field, such as the importance of using borated water in wear testing and the benefit of X-ray photon electron spectroscopy in providing additional wear performance information.

Ed's Industrial Fellowship funding allowed additional coatings to be tested, which was highly beneficial. Dissemination to the wider nuclear industry and ceramics sector was achieved at international conferences in Japan, Singapore and the USA. A scientific journal paper was also published in the *Wear* journal.

Ed is now employed by MBDA as a Senior Materials Engineer.

## Enterprise Fellows

### **Surakat Kudehinbu**

*Technology:* Microfluidic lab-on-a-chip

*RAB-Microfluidics*

RAB-Microfluidics have developed cutting-edge microfluidic technology to provide automated real-time continuous testing and analysis of lubricating oil in valuable machinery. This technology has the advantage of combining the depth and robustness of conventional laboratory analysis with onsite delivery. It improves efficiency, reduces operating expenditure and increases the uptime of heavy rotating machinery. This technological innovation enables RAB-Microfluidics to solve the hard-to-reach and hard-to-sense challenges of many businesses across various industries such as processing and manufacturing, power generation, offshore wind, transport and the maritime industry.

Surakat comments that the Enterprise Fellowship has been of immense value both to him personally and RAB-Microfluidics. The Fellowship granted the company access to fellows and mentors with tremendous business experience and insightful industrial knowledge that has helped bring the company closer to commercialisation. During Surakat's Fellowship, RAB-Microfluidics began generating revenue from paid pilot trials of their technology in the maritime and energy sectors, expanded their team and closed a £1.24 million investment round.

As RAB-Microfluidics enters into its next phase of growth, the company plans to further strengthen their team and develop their product roadmap, with the aim of a full product launch in the maritime sector in the first quarter of 2022.

### **Ben Lakey**

*Technology:* Affordable prostheses

*mitt Wearables*

Since Ben was awarded the Fellowship, Mitt Wearables has raised angel investment, hired its first five employees, received CE Marking approval and launched its first product. Mitt won an Innovate UK Global Challenges Research Fund Grant in 2019 and was awarded 'Disruptor of the Year' at the 2020 London Business Awards.

In the last few months, Ben has started a new digital health company, Syndi Health, within the London 15 cohort of Entrepreneur First, with the aim of supporting the surge of people in need of urgent mental health support. Syndi's first two digital products are medically approved and ready to support patients through continuous and passive monitoring using the most valuable and accessible window into their behaviour and health – their smartphones.

Syndi has secured initial pre-seed investment from Entrepreneur First and will start pilot trials with several NHS Mental Health Trusts and University Student Wellness Support Teams around the UK during 2021.

## **Rowan Minkley**

*Technology:* Sustainable bioplastics

*Chip[s] Board*

Chip[s] Board is developing an eco-friendly wood substitute manufactured from industrial potato waste. Unlike MDF, Chip[s] Board is biodegradable post-use, its production is carbon negative and contains no added formaldehyde or other toxic resins or chemicals. The company has secured a steady supply of raw materials through a partnership with McCain's Foods Ltd. During the Fellowship, Chip[s] Board relocated to a warehouse in Leyton and established a 100-litre production line. The company received a Business of Fashion, Textiles and Technology SME grant and a Knowledge Transfer Network Spark Award.

Rowan says: "The Enterprise Fellowship was a huge turning point in our development. Having bootstrapped the company for the first year while working part-time to keep food on the table, we suddenly had access to some capital to keep the company running and access to high-quality mentorship to accelerate our progress.

Over the past few years, we have grown from a humble team of three to a dynamic team of seven, with industry specialists in each research and development department – and we will shortly be expanding to a team of twelve.

The support programme helped push me with pitch practice and public speaking (something I have never been too fond of), allowing me to articulate our vision and entice investors. Paired with a deep dive into operations and accounting, the programme has shaped my understanding of raising investment and managing a small company.

Since participating, we have secured over one million pounds in equity investment and over three hundred thousand pounds in grants. The most recent investment was secured to relocate from London to Leeds and begin commercialising our technology in a pilot plant."

## **Lewis Hornby**

*Technology:* Hydrating sweets

*Jelly Drops*

Jelly Drops make hydrating sweets for people with dementia. Since being accepted onto the Enterprise Fellowship Jelly Drops has made fantastic progress despite an otherwise challenging year. The company has grown from four to 14 staff, built a production facility, successfully launched its product and has now supplied over 1.5 million Jelly Drops. During the last 12 months Lewis and the team have secured a further two rounds of investment putting them in a strong position to expand staff numbers and production capacity and start shipping to the US.

Since launch the product has received a great response and Lewis comments that it's been incredible to hear the stories shared by people in their community about how Jelly Drops are improving lives. The team have used this feedback to develop the product further – launching a new and improved version in March 2021.

Given the pressure the care sector has been under to protect their residents during the pandemic, roll-out in care homes has understandably been delayed. But in the limited trials the team have conducted they have received great feedback and insights and are now in a great position to launch across the sector with their updated product. This was recognised at the National Dementia Care Awards where Jelly Drops were awarded the Innovation Prize.

Lewis says: "The support offered through the Enterprise Fellowship has been invaluable in helping us successfully scale, for this we are very grateful to the Royal Commission for the Exhibition of 1851 and the Royal Academy of Engineering. This support has given us a great foundation going into 2021 and beyond. We look forward to our continued expansion and getting Jelly Drops in the hands of people that need them the most!"



## Built Environment Fellows

**Ms Ellen Hadden, Ms Astrid Bois d'Enghien, Ms Roberta Marcaccio  
and Mr Tom Greenall, DSDHA**

*Subject:* Cycling and the Built Environment – Sharing the Beautiful Everyday Journey

*Mentor:* Mr Alan Baxter, Alan Baxter Ltd

The focus of this project was 'Can cycling infrastructure help improve London's public realm?' This question immediately raised further questions; what is London's cycling network and why is it different from other cities? And what do we mean by an improved public realm for London?

The team's research into the nature of London's cycling network supported the notion that the scale and morphology of London means that it is often impossible to replicate the ordered infrastructure of European cities such as Copenhagen and Amsterdam. Cycle journeys in London are on the whole much longer and often pass through a much more varied range of street typologies – many of which are narrow and non-orthogonal. The lack of space available on the street network, particularity in central London, means that cyclists, and their infrastructures, are often excluded from the key nodes and landmarks which might help them navigate through this megacity.

The question of what an improved public realm for London means has been difficult to define; architects and urban designers are overwhelmed with a plethora of guidance, design checklists, movement simulation software and technical information that helps shape the design of cities. But this guidance often ignores the aesthetic, temporal and psychological aspects of movement which is integral to the diverse experience, good or bad, of individuals on our streets.

The recent political rhetoric is positive; we want to create healthy, inclusive streets which encourage more walking, cycling and use of low-carbon public transport. But how do we achieve this in ever-changing, crowded, central London where demands on space are such that some form of sharing is required but where conflicts over behaviour and users' priority are most likely to arise?

The debate over cycling and the public realm, falls too easily into the polarised camps of segregated or shared, but the team see the role of the urban designer as one that can challenge this oversimplification. Our urban environment is impacted by multiple mutable factors including policy, weather conditions, diverse behaviour and activity. Our city requires designs that accommodate this movement and change. Yet we lack a consistent method to visually represent and test the range of factors affecting a space when designing for movement. The team's research seeks to provide this method.

The team sought to develop a visual or drawn methodology for designing cycling (or other movement) infrastructures that could help improve the experience of London's public realm for all users. They have developed a nine-criteria design toolkit, which can be used in tandem with existing guidance such as TfL's Healthy Streets Indicators, that provides a methodology for exploring the spatial, temporal and psychological aspects of movement.

The team have tested the design methodology on a series of case studies of different scales and types in London to demonstrate how it might be used; this included testing proposals as an alternative vision for the reconfiguration of Oxford Street. It is the team's hope that designs produced using this methodology will help to make London's streets healthier, more enjoyable and beautiful places in which to be.

**Professor Irena Bauman**

*Subject:* Manufacturing an Inhabitable City – Built InCommon

*Mentor:* Professor Flora Samuels, University of Reading

Irena's fellowship conceptualised and developed a replicable prototype for new neighbourhood-based facilities, an enabling infrastructure to support localised manufacture of residential and commercial buildings. A network of such local workshops would generate a Built InCommon ecology of supply chains, skills training, and users.

Irena conducted a review of the industry, including the policy environment, the range of available Modern Methods of Construction (MMC), the range and types of factories, and the range of the emerging distributed construction systems. This helped her understand the supply side. She also undertook a similar review of the demand side by researching the sector of housing providers that could be interested in the social, economic, and environmental value offered by Built InCommon.

This early research revealed a number of distributed systems that could be fabricated locally by communities themselves, and a number of organizations interested in exploring the potential of setting up a Built InCommon facility.

The regulatory and financial environment were also reviewed. To fully understand the impact of regulations on the distributed systems, she initiated the Build Offsite Property Assurance Scheme process of accreditation for MassBespoke – one of the new construction systems – which provided first-hand experience for the study.

The next focus was the business models for the distributed fabrication of buildings. Irena designed and costed a flying factory, working with two community development trusts in different locations to develop integrated local supply chains with existing workshops and other local stakeholders, including funders and public bodies.

The main outputs of the fellowship have been The Built InCommon Beginners Guide, which includes six case studies of community-led, locally fabricated homes and a five-minute video explaining all the key findings and including testimonies from the community organizations that are pioneering the concept and developing the infrastructure and ecology of Built InCommon. Three Built InCommon build projects have been completed and three other, larger affordable housing projects (50 dwellings in total) are awaiting planning approval. The ecology of Built InCommon is taking roots and growing.



## Design Fellow

### **Ms Jennifer George**

*Subject:* Design and ‘Fake News’ – The Shelter Schema: Designing for Displacement

*Mentor:* Dr John Orr, University of Cambridge

In response to a call to disrupt ‘fake news’ and false information, Jennifer proposed a system for aggregating existing information in the shelter and settlements sector of humanitarian aid into a digitally accessible format for shelter practitioners on the ground, enabling practitioners to make better informed decisions in humanitarian shelter projects.

Following the completion of a prototype of the system in year one, and a successful collaboration with the International Organisation for Migration in year two, the software is now in place. It allows practitioners to access information, education, and communication (IEC) materials related to shelter. In addition to this, IOM have conducted a rigorous review of the IEC materials in the system, utilising their extensive networks of shelter practitioners. This means that field practitioners can also view the review comments on the documents made by technical experts, making informed choices on best practice. As a result of this collaboration, IOM have issued a thank you to the project, stating that ‘by having the IEC material openly accessible through the software platform, this project will facilitate the rapid development of common messaging in emergency responses’.

Jennifer’s fellowship has also enabled wider thought in the shelter sector, including the publication of a new definition of sheltering, opinion pieces in ‘Shelter Projects’ and Forced Migration Review, book chapters in InterAction’s Roadmap for Research and a Routledge Handbook, and papers in academic journals. The new definition of sheltering in particular could have significant impact on future policy and projects. It has also enabled talks at the Centre for Geopolitics, Cambridge Festival of Ideas, and across academic departments.

Most recently, Jennifer was invited to join the 2021 UN Youth Forum Roundtable on ‘Leveraging Technology to Enable Migrants’ and the 2021 UN Global Forum on Migration and Development to provide insight on the development of this software, and the usefulness of digitally-accessible reviewed information, as best practice for the humanitarian sector going forward. This could have real and valuable impact on the creation of future digital systems by governments, policy makers and humanitarian leaders.

Jennifer has recently been awarded the Royal Charter International Research Award for Young Constructors from BRE and the Worshipful Company of Constructors to continue the research started during her fellowship.

## Industrial Design Students

### Harry Barber

*Course:* Innovation Design Engineering

*Royal College of Art*

Harry's second year projects focused on providing sustainable solutions to contexts where people currently rely on fossil fuel powered machines.

Harry's group project, *Saiga*, was a wearable that changes its user's perception of temperature by cooling specific locations on their neck and giving them the option to breathe cold air when necessary. It was proposed as a way of reducing dependence on air conditioners which are used worldwide despite being highly polluting, inefficient and energy demanding machines. The *Saiga* wearable came out of an extensive experimental design process where Harry and his group discovered methods which allow us to alter our perception of temperature rather than changing the temperature of the environment around us.

Harry's solo project, *Sycamore*, was a portable wind power harvester designed as a sustainable alternative to diesel generators. It produces power using an inflatable kite that flies crosswind through the sky tethered 100m above a base on the ground. The whole system can be packed down into a small box for transportation and it is able to generate substantial amounts of power autonomously and entirely renewably.

Due to its unique portability, *Sycamore* is the first renewable energy technology that has the potential to bring power to contexts without a power grid or where the power grid is broken, where people currently depend on diesel generators for power. This project was awarded first prize in the KI Award in 2020.

Since graduating, Harry has been working as a Future Product Researcher at Brompton Bicycle in London. His role involves researching what cities of the future will look like, and designing, prototyping and testing ways that we could be moving through them.

### Nadia Bassiri

*Course:* Innovation Design Engineering

*Royal College of Art*

During her studentship Nadia focused on projects exploring the intersection between technology and the future of healthcare.

For her group project she explored ways to reduce rising chronic illnesses caused by a lack of physical activity. Her group created *ALLYN*, a device that attaches to widely available home exercise bikes, transforming them into immersive exercise machines. *ALLYN* controls the resistance of the exercise bike and facilitates a convenient virtual workout between two or more people in different locations, simulating a tandem bike ride. This novel tandem bike exercise makes connected users indispensable to one another and is built upon the scientifically proven motivational mechanism known as the Köhler Effect, where a sense of indispensability is known to increase effort and adherence during group exercises. *ALLYN* was exhibited at two graduate shows, where an interactive set allowed people to successfully try the tandem bike experience.

For her solo project, Nadia created *TRACE*, a behaviour tracking wearable and app for people with Obsessive Compulsive Disorder (OCD) and collaborated with mental health professionals and people with lived experience of OCD. OCD is an anxiety disorder where obsessive thoughts trap people in a cycle of compulsive behaviours. Compulsions can often manifest as ritualistic interactions with objects and *TRACE* is designed to track these rituals, providing powerful novel behavioural data that can be used by therapists and users to monitor and better understand symptoms, with the aim of improving and recommending treatment via the app.

After graduating, Nadia started a new role as Lead Design Engineer at AMPHIBIO, an InnovationRCA start-up developing bio-inspired materials technology with applications in deep sea diving and sustainable textiles for sportswear.

## Jeffrey Chow

Course: Innovation Design Engineering

Royal College of Art

Jeffrey's final year project tackled the global issue of food waste. His approach focused on changing consumer behaviours, households being the largest contributor to food waste in the UK and other countries. Working in collaboration with PhD students from Imperial College Bioengineering, he developed *HoneyBox*, a technology-based behavioural intervention that completely automates food management for consumers. It consists of a smart food container that uses a low-cost, paper-based gas sensor to measure spoilage gases and detect food degradation. *HoneyBox* adds value to fresh ingredients by informing consumers about food quality and extending foods' shelf-life. The product is used with an app that provides detailed information on any food, an overview of the food stored in the fridge, automated reminders before foods expire, and suggested recipes that pair with stored foods. *HoneyBox* provides consumers with never-before-seen real-time information about their food to help them manage their fridge, reduce food waste and guarantee food safety. The project is also built on evidence from scientific literature that successful food waste preventative solutions align consumers' personal goals, such as saving time/money and eating good food, with food waste reduction goals which primarily involve planning or managing food better.

Jeffrey has now joined the PhD team BlakBear to continue developing *HoneyBox*. They have recently secured a government grant from Waste Resources and Action Planning for a one-year consumer trial of *HoneyBox*. Jeffrey is also developing prototypes to pilot BlakBear's technology with food processors and retailers in the hope of tackling food waste across the entire food chain.

## Aimee-Elisabeth Kyffin

Course: Innovation Design Engineering

Royal College of Art

With a background in Product Design, Aimee joined the IDE course at the Royal College of Art and Imperial College London to further her education and give her time to discover how to bring together multidisciplinary teams to create positive impact on the world around them, by and through Design, Engineering, Social Sciences and the Commercial disciplines.

For her final group project, Aimee and her course mates Claudia Maw, Daan Leenarts and Melinda Kuei, spent 3 months designing and testing *Heart Restart*. *Heart Restart* is a unique and innovative defibrillator because of its small size, the fact that it is owned by the at-risk patient and that it empowers their friends and family to save their life in case of an emergency. *Heart Restart* gives a second chance at life from a pocket. Aimee and her team are currently working with medical and technical experts to continue the development of *Heart Restart*.

For her final solo project, Aimee worked in partnership with Shafina Vohra, a PhD student at Imperial College, to develop *Clickit*. *Clickit* provides multi-sensory language development opportunities for children, through the use of colour and shape when learning to read and write. Everyone deserves an equal chance at an education, especially those who are dyslexic. *Clickit* is a way of giving these children an education and a future. Extensive testing with students of all ages and abilities has shown the value of teaching all children to learn in this new way. Aimee and Shafina are continuing to work together to further develop *Clickit* with the hope of bringing it to market.

Currently Aimee is working as an Experience Designer for Chemistry Team, a Strategic Design Consultancy with an emphasis on healthcare and public sector projects around the world.

## Tom Pais

Course: Innovation Design Engineering

Royal College of Art

Throughout his Master's degree, Tom explored how cyber-physical systems and digital innovations could make an immediate impact on our health, environment, and wellbeing.

For his final project Tom developed *GEIA*, an artificial intelligence platform that makes indoor health measurable and manageable through 30+ real-time proxy variables, giving building managers the data they need to continuously make their building a healthier place. With over 90% of all infections – including COVID-19 – taking place inside buildings, it is clear that pathogens are currently thriving in absence of smart, targeted cleaning and indoor health management. *GEIA* was exhibited at Dutch Design Week 2020 and has garnered interest from the world's largest real estate and building management corporations.

Upon graduating, Tom combined nurturing *GEIA* into trial phase with working as an investment analyst for a sustainable venture capital fund. Currently, Tom is building Gorillas – the fastest growing start-up in Europe – from the ground up in the Netherlands. He aims to unite the operational experience of building a business from 5 to 300 employees with the creative, technical, and human-centred lessons learned during his course in Innovation Design Engineering, in order to continue building impactful ventures.

## Ravi Woods

Innovation Design Engineering

Royal College of Art

For his final project, Ravi developed *Eccla*; a modular system of furniture for churches. Currently, most churches have pews; heavy benches that discourage flexible use of the church space. However, in the 21<sup>st</sup> century, numbers are declining, with church membership having decreased by 8% since 2012. In response, churches are having to use their space more flexibly, with furniture playing a key role. However current solutions, such as stackable chairs, look messy and untraditional within the church space.

*Eccla* is a furniture system that aims to strike a balance: giving churches the flexibility to use their space in a range of ways, while still keeping a traditional design aesthetic. This is achieved through wood and metal finishing, and iconography inlaid within the piece.

Each *Eccla* bench is made of two pieces – a base and a back – which simply clamp together. This allows for four main setups: as a straight row for traditional services, as curved rows for concerts or lectures, as tables & chairs for Bible studies & dinner events and stacked away for full use of the space.

Thus, *Eccla* can be used for a range of events, while also giving churches the opportunity to rent out their spaces.

During his studentship, Ravi enjoyed working on the design and engineering of the built space and now works at the engineering firm Max Fordham LLP, where he has specialised in the lighting design and energy usage of large-scale cultural buildings.

## Alumni Awards, Honours and Achievements

A selection of the alumni appointments, publications, honours and awards notified to the Commission. The Commission encourages all alumni to keep their alumni profiles up to date so that their successes can be celebrated.

### Overseas Scholars

Professor Richard Sibson (1969-1972)

- Awarded R.A.F. Penrose Gold Medal, Society of Economic Geologists

Professor Surya Thakur (1970-1973)

- Published second edition of *Laser Induced Breakdown Spectroscopy*

### Research Fellows

Dr Jo Ashbourn (2002-2004)

- Organised conferences on *The Rise of Big Science in Physics*, *The Greatest Physics Discoveries of the 20th Century* and *Physics of the Impossible Revisited* at the St Cross Centre for the History and Philosophy of Physics

Professor Michael Cant (2000-2002)

- Appointed a Fellow at the Institute for Advanced Study, Berlin

Professor Apala Majumdar (2006-2008)

- Awarded British Liquid Crystal Society's Cyril Hilsum Medal
- Awarded Suffrage Science Award in Mathematics

Professor Rachel Oliver (2003-2005)

- Named one of the Top 50 Women in Engineering by the Women's Engineering Society

Professor Hugh Osborn (1966-1968)

- Elected a Fellow of the Royal Society

Dr Richard Preece (1977-1979)

- Awarded Quaternary Research Association's James Croll Medal

Dr Nicole Reindl (2017 – 2019)

- “An in-depth reanalysis of the alleged type Ia supernova progenitor Henize 2–428” published as a highlight article in *Astronomy & Astrophysics*

Professor Edward Tate (1999-2001)

- Awarded Corday-Morgan Prize, Royal Society of Chemistry
- Cofounded Myricx Pharma

### Industrial Fellows

Dr James Palles-Dimmock (2013-2016)

- Completed £8m investment round with Quantum Motion Technologies Ltd

### Industrial Design Students

Mr Steven Williams (2008-2010)

- Launched ICODice (<https://icodice.co.uk>), a unique learning aid for students and professionals alike, bringing the mundane formula sheet into three dimensions

## Enterprise Fellows

Guillem Singla Buxarrais (2017)

- *NeuroBall*, a novel medical device for post-stroke rehabilitation:
  - Secured investment from the o2h Therapeutics and AI Fund
  - Secured support from MedCity and Stroke Association through Collaborate to Innovate
  - Started pilots with leading rehab facilities in the US, following FDA registration

Victoria Hamilton (2017)

- *Recoil Kneepads* picked by ‘Business Insider’ as the best such products available for extended use.

Ming Kong (2016)

- Launched a successful Kickstarter campaign to bring his company TGO’s *etee* button-free VR controller to market
- TGO shortlisted for an E&T Magazine award in Outstanding Innovation in Manufacturing 4.0

Ms Hsin-Hua (Sheana) Yu (2018)

- Commercial launch of *Aergo*, the world’s first automated postural management seating system

## Rome Scholars

Mr Hugh Petter (1990)

- Awards from SW RIBA, Civic Trust and National Housing Awards for mixed use urban extension to Newquay at Nansledan

Ms Carole Robb (1979)

- Solo exhibition, Tibaldi Gallery, Rome

# Report by the Chairman of the Finance Committee

## *Executive summary*

The net assets of the Commission at 31 December 2020 stood at £138m compared with £128m at 31 December 2019. The total expenditure on charitable activities during 2020 was £5.2m, compared to £4.3m the previous year. For the last nine years a strategic asset allocation biased heavily in favour of real assets has been consistently pursued by the asset managers appointed and regularly reviewed by the Commission. Notwithstanding recent volatility, this policy has aligned itself with the value expansion in equity markets with the result that the nominal value of the Commission's portfolio has grown at an average annual rate of approximately 8.2% after all fees and disbursements.

## *Organisation*

The Board of Management has appointed the Finance Committee as a sub-committee to supervise the Commission's finances and investments; this Committee meets at least twice a year. During 2020 there were two formal meetings and an additional nine teleconferences with the Commission's investment managers to monitor the performance of the portfolio in light of the global pandemic and to take appropriate action. I would like to thank all members of the Committee for their sterling work in overseeing the Commission's finances.

## *Sources of Funding*

The Commission's income and gains derive primarily from its investment portfolio. In 2020, property (the Commission's estate) made up 16%, stock market investments and bonds 83% and cash 1% of the capital assets (for 2019 the corresponding figures were 16%, 83% and 1% respectively).

## *Reserves Policy*

The total funds at the balance sheet date were £138,125,545 (2019: £128,403,095).

These funds originated from the surplus arising from the Great Exhibition of 1851 and have been enhanced by careful stewardship of the assets invested over many years. They are technically unrestricted, giving the Commissioners the ability to spend the funds as they wish in fulfilment of the charitable objectives of the Commission. None of the funds are in assets that cannot readily be realised.

In order to balance the needs of current and potential future beneficiaries of the charity, the Commissioners recognise the need to maintain a strong capital base so as to deliver an appropriate level of return to enable the Commission to continue to fulfil its charitable objectives on a long term basis. Accordingly, all of the Commission's funds are invested in line with the investment policy described below and normal expenditure commitments are set to match the assumed average return above inflation delivered by the portfolio.

Given the Commission's flexibility to spend capital if required, the Commissioners do not consider that there is any merit in identifying an optimum level of free reserves that might be readily available if required but will respond appropriately to spending needs identified as and when circumstances arise.

## *Investment Policy*

The Commissioners believe that they can best 'make a difference' by maximising the financial return from the investment portfolio and using that return to fund fellowships, studentships and other charitable grants. The Commissioners' investment objective is therefore to achieve sufficient total returns to fund the existing award programmes whilst also protecting the capital value of the portfolio for future beneficiaries. Superior performance will be used to sustainably expand the programme of activities. The Commission reviews its asset allocation and manager selection on a regular basis with these objectives in mind.



Commissioners have determined that a strategic asset allocation biased heavily in favour of ‘real’ assets (equities, properties, commodities, etc.) as opposed to ‘nominal’ assets (cash, bonds etc.) gives it the best chance of meeting its overall investment objective over the long term. In order to ensure sufficient liquidity so that grant commitments should always be able to be met without the need to sell assets at distressed prices, Commissioners have determined that a minimum of £5m should normally be held in ‘nominal’ assets such as cash and bonds; beyond this, it is expected that the portfolio will normally comprise ‘real’ assets.

As at the balance sheet date, the Commission’s portfolio was spread across three investment managers: a global equity fund of approximately £71.2m managed by Schroders (C.I.) Ltd; a portfolio of exchange traded funds of approximately £38.5m actively managed by Charles Stanley & Co. Ltd and an investment of approximately £10.6m in a strategic bond fund managed by JP Morgan Asset Management Ltd. The Commission also owns the freehold of various properties on its legacy estate in South Kensington valued at £23.3m.

The overall portfolio targets an absolute return over the economic cycle of RPI + 4%, after all charges; there is no income target although the composition of the portfolio is such that in a normal year income of around 2 – 3% pa is expected. Each fund manager also compares performance against appropriate market and sector benchmarks.

The Commission recognises that its investments have wider impacts and seeks to align its investment strategy with its aims, reflecting the views of its stakeholders and taking into account broader public benefit. The Commission expects its investment managers to integrate Environmental, Social and Governance (ESG) considerations into the normal investment process and to fulfil the requirements of the UK Stewardship Code, actively engaging with the companies in which they invest to promote best practice corporate behaviour and sustainable business practices. Given its limited staff resources, it is not practical for the Commission to engage directly with individual companies, but it does expect its investment managers to report annually on their engagement activities and results.

The Commission expects its investment managers to apply ESG considerations to both segregated holdings and pooled holdings, taking account of the extent to which suitable alternative investment vehicles are available and bearing in mind de minimis considerations. The Commission will only appoint managers who are signatories to the UN Principles of Responsible Investment (UN PRI) and will take into account the ranking assigned to those managers by the UN PRI.

The Commission may exclude certain stocks or sectors where these are seen to be in direct conflict with its objects and activities. Equally, where consistent with the financial objectives, the Commission seeks to invest in areas with positive environmental and / or social impact, such as clean energy and various areas of new technology.

The Commission recognises that climate change is a key challenge for the next decade and that limiting global temperature rises will require significant change in business, investment, technology development and fossil fuel use. The Commission monitors the carbon emissions of its main equity investment portfolio and through its investment managers seeks to reduce these emissions over time. As at the balance sheet date, the Commission’s main segregated equity portfolio had scope 1 and 2 carbon emissions that were 81% less than the MSCI World index (2019: 67% less than the MSCI World index). The carbon intensity of the Commission’s combined equity portfolio (direct and indirect holdings), measured in tonnes of CO<sub>2</sub> emissions per million dollars of sales was approximately half that of the MSCI World index.

#### *Disbursement policy*

The Commission’s long-term aim is to disburse approximately 4% per annum of the trailing three-year average closing capital value of its investment portfolio.

Liquidity is maintained at a sufficient level to ensure the cash outside the investment portfolio is enough to cover short-term expenditure.



## *Comments on the Results for the Year*

In 2020, the portfolio generated returns of £15,593,069 (2019: returns of £22,144,755). After allowing for donations and other income of £72,032 (2019: £24,792), total expenditure of £5,919,025 (2019: £4,924,544) and actuarial losses of £23,626 (2019: gains of £76,852) this resulted in a net increase in funds available to finance future grants of £9,722,450 (2019: £17,321,855).

The total return comprises income and gains / losses. The annual income generated in 2020 by the Commission's assets was £2,715,229 or approximately 2% of opening portfolio value, somewhat less than the yield the previous year (2019: £2,728,598, 2.5%) reflecting the impact of the pandemic on corporate dividends. Capital values also experienced greater volatility during the year, but the Commission's investment managers were able to position the portfolio to take advantage of those sectors of the economy able to perform well during the pandemic and as a result the Commission's liquid investment portfolio enjoyed gains of £10,902,758 (2019: £17,229,216). The directly held property portfolio also saw revaluation gains of £1,975,082 (2019: £2,186,940), the majority of the gain relating to one high end residential property which was the subject of negotiations regarding freehold transfer.

Expenditure on raising funds – which primarily comprises investment and property management fees – increased from £658,343 to £740,364. This increase primarily reflects professional fees incurred in respect of the potential freehold transfer referred to above.

Total expenditure on charitable activities of £5,178,661 was £912,460 more than the previous year. This primarily reflects an exceptional Special Award of £1.2m for public realm improvements at the northern end of the Commission's estate.

## *Overview*

The Commission manages its assets on a total return basis. Overall, the Commission achieved a total return net of fees of approximately 11%, considerably in excess of the RPI + 4% target for the year of 5.2%. This return was comfortably ahead of peer group indices such as the ARC Equity Risk Charity Index (2.3%), although somewhat below stock market indices such as the MSCI AC World (12.7%) and the IA Global Equity Index (14.8%). In 2019 the Commission achieved a total return of approximately 18%, compared to a target of 6.2%, an MSCI AC World Index return of 21.7%, an IA Global Equity Index return of 22.1% and ARC Equity Risk Charity Index return of 17.4%.

Looking at the last nine years together, since the current investment policy was established, the real return on the portfolio net of fees has averaged 8.6% pa, more than sufficient to fund the target 4% disbursement. Clearly, the financial position and performance of the Commission year to year is sensitive to movements on world stock markets but the outperformance over recent years means the Commission's financial position is extremely strong. Moreover, while volatility will inevitably affect short term performance, the portfolio is well positioned to capture returns over the long term.

Charitable expenditure during the year increased in both absolute and percentage terms, slightly exceeding the target 4% of the trailing three-year average closing capital value of the portfolio (2019: 3.6%). There remains an accumulated underspend from prior years. Commissioners will consider the scope in coming years to award additional fellowships, recognising that some fellows will be so successful they withdraw early; to allow fewer awards in one area to be balanced by additional awards in another; and to make additional Special Awards. Commissioners also remain mindful of the desirability of maintaining disbursements through periods of inferior market return.

## *The Commission's Auditors*

In 2008, Moore Kingston Smith LLP was appointed the Commission's auditors following a competitive tender. The audit partner meets with the Finance Committee at least once each year. In the interests of good governance, the audit manager changes at least every five years and the audit partner at least every ten years.

## Statement of Commissioners' Responsibilities

The Commissioners are responsible for preparing the Trustees' Report and the financial statements in accordance with applicable law and United Kingdom Accounting Standards (United Kingdom Generally Accepted Accounting Practice.)

The law applicable to charities in England & Wales requires the Commissioners to prepare financial statements for each financial year which give a true and fair view of the state of the affairs of the Commission and of the incoming resources and application of resources of the Commission for that period. In preparing these financial statements, the Commissioners are required to:

- select suitable accounting policies and then apply them consistently;
- observe the methods and principles in the Charities SORP;
- make judgements and estimates that are reasonable and prudent;
- state whether applicable accounting standards have been followed, subject to any material departures disclosed and explained in the financial statements;
- prepare the financial statements on the going concern basis unless it is inappropriate to presume that the Commission will continue in business.

The Commissioners are responsible for keeping proper accounting records that disclose with reasonable accuracy at any time the financial position of the Commission and enable them to ensure that the financial statements comply with the Charities Act 2011, the Charity (Accounts and Reports) Regulations 2008 and the provisions of the Royal Charter. They are also responsible for safeguarding the assets of the Commission and hence for taking reasonable steps for the prevention and detection of fraud and other irregularities.

The Annual Report on pages 1 to 39 and 65 to 70 was approved by the Commissioners on 7 July 2021.

Sir William Castell LVO

# Independent Auditors' Report to the Commissioners of Royal Commission for the Exhibition of 1851

## *Opinion*

We have audited the financial statements of the Royal Commission for the Exhibition of 1851 for the year ended 31 December 2020 which comprise the Statement of Financial Activities, the Summary Income and Expenditure Account, the Balance Sheet, the Cash Flow Statement and notes to the financial statements, including a summary of significant accounting policies. The financial reporting framework that has been applied in their preparation is applicable law and United Kingdom Accounting Standards, including FRS 102 'The Financial Reporting Standard Applicable in the UK and Republic of Ireland' (United Kingdom Generally Accepted Accounting Practice).

In our opinion the financial statements:

- give a true and fair view of the state of the charity's affairs as at 31 December 2020, and of its incoming resources and application of resources, for the year then ended;
- have been properly prepared in accordance with United Kingdom Generally Accepted Accounting Practice; and
- have been prepared in accordance with the requirements of the Charities Act 2011.

## *Basis for opinion*

We conducted our audit in accordance with International Standards on Auditing (UK) (ISAs (UK)) and applicable law. Our responsibilities under those standards are further described in the *Auditor's responsibilities for the audit of the financial statements* section of our report. We are independent of the charity in accordance with the ethical requirements that are relevant to our audit of the financial statements in the UK, including the FRC's Ethical Standard, and we have fulfilled our other ethical responsibilities in accordance with these requirements. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion.

## *Conclusions relating to going concern*

In auditing the financial statements, we have concluded that the Commissioners' use of the going concern basis of accounting in the preparation of the financial statements is appropriate.

Based on the work we have performed, we have not identified any material uncertainties relating to events or conditions that, individually or collectively, may cast significant doubt on the charity's ability to continue as a going concern for a period of at least twelve months from when the financial statements are authorised for issue.

Our responsibilities and the responsibilities of the Commissioners with respect to going concern are described in the relevant sections of this report.

## *Other information*

The other information comprises the information included in the annual report, other than the financial statements and our auditor's report thereon. The Commissioners are responsible for the other information. Our opinion on the financial statements does not cover the other information and, except to the extent otherwise explicitly stated in our report, we do not express any form of assurance conclusion thereon.

## Independent Auditors' Report to the Commissioners of Royal Commission for the Exhibition of 1851 (continued)

In connection with our audit of the financial statements, our responsibility is to read the other information and, in doing so, consider whether the other information is materially inconsistent with the financial statements or our knowledge obtained in the audit or otherwise appears to be materially misstated. If we identify such material inconsistencies or apparent material misstatements, we are required to determine whether there is a material misstatement in the financial statements or a material misstatement of the other information. If, based on the work we have performed, we conclude that there is a material misstatement of this other information, we are required to report that fact.

We have nothing to report in this regard.

### *Matters on which we are required to report by exception*

We have nothing to report in respect of the following matters where the Charities Act 2011 requires us to report to you if, in our opinion:

- the information given in the Commissioners' Annual Report is inconsistent in any material respect with the financial statements; or
- the charity has not kept adequate accounting records; or
- the financial statements are not in agreement with the accounting records and returns; or
- we have not received all the information and explanations we required for our audit.

### *Responsibilities of Commissioners*

As explained more fully in the Commissioners' responsibilities statement set out on page 39, the Commissioners are responsible for the preparation of the financial statements and for being satisfied that they give a true and fair view, and for such internal control as the Commissioners determine is necessary to enable the preparation of financial statements that are free from material misstatement, whether due to fraud or error.

In preparing the financial statements, the Commissioners are responsible for assessing the charity's ability to continue as a going concern, disclosing, as applicable, matters related to going concern and using the going concern basis of accounting unless the Commissioners either intend to liquidate the charity or to cease operations, or have no realistic alternative but to do so.

### *Auditor's responsibilities for the audit of the financial statements*

We have been appointed as auditor under section 144 of the Charities Act 2011 and report in accordance with regulations made under section 154 of that Act.

Our objectives are to obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is a high level of assurance but is not a guarantee that an audit conducted in accordance with ISAs (UK) will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements.

Irregularities, including fraud, are instances of non-compliance with laws and regulations. We design procedures in line with our responsibilities, outlined above, to detect material misstatements in respect of irregularities, including fraud. The extent to which our procedures are capable of detecting irregularities, including fraud is detailed below.

## Independent Auditors' Report to the Commissioners of Royal Commission for the Exhibition of 1851 (continued)

### *Explanation as to what extent the audit was considered capable of detecting irregularities, including fraud*

The objectives of our audit in respect of fraud, are: to identify and assess the risks of material misstatement of the financial statements due to fraud; to obtain sufficient appropriate audit evidence regarding the assessed risks of material misstatement due to fraud, through designing and implementing appropriate responses to those assessed risks; and to respond appropriately to instances of fraud or suspected fraud identified during the audit. However, the primary responsibility for the prevention and detection of fraud rests with both management and those charged with governance of the charity.

Our approach was as follows:

- We obtained an understanding of the legal and regulatory requirements applicable to the charity and considered that the most significant are the Charities Act 2011, the Charity SORP, and UK financial reporting standards as issued by the Financial Reporting Council.
- We obtained an understanding of how the charity complies with these requirements by discussions with management.
- We assessed the risk of material misstatement of the financial statements, including the risk of material misstatement due to fraud and how it might occur, by holding discussions with management.
- We inquired of management and those charged with governance as to any known instances of non-compliance or suspected non-compliance with laws and regulations.
- Based on this understanding, we designed specific appropriate audit procedures to identify instances of non-compliance with laws and regulations. This included making enquiries of management and obtaining additional corroborative evidence as required.
- As part of an audit in accordance with ISAs (UK) we exercise professional judgement and maintain professional scepticism throughout the audit. We also:
- Identify and assess the risks of material misstatement of the financial statements, whether due to fraud or error, design and perform audit procedures responsive to those risks, and obtain audit evidence that is sufficient and appropriate to provide a basis for our opinion. The risk of not detecting a material misstatement resulting from fraud is higher than for one resulting from error, as fraud may involve collusion, forgery, intentional omissions, misrepresentations, or the override of internal control.
- Obtain an understanding of internal control relevant to the audit in order to design audit procedures that are appropriate in the circumstances, but not for the purposes of expressing an opinion on the effectiveness of the charity's internal control.
- Evaluate the appropriateness of accounting policies used and the reasonableness of accounting estimates and related disclosures made by the Commissioners.
- Conclude on the appropriateness of the Commissioners' use of the going concern basis of accounting and, based on the audit evidence obtained, whether a material uncertainty exists related to events or conditions that may cast significant doubt on the charity's ability to continue as a going concern. If we conclude that a material uncertainty exists, we are required to draw attention in our auditor's report to the related disclosures in the financial statements or, if such disclosures are inadequate, to modify our opinion. Our conclusions are based on the audit evidence obtained up to the date of our auditor's report. However, future events or conditions may cause the charity to cease to continue as a going concern.
- Evaluate the overall presentation, structure and content of the financial statements, including the disclosures, and whether the financial statements represent the underlying transactions and events in a manner that achieves fair presentation.

We communicate with those charged with governance regarding, among other matters, the planned scope and timing of the audit and significant audit findings, including any significant deficiencies in internal control that we identify during our audit.

*Use of our report*

This report is made solely to the charity's Commissioners, as a body, in accordance with Chapter 3 of Part 8 of the Charities Act 2011. Our audit work has been undertaken so that we might state to the charity's Commissioners those matters we are required to state to them in an auditor's report and for no other purpose. To the fullest extent permitted by law, we do not accept or assume responsibility to any party other than the charity and charity's Commissioners as a body, for our audit work, for this report, or for the opinion we have formed.

Moore Kingston Smith LLP      11 August 2021

Statutory Auditor

Devonshire House  
60 Goswell Road  
London  
EC1M 7AD

Moore Kingston Smith LLP is eligible to act as auditor in terms of Section 1212 of the Companies Act 2006.

# Royal Commission for the Exhibition of 1851

## Statement of Financial Activities for the Year Ended 31 December 2020

|                                                                   | Notes | Unrestricted<br>Funds<br>2020<br>£ | Unrestricted<br>Funds<br>2019<br>£ |
|-------------------------------------------------------------------|-------|------------------------------------|------------------------------------|
| <b>Income from:</b>                                               |       |                                    |                                    |
| Donations                                                         | 4     | 71,107                             | 20,000                             |
| Investments                                                       | 5     | 2,715,229                          | 2,728,598                          |
| Other                                                             | 6     | 925                                | 4,792                              |
| <b>Total income</b>                                               |       | <b>2,787,261</b>                   | <b>2,753,390</b>                   |
| <b>Expenditure on:</b>                                            |       |                                    |                                    |
| Raising funds                                                     | 7     | 740,364                            | 658,343                            |
| Charitable activities                                             | 8     | 5,178,661                          | 4,266,201                          |
| <b>Total expenditure</b>                                          |       | <b>5,919,025</b>                   | <b>4,924,544</b>                   |
| <b>Net expenditure before gains and losses<br/>on investments</b> |       | <b>(3,131,764)</b>                 | <b>(2,171,154)</b>                 |
| <b>Net gains on investments</b>                                   |       |                                    |                                    |
| Gains on property                                                 |       | 1,975,082                          | 2,186,941                          |
| Gains on investments                                              |       | 10,902,758                         | 17,229,216                         |
| <b>Total of net gains on investments</b>                          |       | <b>12,877,840</b>                  | <b>19,416,157</b>                  |
| <b>Net income</b>                                                 |       | <b>9,746,076</b>                   | <b>17,245,003</b>                  |
| <b>Other recognised gains and losses</b>                          |       |                                    |                                    |
| Actuarial gains / (losses) on<br>defined benefit pension scheme   | 14    | (23,626)                           | 76,852                             |
| <b>Net movement in funds</b>                                      |       | <b>9,722,450</b>                   | <b>17,321,855</b>                  |
| <b>Reconciliation of funds</b>                                    |       |                                    |                                    |
| Total funds brought forward                                       |       | 128,403,095                        | 111,081,240                        |
| Net movement in funds                                             |       | 9,722,450                          | 17,321,855                         |
| <b>Total funds carried forward</b>                                |       | <b>138,125,545</b>                 | <b>128,403,095</b>                 |

The notes on pages 47 to 64 form part of these accounts. Notes 1-2 provide details of the Commission's objectives and accounting policies.

# Royal Commission for the Exhibition of 1851

## Balance Sheet as at 31 December 2020

|                                                         | Notes | Total<br>Funds<br>2020<br>£ | Total<br>Funds<br>2019<br>£ |
|---------------------------------------------------------|-------|-----------------------------|-----------------------------|
| <b>Fixed asset investments</b>                          |       |                             |                             |
| Investment properties                                   | 15    | 23,345,382                  | 21,370,300                  |
| Listed investments                                      | 16    | 119,307,960                 | 110,771,099                 |
| Cash held as part of the investment portfolio           |       | 1,017,499                   | 1,656,546                   |
|                                                         |       | <u>143,670,841</u>          | <u>133,797,945</u>          |
| <b>Current assets</b>                                   |       |                             |                             |
| Debtors                                                 | 17    | 1,140,855                   | 272,882                     |
| Cash at bank and in hand                                |       | 1,103,335                   | 950,898                     |
|                                                         |       | <u>2,244,190</u>            | <u>1,223,780</u>            |
| <b>Liabilities</b>                                      |       |                             |                             |
| Creditors: Amounts falling due within one year          | 18    | (4,580,884)                 | (3,867,120)                 |
| <b>Net current liabilities</b>                          |       | <u>(2,336,694)</u>          | <u>(2,643,340)</u>          |
| <b>Total assets less current liabilities</b>            |       | 141,334,147                 | 131,154,605                 |
| Creditors: Amounts falling due after more than one year | 18    | (2,783,602)                 | (2,324,510)                 |
| <b>Net assets excluding pension liability</b>           |       | <u>138,550,545</u>          | <u>128,830,095</u>          |
| Defined benefit pension scheme liability                | 14    | (425,000)                   | (427,000)                   |
| <b>Net assets</b>                                       |       | <u><u>138,125,545</u></u>   | <u><u>128,403,095</u></u>   |
| <b>The funds of the Charity:</b>                        |       |                             |                             |
| <b>Capital Funds</b>                                    |       |                             |                             |
| Balance as at 1 January                                 |       | 128,403,095                 | 111,081,240                 |
| Movement in year                                        |       | 9,722,450                   | 17,321,855                  |
| <b>Balance as at 31 December</b>                        |       | <u><u>138,125,545</u></u>   | <u><u>128,403,095</u></u>   |

Approved by the Commissioners on 7 July 2021 and signed on their behalf by:

Sir William Castell  
Chairman, Finance Committee

NL Williams  
Secretary

The notes on pages 47 to 64 form part of these accounts.



# Royal Commission for the Exhibition of 1851

## Statement of Cash Flows for the Year Ended 31 December 2020

|                                                                    | <b>Total<br/>Funds<br/>2020<br/>£</b> | <b>Total<br/>Funds<br/>2019<br/>£</b> |
|--------------------------------------------------------------------|---------------------------------------|---------------------------------------|
| <b>Cash flows from operating activities</b>                        |                                       |                                       |
| Donations received (excluding donations in kind)                   | 71,107                                | 20,000                                |
| Grants and award paid                                              | (3,460,087)                           | (3,775,651)                           |
| Payments to suppliers                                              | (885,401)                             | (914,215)                             |
| Payments in respect of employees                                   | (312,540)                             | (306,959)                             |
| Other payments                                                     | (22,214)                              | (25,960)                              |
| <b>Cash used in operating activities</b>                           | <b>(4,609,135)</b>                    | <b>(5,002,785)</b>                    |
| <b>Cash flows from investing activities</b>                        |                                       |                                       |
| Dividends, interest and rent from investments                      | 1,756,794                             | 2,757,279                             |
| Proceeds from sale of investments                                  | 60,431,106                            | 31,721,396                            |
| Purchase of investments                                            | (58,065,375)                          | (27,681,469)                          |
| <b>Net cash provided by investing activities</b>                   | <b>4,122,525</b>                      | <b>6,797,206</b>                      |
| <b>Change in cash and cash equivalents in the reporting period</b> | <b>(486,610)</b>                      | <b>1,794,421</b>                      |
| Cash and cash equivalents brought forward                          | 2,607,444                             | 813,023                               |
| <b>Cash and cash equivalents carried forward</b>                   | <b>2,120,834</b>                      | <b>2,607,444</b>                      |
| <b>Disclosed as:</b>                                               |                                       |                                       |
| Cash held as part of the investment portfolio                      | 1,017,499                             | 1,656,546                             |
| Cash at bank and in hand                                           | 1,103,335                             | 950,898                               |
|                                                                    | <b>2,120,834</b>                      | <b>2,607,444</b>                      |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2020

### 1. STATUS AND OBJECTIVES

The Commission for the Exhibition of 1851 was set up by Royal Charter in 1850 to plan and promote the Exhibition of Works of Industry of all Nations, which was to be held in London in 1851. When the affairs of the Great Exhibition had eventually been wound up, the Commissioners were appointed, under a supplemental Charter, as a permanent body to administer the surplus funds at their disposal. These were to be applied in order to “increase the means of industrial education and extend the influence of science and art upon productive industry”.

### 2. ACCOUNTING POLICIES

The accounts are prepared under the historic cost convention, modified by the revaluation from time to time of certain fixed assets, and in accordance with the Financial Reporting Standard applicable in the UK and Republic of Ireland (effective January 2015) (FRS102), Accounting and Reporting by Charities: Statement of Recommended Practice applicable to charities preparing their accounts in accordance with the Financial Reporting Standard applicable in the UK and Republic of Ireland (effective January 2019) (SORP) and the Charities Act 2011.

In the estimation of the trustees (the Commissioners), there are no material uncertainties that call into doubt the Commission’s ability to continue and the accounts have therefore been prepared on a going concern basis.

The Commission, like every other organisation, has been impacted by the pandemic; many events had to be cancelled and some programmes moved on-line. In terms of its core grant-making activity, however, the Commission has largely been able to continue as planned.

As soon as the possibility of a pandemic became clear, the Finance Committee acted to ensure that there were sufficient cash or near cash assets in place to fund at least three years’ expenditure in full. This gave confidence that the Commission would be able to ride out the immediate disruption and need not curtail any of its programmes. Investment markets have, to be sure, been much more volatile and the day to day value of the Commission’s portfolio has inevitably reflected that. The Commission is a long-term investor, however, and Commissioners remain confident in the underlying strength of the portfolio; they see no evidence at this stage of any permanent loss of value. Indeed, the value of the Commission’s portfolio has risen over the year.

Similarly, while some of the Commission’s tenants have asked for and received temporary support with deferred rent demands and the like, there is not considered to be any risk to the long-term value of the estate. That is not to say of course that some of our legacy institutions have not been severely impacted.

The Commission had robust business continuity plans in place and Commissioners, Committee members and staff have adapted relatively straightforwardly to the need for remote working. The 2020 and 2021 award rounds for all the Commission’s Fellowships and Studentships have gone ahead as planned with a full complement of awards made. A majority of existing award holders have been able to adapt their workflow patterns to fit the unusual circumstances imposed by lockdowns etc. Where this has not been possible, the Commission has granted extensions and provided the necessary financial support.

All in all, Commissioners are confident that whatever the short-term disruptions, the pandemic should not have any material, long-term impact on the Commission’s work.

The Commission meets the definition of a public benefit entity under FRS102.

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2020

### 2. ACCOUNTING POLICIES (continued)

The financial statements are presented in sterling which is the functional currency of the charity. Monetary amounts are rounded to the nearest pound.

#### (a) Investments

- (i) Are shown in the balance sheet at market value; any unrealised gain over original cost is shown in the statement of financial activities.
- (ii) Income on investments is included in the accounts when receivable.
- (iii) Cash held as part of the investment portfolio includes short-term deposits held temporarily with the company's bankers pending re-investment.

#### (b) Donations, legacies and similar income

Donations, legacies and similar income are included in the year in which they are receivable, that is, when the Commission becomes entitled to the income. Donations received for general purposes are included as unrestricted funds. Where the wishes of the donor are legally binding on Commissioners, donations are accounted for as Restricted Funds with their use limited to that defined by the donor.

#### (c) Fixed Assets and Depreciation

All purchases of capital items under £10,000 are written off in the year of purchase. Capital items over £10,000 are depreciated over their estimated useful economic lives. Currently no items are being depreciated.

#### (d) Investment Properties

All the Commission's properties are let to provide an income on a full repairing lease. All properties are inspected regularly by the Commission's Surveyors and revalued by them from time to time. The last full revaluation was undertaken at 31 December 2019 and was based on the existing use and occupation of the land, and the duration of leases at ground rents and rack rents. These valuations are reviewed and adjusted annually as described in note 15.

#### (e) Realised and Unrealised Gains on Investments

Gains and losses on investments and assets held for the Commission's use are treated in accordance with the Statement of Recommended Practice. They are recognised in the statement of financial activities for the year in which they occur.

#### (f) Cash and cash equivalents

Cash and cash equivalents include cash in hand, deposits held at call with banks, other short-term liquid investments with original maturities of three months or less, and bank overdrafts. Cash held on capital account pending investment by the charity's investment managers, together with cash for investment in transit between investment managers, is disclosed within fixed asset investments; all other cash and cash equivalents is disclosed within current asset investments.

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2020

### 2. ACCOUNTING POLICIES (continued)

#### (g) Lease premiums and licences

Premiums received for lease extensions are treated as capital receipts and included within gains / (losses) on property transactions. Certain other premiums received which do not materially affect the underlying value of the Commission's investment are treated as income receipts.

#### (h) Charitable activities

The primary charitable activity is the making of grants and awards. Grants and awards payable are accounted for on an accruals basis. Multi-year grants are accounted for in full in the year that the grant is awarded. The Commission recognises future liabilities discounted to their present value where material.

The majority of grants and awards are made to individuals who have been granted Fellowships or Studentships by the Commission. A limited number of awards are made to Institutions in furtherance of their educational needs. Some support is also provided to the legacy institutions on the Commission's South Kensington estate and to organisations facilitating access to the Commission's archives. A full analysis is shown in note 9.

The Commission also undertakes some direct charitable activities, in particular networking and educational events organised for the Commission's Fellows, Students, Alumni and the general public. Further details are shown in note 10.

#### (i) Allocation of support costs

Support costs are allocated on the basis of board or staff time as appropriate.

#### (j) Financial instruments

The Commission has elected to apply the provisions of Section 11 *Basic Financial Instruments* and Section 12 *Other Financial Instruments Issues* of FRS 102 to all of its financial instruments.

Financial instruments are recognised in the Commission's balance sheet when the Commission becomes party to the contractual provisions of the instrument.

##### *Basic financial assets*

Basic financial assets, which include trade and other debtors and cash and bank balances, are initially measured at transaction price including transaction costs and are subsequently carried at amortised cost using the effective interest method unless the arrangement constitutes a financing transaction, where the transaction is measured at the present value of the future receipts discounted at a market rate of interest.

##### *Other financial assets*

Other financial assets, including investments in equity instruments which are not subsidiaries, associates or joint ventures, are initially measured at fair value, which is normally the transaction price. Such assets are subsequently carried at fair value and the changes in fair value are recognised in the statement of financial activities, except that investments in equity instruments that are not publicly traded and whose fair values cannot be measured reliably are measured at cost less impairment.

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2020

### 2. ACCOUNTING POLICIES (continued)

#### (j) Financial instruments (continued)

Trade debtors, loans and other debtors that have fixed or determinable payments that are not quoted in an active market are classified as 'loans and receivables'. Loans and receivables are measured at amortised cost using the effective interest method, less any impairment.

##### *Basic financial liabilities*

Basic financial liabilities, including trade and other creditors, are initially recognised at transaction price unless the arrangement constitutes a financing transaction, where the debt instrument is measured at the present value of the future payments discounted at a market rate of interest.

Debt instruments are subsequently carried at amortised cost, using the effective interest rate method.

Trade creditors are obligations to pay for goods or services that have been acquired in the ordinary course of business from suppliers. Accounts payable are classified as current liabilities if payment is due within one year or less. If not, they are presented as non-current liabilities. Trade creditors are recognised initially at transaction price and subsequently measured at amortised cost using the effective interest method.

##### *Other financial liabilities*

Derivatives, including interest rate swaps and forward foreign exchange contracts, are not basic financial instruments. Derivatives are initially recognised at fair value on the date a derivative contract is entered into and are subsequently re-measured at their fair value. Changes in the fair value of derivatives are recognised in the statement of financial activities in finance costs or finance income as appropriate, unless they are included in a hedging arrangement.

#### (k) Retirement benefits

Payments to defined contribution retirement benefit schemes are charged as an expense as they fall due.

The cost of providing benefits under defined benefit plans is determined separately for each plan using the projected unit credit method and is based on actuarial advice.

The net interest element is determined by multiplying the net defined benefit liability by the discount rate, taking into account any changes in the net defined benefit liability during the period as a result of contribution and benefit payments. The net interest is recognised in the statement of financial activities.

Remeasurement changes comprise actuarial gains and losses and the return on the net defined benefit liability excluding amounts included in net interest. These are recognised immediately in the statement of financial activities in the period in which they occur.

The defined net benefit pension liability in the balance sheet comprises the total of the present value of the defined benefit obligation (using a discount rate based on high quality corporate bonds).

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2020

### 2. ACCOUNTING POLICIES (continued)

#### (l) Significant judgements and key sources of estimation uncertainty

In the application of the charity's accounting policies, Commissioners are required to make judgements, estimates and assumptions about the carrying value of assets and liabilities that are not readily apparent from other sources. The estimates are based on historical experience and other factors that are considered to be relevant. Actual results may differ from these estimates. The key sources of estimation uncertainty that have a significant effect on the amount recognised in the accounts are:

- the valuation of investment properties, which are stated at their estimated fair value based on professional valuations as disclosed in Note 15;
- the valuation of multi-year grant commitments, which take into account estimates of future inflation, early withdrawal rates, claim rates and other factors affecting the final amount payable; in this context, and given current interest rates and grant periods, discounting for the time value of money is not considered material;
- the valuation of the defined benefit pension scheme liability, which is based on actuarial assumptions and a professional valuation as set out in Note 14;
- the valuation of future minimum lease payments under non-cancellable operating leases, which are discounted for inflation in accordance with Bank of England targets and ignore the potential effects of leasehold enfranchisements, as set out in Note 15.

### 3. FUNDS

All the Commission's income and capital is expendable at the discretion of the Commissioners. The Commission therefore maintains a single unrestricted fund.

### 4. DONATIONS

The Commission received donations of the majority of their assets from the Sir Misha Black Awards Committee. The donation is for the general charitable purposes of the Commission. The Commission has agreed to provide administrative support to the Sir Misha Black Awards Committee and to meet the costs of their annual Medal and Award ceremonies.

### 5. INVESTMENT INCOME

|                                  | 2020             | 2019             |
|----------------------------------|------------------|------------------|
|                                  | £                | £                |
| Rental income from UK properties | 1,300,782        | 612,194          |
| Income from managed investments  | 1,379,063        | 2,111,283        |
| Interest on rent arrears         | 32,995           | –                |
| Interest on cash deposits        | 2,389            | 5,121            |
|                                  | <u>2,715,229</u> | <u>2,728,598</u> |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2020

### 6. OTHER INCOME

|                | 2020       | 2019         |
|----------------|------------|--------------|
|                | £          | £            |
| Licence income | 925        | 4,792        |
|                | <u>925</u> | <u>4,792</u> |

### 7. COST OF RAISING FUNDS

|                                   | 2020           | 2019           |
|-----------------------------------|----------------|----------------|
|                                   | £              | £              |
| Investment management fees        | 507,244        | 528,878        |
| Property management fees          | 66,434         | 63,842         |
| Legal fees                        | 60,255         | 21,873         |
| Provisions                        | 53,333         | –              |
| Allocated support costs (note 11) | 53,098         | 43,750         |
|                                   | <u>740,364</u> | <u>658,343</u> |

### 8. CHARITABLE ACTIVITIES

|                               | Grants<br>(note 9) | Direct<br>costs<br>(note 10) | Allocated<br>support<br>costs<br>(note 11) | 2020             | 2019             |
|-------------------------------|--------------------|------------------------------|--------------------------------------------|------------------|------------------|
|                               | £                  | £                            | £                                          | £                | £                |
| Fellowships and studentships  | 3,008,321          | 89,726                       | 147,469                                    | 3,245,516        | 3,164,652        |
| STEM education and outreach   | 285,210            | 67,776                       | 57,804                                     | 410,790          | 636,870          |
| Support for legacy estate     | 1,332,550          | 35,193                       | 57,804                                     | 1,425,547        | 328,196          |
| Archives and alumni relations | 21,298             | 17,848                       | 57,662                                     | 96,808           | 136,483          |
|                               | <u>4,647,379</u>   | <u>210,543</u>               | <u>320,739</u>                             | <u>5,178,661</u> | <u>4,266,201</u> |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2020

### 9. GRANTS AWARDED

#### *(a) Fellowships and studentships*

|                                    | 2020<br>No. | 2020<br>£ | 2019<br>No. | 2019<br>£ |
|------------------------------------|-------------|-----------|-------------|-----------|
| Research Fellowships               | 10          | 1,707,647 | 11          | 1,743,614 |
| Industrial Fellowships             | 10          | 494,982   | 9           | 509,607   |
| Industrial Design Studentships     | 10          | 412,192   | 9           | 354,850   |
| Built Environment Fellowship       | –           | –         | 1           | 100,000   |
| Design Fellowship                  | 1           | 90,000    | –           | –         |
| Enterprise Fellowships             | 5           | 312,500   | 3           | 187,762   |
| Great Exhibition Scholarships      | –           | (9,000)   | –           | –         |
|                                    | <hr/>       | <hr/>     | <hr/>       | <hr/>     |
| Total fellowships and studentships | 36          | 3,008,321 | 33          | 2,895,833 |
|                                    | <hr/>       | <hr/>     | <hr/>       | <hr/>     |

All of the fellowships and studentships were awarded to individuals. The Annual Report includes more information on the awards granted, including where relevant details of each of the institutions at which individual recipients are carrying out their studies / research.



# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2020

### 9. GRANTS AWARDED (continued)

#### (b) STEM education and outreach

|                                                                               | 2020<br>£ | 2019<br>£ |
|-------------------------------------------------------------------------------|-----------|-----------|
| SmartSTEMs – Digital portal                                                   | 14,850    | –         |
| Ruth Mountford – They Made It podcasts                                        | 5,000     | –         |
| Fun Kids Radio – How's That Made?                                             | 10,000    | –         |
| Physics Partners – Physics videos                                             | 9,800     | –         |
| Primary Engineer – Leaders award podcasts                                     | 10,160    | –         |
| In2ScienceUK – Alumni programme                                               | 14,750    | –         |
| RedR UK – Engineering in emergencies / Affiliate scheme                       | 5,000     | 30,000    |
| London Transport Museum – Engineering your neighbourhood                      | 20,602    | –         |
| Cranfield University – National flying laboratory centre                      | 197,000   | –         |
| Smallpeice Trust – Space Engineering course / Humanitarian Engineering course | –         | 10,000    |
| Serpentine Trust – Digital knowledge and skills sharing workshops             | –         | 15,000    |
| Armourers' & Brasiers' Company – Cambridge Forum                              | –         | 1,000     |
| Foundation for Science and Technology – Debate sponsorship                    | –         | 1,000     |
| County Upper School – Junior Cospace Robotics Competition                     | –         | 1,952     |
| Design Museum – the Great Competition                                         | –         | 3,000     |
| STEM Learning – ENTHUSE partnership                                           | –         | 60,000    |
| WISE Campaign – My Skills, My Life                                            | –         | 60,000    |
| The Common Room – Children of the Revolution                                  | –         | 40,000    |
| Foundation for Science and Technology – Future Leaders programme              | –         | 9,000     |
| Design and Technology Association – Designing your Future                     | –         | 14,625    |
| The PTI – Subject leadership CPD programme                                    | –         | 14,800    |
| Smallpeice Trust – Arkwright scholarships                                     | –         | 46,200    |
| British Science Association – CREST Awards for disadvantaged students         | –         | 74,650    |
| UK Electronics Skills Foundation – Electronics Everywhere                     | –         | 48,000    |
| Travel bursaries and conference prizes                                        | –         | 500       |
|                                                                               | <hr/>     | <hr/>     |
|                                                                               | 287,162   | 429,727   |
| Less: Past awards written back where not utilised in full                     | (1,952)   | –         |
|                                                                               | <hr/>     | <hr/>     |
|                                                                               | 285,210   | 429,727   |
|                                                                               | <hr/>     | <hr/>     |

All but one of the STEM education and outreach grants were awarded to institutions (2019: all of the STEM education and outreach grants were awarded to institutions except for one travel bursary and one poster prize).

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2020

### 9. GRANTS AWARDED (continued)

#### (c) *Support for legacy estate*

|                                               | 2020<br>£        | 2019<br>£      |
|-----------------------------------------------|------------------|----------------|
| Royal Albert Hall – Public realm project      | 1,225,000        | –              |
| National Railway Museum – The Great Machine   | 105,050          | –              |
| Exhibition Road Culture Group – Covid Culture |                  |                |
| Shock event / Day of Design                   | 2,500            | 9,500          |
| Victoria and Albert Museum – Raphael Cartoons | –                | 227,000        |
|                                               | <u>1,332,550</u> | <u>236,500</u> |

All of the grants in support of the legacy estate in both 2020 and 2019 were awarded to institutions.

#### (d) *Archives and alumni relations*

|                                                                | 2020<br>£     | 2019<br>£     |
|----------------------------------------------------------------|---------------|---------------|
| University of Oxford – Digitising Albert                       | 26,500        | 53,000        |
| Royal Collection Trust – Queen’s Bindery Apprenticeship Scheme | 1,500         | –             |
| English Heritage Trust – Victoria and Albert at Osborne        | –             | 2,500         |
|                                                                | <u>28,000</u> | <u>55,500</u> |
| Less: Past awards written back where not utilised in full      | 6,702         | –             |
|                                                                | <u>21,298</u> | <u>55,500</u> |

All of the grants in support of archives and alumni relations in both 2020 and 2019 were awarded to institutions.

In total, 13 grants were made to institutions and 37 to individuals (2019: 21 grants to institutions and 35 to individuals).

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2020

### 10. DIRECT COSTS

|                                         | 2019           | 2020           | Archives<br>and alumni<br>relations | Support<br>for legacy<br>estate | STEM<br>education<br>and<br>outreach | Fellowships<br>and<br>studentships |
|-----------------------------------------|----------------|----------------|-------------------------------------|---------------------------------|--------------------------------------|------------------------------------|
|                                         | £              | £              | £                                   | £                               | £                                    | £                                  |
| Promotion and selection costs           | 76,404         | 83,148         | –                                   | –                               | –                                    | 83,148                             |
| Networking and educational events       | 208,322        | 77,635         | 3,281                               | –                               | 67,776                               | 6,578                              |
| Estate memberships, projects and advice | 37,327         | 35,193         | –                                   | 35,193                          | –                                    | –                                  |
| Archive supplies and acquisitions       | 6,196          | 7,487          | 7,487                               | –                               | –                                    | –                                  |
| Alumni website and expenses             | 7,080          | 7,080          | 7,080                               | –                               | –                                    | –                                  |
|                                         | <u>335,329</u> | <u>210,543</u> | <u>17,848</u>                       | <u>35,193</u>                   | <u>67,776</u>                        | <u>89,726</u>                      |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2020

### 11. SUPPORT COSTS

|                             | Cost of raising funds<br>£ | Fellowships and studentships<br>£ | STEM education and outreach<br>£ | Support for legacy estate<br>£ | Archives and alumni relations<br>£ | 2020<br>£      | 2019<br>£      | Basis of allocation |
|-----------------------------|----------------------------|-----------------------------------|----------------------------------|--------------------------------|------------------------------------|----------------|----------------|---------------------|
| Governance costs (note 12)  | 11,880                     | 11,880                            | 9,504                            | 9,504                          | 4,751                              | 47,519         | 15,076         | Board time          |
| Staff costs (note 13)       | 34,426                     | 113,245                           | 40,341                           | 40,341                         | 44,190                             | 272,543        | 266,315        | Staff time          |
| Retired staff pension costs | 1,036                      | 3,408                             | 1,214                            | 1,214                          | 1,330                              | 8,202          | 13,758         | Staff time          |
| Facility costs              | 1,556                      | 5,120                             | 1,824                            | 1,824                          | 1,998                              | 12,322         | 12,322         | Staff time          |
| Office refurbishment        | -                          | -                                 | -                                | -                              | -                                  | -              | 5,888          | Staff time          |
| Office costs                | 2,553                      | 8,397                             | 2,991                            | 2,991                          | 3,278                              | 20,210         | 30,684         | Staff time          |
| Legal and professional fees | 1,439                      | 4,734                             | 1,686                            | 1,686                          | 1,848                              | 11,393         | 4,009          | Staff time          |
| Travel and entertaining     | 208                        | 685                               | 244                              | 244                            | 267                                | 1,648          | 9,010          | Staff time          |
|                             | <u>53,098</u>              | <u>147,469</u>                    | <u>57,804</u>                    | <u>57,804</u>                  | <u>57,662</u>                      | <u>373,837</u> | <u>357,062</u> |                     |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2020

### 12. GOVERNANCE COSTS

|                                | 2020<br>£     | 2019<br>£     |
|--------------------------------|---------------|---------------|
| Audit fees (including VAT)     |               |               |
| – Current year                 | 10,200        | 10,000        |
| – Prior year overaccrual       | (100)         | (1,400)       |
| Actuarial fees                 | 1,900         | 1,680         |
| Annual report                  | 769           | 1,923         |
| Meeting costs                  | 190           | 2,873         |
| Commissioner recruitment costs | 34,560        | –             |
|                                | <u>47,519</u> | <u>15,076</u> |

### 13. STAFF COSTS AND RELATED PARTY TRANSACTIONS

|                                       | 2020<br>£      | 2019<br>£      |
|---------------------------------------|----------------|----------------|
| Salaries (including benefits in kind) | 221,203        | 185,082        |
| Employers NI                          | 20,330         | 17,311         |
| Pension contributions                 | 30,148         | 60,124         |
| Staff recruitment                     | –              | 1,171          |
| Training and development              | 862            | 2,627          |
|                                       | <u>272,543</u> | <u>266,315</u> |

The average number of employees during the year analysed by function was:

|                            | 2020<br>No. | As restated<br>2019<br>No. |
|----------------------------|-------------|----------------------------|
| Support and administration | 4.0         | 3.5                        |
| Archive                    | 1.0         | 1.0                        |
|                            | <u>5.0</u>  | <u>4.5</u>                 |

The full time equivalent number of employees during the year analysed by function was:

|                            | 2020<br>No. | As restated<br>2019<br>No. |
|----------------------------|-------------|----------------------------|
| Support and administration | 2.8         | 2.7                        |
| Archive                    | 0.4         | 0.4                        |
|                            | <u>3.2</u>  | <u>3.1</u>                 |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2020

### 13. STAFF COSTS AND RELATED PARTY TRANSACTIONS (continued)

The 2019 average number of employees has been restated to more accurately reflect the split between Support and administration and Archive. The 2019 full-time equivalent number of Support and administration employees has been increased by 0.2 to more accurately reflect the balance across the year.

One employee earned between £90,000 and £100,000 (2019: one employee earned between £90,000 and £100,000). No pension contributions were paid in respect of this employee (2019: no pension contributions were paid in respect of this employee).

Commissioners do not receive remuneration. During the year re-imbursements were made to two Commissioners in respect of travelling and other expenses totalling £601 (2019: to four Commissioners totalling £1,600).

The total amount paid in respect of key management personnel (i.e. the Secretary and Finance Director), including employer's national insurance and employer pension contributions, was £175,003 (2019: £164,373).

There were no other related party transactions during the year (2019: none).

### 14. PENSIONS AND OTHER LONG-TERM EMPLOYEE BENEFITS

All current and new members of staff are eligible to join a personal pension scheme of their choice with the Commission contributing 15% of salary (2019: 15% of salary). There is no requirement for employee contributions. Staff may opt to sacrifice some of their salary in return for an additional employer contribution. Employer contributions of £30,148 (2019: £60,124) were made in the year. There were no contributions outstanding at the year-end (2019: £3,201 contributions were outstanding at the year-end). There were no prepaid contributions at the year-end (2019: £nil).

All current and new members of staff also benefit from an unfunded / uninsured death in service scheme under which the Commissioners (at their absolute discretion) may pay a nominated beneficiary a lump sum equivalent to 18 months' salary if an employee dies while employed by the Commission. No liability for the scheme is recognised in the accounts as Commissioners do not believe there is any sensible way to estimate the liability. Actuarial calculations based on assumptions comparable to those used in valuing the defined benefit pension liability (see below) suggest that any liability in respect of the death in service scheme would in any case be immaterial.

All current and new members of staff also benefit from a Group Income Protection policy with Canada Life which covers basic salary and pension contributions for staff unable to work due to long term illness.

The Commission operates an unfunded pension scheme in the UK (the 'Scheme'). The Scheme is an unregistered, non-contributory defined benefit scheme. As the Scheme is unfunded, no contributions are paid by the Commission, other than to meet benefits as they fall due. As no triennial valuations are carried out, a valuation is carried out at the balance sheet date each year by an independent qualified actuary.

The Scheme was closed to new members on 14 July 2004. As at 31 December 2020, all six remaining members of the Scheme are receiving a pension and there is no further accrual of benefits. There is therefore no service cost for the year. The amount recognised in arriving at net expenditure for the year is an expense of £8,202 (2019: £13,758) which is fully in respect of net interest on the net liability.

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2020

### 14. PENSIONS AND OTHER LONG-TERM EMPLOYEE BENEFITS (continued)

As regards the unfunded, defined benefit pension scheme:

*The principal assumptions used by the actuary were:*

|                                       | FRS102<br>Valuation<br>2020<br>(% p.a.) | FRS102<br>Valuation<br>2019<br>(% p.a.) |
|---------------------------------------|-----------------------------------------|-----------------------------------------|
| <i>Financial assumptions</i>          |                                         |                                         |
| Gross investment return               |                                         |                                         |
| In-service members                    |                                         |                                         |
| Pre-retirement                        | N/A                                     | N/A                                     |
| Post-retirement                       | N/A                                     | N/A                                     |
| Current pensioners                    | 1.4%                                    | 2.0%                                    |
| Pensionable earnings increases        | N/A                                     | N/A                                     |
| Price inflation                       | 3.0%                                    | 3.0%                                    |
| Pension increases                     | 3.0%                                    | 3.0%                                    |
| Allowance for administration expenses | 0.0%                                    | 0.0%                                    |
| <i>Demographic assumptions</i>        |                                         |                                         |
| Mortality                             |                                         |                                         |
| Pre-retirement                        | N/A                                     | N/A                                     |
| Post-retirement                       | S3PA                                    | S3PA                                    |
|                                       | CMI 2019 1%                             | CMI 2018 1%                             |
| Withdrawal allowance                  | No allowance                            | No allowance                            |
| Early retirement allowance            | No allowance                            | No allowance                            |
| Proportion married                    | 90%                                     | 90%                                     |
| Wife's age                            | 3 years younger<br>than husband         | 3 years younger<br>than husband         |

The assumptions used by the actuary are best estimates chosen from a range of possible actuarial assumptions which, due to the timescale covered, may not necessarily be borne out in practice.

*Value of Scheme assets and liabilities:*

|                                     | 2020<br>£ | 2019<br>£ |
|-------------------------------------|-----------|-----------|
| Market value of Scheme assets       | –         | –         |
| Present value of Scheme liabilities | (425,000) | (427,000) |
|                                     | <hr/>     | <hr/>     |
| Scheme deficit                      | (425,000) | (427,000) |
| Related deferred tax asset          | –         | –         |
|                                     | <hr/>     | <hr/>     |
| Net liability                       | (425,000) | (427,000) |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2020

### 14. PENSIONS AND OTHER LONG-TERM EMPLOYEE BENEFITS (continued)

#### *Movements in the year:*

|                                        | 2020<br>£         | 2019<br>£         |
|----------------------------------------|-------------------|-------------------|
| Scheme deficit at beginning of year    | (427,000)         | (529,000)         |
| Current service cost                   | –                 | –                 |
| Interest on obligation                 | (8,202)           | (13,758)          |
| Actuarial gain / (loss) on liabilities | (23,626)          | 76,852            |
| Benefits paid directly by employer     | 33,828            | 38,906            |
|                                        | <u>          </u> | <u>          </u> |
| Scheme deficit at end of year          | <u>(425,000)</u>  | <u>(427,000)</u>  |

The interest on obligation of £8,202 (2019: £13,758) is disclosed within Support costs (note 11) while the actuarial loss on liabilities of £23,626 (2019: gain of £76,852) is disclosed within Other recognised gains and losses on the face of the SOFA.

### 15. INVESTMENT PROPERTIES AND OPERATING LEASES

|                                                 | 2020<br>£         | 2019<br>£         |
|-------------------------------------------------|-------------------|-------------------|
| (a) Movements in value of investment properties |                   |                   |
| Balance at 1 January                            | 21,370,300        | 19,903,865        |
| Sales during the year                           | –                 | (301,630)         |
| Unrealised gain on year-end revaluation         | 1,975,082         | 1,768,065         |
|                                                 | <u>          </u> | <u>          </u> |
| Valuation at 31 December                        | <u>23,345,382</u> | <u>21,370,300</u> |

The valuation as at 31 December 2020 shown above resulted from a full revaluation of the properties at 31 December 2019, undertaken by Cluttons LLP, Chartered Surveyors and Property Consultants. The valuation was carried out on an open market value basis in accordance with the RICS Appraisal and Valuation Manual and is based on existing usage and occupation of the land, and the duration of leases at ground and rack rents. In reaching the 31 December 2020 valuation, the value at 31 December 2019 has been adjusted, based on further advice from Cluttons, to take into account movements in local property market indices, changes in estimated rental values, the decreasing length of leases and lease extension / leasehold enfranchisement claims received. All of the investment properties are located in the UK.



# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2020

### 15. INVESTMENT PROPERTIES AND OPERATING LEASES (continued)

#### (b) Operating leases – lessor

The Commission is entitled as landlord to income from investment properties under operating leases. Future minimum lease payments under non-cancellable operating leases, discounted for inflation, for each of the following periods are as follows:

|                                                   | 2020<br>£         | 2019<br>£         |
|---------------------------------------------------|-------------------|-------------------|
| Not later than one year                           | 175,788           | 82,500            |
| Later than one year and not later than five years | –                 | 52,242            |
| Later than five years                             | 9,996,587         | 12,381,934        |
|                                                   | <u>10,172,375</u> | <u>12,516,676</u> |

The Commission's investment properties are let for periods ranging up to 999 years. All leases are on full repairing and insuring terms. One lease has a break clause which has been taken into account in calculating minimum lease payments. Leases of residential property are potentially subject to leasehold enfranchisement; this has been ignored in arriving at the above figures.

### 16. INVESTMENTS

|                                     | 2020<br>£          | 2019<br>£          |
|-------------------------------------|--------------------|--------------------|
| (a) Movements in listed investments |                    |                    |
| Market value 1 January              | 110,771,099        | 96,856,625         |
| Acquisitions at cost                | 58,063,652         | 27,685,327         |
| Disposals at carrying value         | (52,976,767)       | (24,392,681)       |
| Net gains on revaluation            | 3,449,976          | 10,621,828         |
|                                     | <u>119,307,960</u> | <u>110,771,099</u> |
| Market value 31 December            |                    |                    |
| Value at cost 31 December           | 89,589,653         | 84,502,769         |

#### (b) Geographic breakdown

|                | 2020<br>£             | 2020<br>£        | 2019<br>£             | As restated<br>2019<br>£ |
|----------------|-----------------------|------------------|-----------------------|--------------------------|
|                | Listed<br>investments | Cash             | Listed<br>investments | Cash                     |
| In the UK      | 61,560,772            | 902,632          | 55,437,509            | 1,656,516                |
| Outside the UK | 57,747,188            | 114,867          | 55,333,590            | 30                       |
|                | <u>119,307,960</u>    | <u>1,017,499</u> | <u>110,771,099</u>    | <u>1,656,546</u>         |

The 2019 figure for cash held in the UK has been restated to only disclose cash held as part of the investment portfolio.

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2020

### 16. INVESTMENTS (continued)

All investments are listed on a recognised stock exchange.

There were no individual holdings the market value of which is considered to be material in the context of the portfolio as a whole.

### 17. DEBTORS

|                                       | 2020<br>£             | 2019<br>£           |
|---------------------------------------|-----------------------|---------------------|
| Rents receivable                      |                       |                     |
| – in hands of surveyors               | 250,079               | 160,010             |
| – in arrears                          | 822,536               | 80,498              |
|                                       | <hr/> 1,072,615       | <hr/> 240,508       |
| Lease enfranchisement costs (accrued) | –                     | 5,450               |
| Other debtors                         | 8,585                 | 280                 |
| Prepayments                           | 26,655                | 26,594              |
| Accrued income                        | 33,000                | 50                  |
|                                       | <hr/> <hr/> 1,140,855 | <hr/> <hr/> 272,882 |

### 18. CREDITORS

|                                     | 2020<br>£       | 2019<br>£       |
|-------------------------------------|-----------------|-----------------|
| Amounts falling due within one year |                 |                 |
| Grants payable                      | 4,418,496       | 3,686,938       |
| Other creditors                     | 162,388         | 180,182         |
|                                     | <hr/> 4,580,884 | <hr/> 3,867,120 |

|                                   | 2020<br>£     | 2019<br>£     |
|-----------------------------------|---------------|---------------|
| Analysis of other creditors       |               |               |
| Investment management fees        | 131,814       | 130,456       |
| Property management fees          | 5,700         | 10,200        |
| Audit fees                        | 10,200        | 10,000        |
| Other legal and professional fees | 3,400         | 3,300         |
| Others                            | 11,274        | 26,226        |
|                                   | <hr/> 162,388 | <hr/> 180,182 |

# Royal Commission for the Exhibition of 1851

## Notes to the Financial Statements for the Year Ended 31 December 2020

### 18. CREDITORS (continued)

|                                                     | 2020<br>£        | 2019<br>£        |
|-----------------------------------------------------|------------------|------------------|
| <b>Amounts falling due after more than one year</b> |                  |                  |
| Grants payable                                      | 2,783,602        | 2,324,510        |
| Due in one to two years                             | 1,821,110        | 1,601,535        |
| Due within two to five years                        | 962,492          | 722,975          |
|                                                     | <u>2,783,602</u> | <u>2,324,510</u> |

The analysis of grants payable by award is as follows

| Award                            | Period of<br>commitment | 2020<br>£        | 2019<br>£        |
|----------------------------------|-------------------------|------------------|------------------|
| Fellowships and studentships     |                         |                  |                  |
| – Research Fellowships           | 3 years                 | 3,099,479        | 2,815,066        |
| – Industrial Fellowships         | 3 years                 | 1,595,090        | 1,655,656        |
| – Industrial Design Studentships | 2 years                 | 339,645          | 355,550          |
| – Built Environment Fellowships  | 2 years                 | 58,402           | 95,604           |
| – Design Fellowships             | 2 years                 | 142,500          | 120,000          |
| – Enterprise Fellowships         | 1 year                  | 187,500          | 375,000          |
| STEM education and outreach      | 1 year                  | 342,932          | 281,932          |
| Support for legacy estate        | 3 years                 | 1,410,050        | 205,000          |
| Archives and alumni relations    | 1 year                  | 26,500           | 107,640          |
|                                  |                         | <u>7,202,098</u> | <u>6,011,448</u> |

### 19. FINANCIAL INSTRUMENTS

|                                                                                | 2020<br>£        | 2019<br>£        |
|--------------------------------------------------------------------------------|------------------|------------------|
| <b>Carrying amount of financial assets</b>                                     |                  |                  |
| Debt instruments measured at amortised cost<br>(debtors excluding prepayments) | 1,114,200        | 246,288          |
|                                                                                | <u>1,114,200</u> | <u>246,288</u>   |
| <b>Carrying amount of financial liabilities</b>                                |                  |                  |
| Measured at amortised cost                                                     | 7,364,486        | 6,191,630        |
|                                                                                | <u>7,364,486</u> | <u>6,191,630</u> |

## Administrative Information

### Structure, Governance and Management

The Commission is constituted as a limited company incorporated by Royal Charter. Its governing documents are the original Charter dated 3 January 1850 and a Supplemental Charter dated 2 December 1851.

The Commission may have up to twelve trustees, known as Royal Commissioners, at any one time, who together constitute the Board of Management, which meets formally twice a year. Commissioners are chosen to bring wide experience in areas relevant to the Commission's work – science, engineering, industry, design, architecture and finance. To maintain an appropriate balance of skills, Commissioners normally serve for 10 years, and Commissioners themselves identify possible successors, who may serve on a committee prior to election. Following election by the Board of Management, Commissioners are only appointed with the approval of the President.

All other committees are advisory in remit, are subordinate to the Board of Management and report to it, and all committee Chairmen are Commissioners. Ad hoc committees may be formed for limited periods and specific purposes. Any committee other than the Board of Management may have non-Commissioners as members subject to the wishes of the Chairman of that committee. All committees, except ad hoc committees, meet at least once annually. All committees are serviced by the Secretary and, where appropriate, by the Finance Director.

The Secretary also provides full briefing and induction programmes for all new Commissioners and committee members when appointed. As part of this introduction Commissioners are provided with a Governance Book containing full details of the Commission's history, role, strategy, procedures and Commissioners' responsibilities, as well as the relevant Charity Commission guidance for trustees. During their tenure, further opportunities for Commissioners to develop their knowledge of areas relevant to the Commission's activities are provided as appropriate.

Day to day running of the Commission is delegated to the Secretary, assisted by a small staff team. Matters of strategy, and all grants greater than £5,000, are decided by Commissioners.

Full details of Commissioners and Committee members in post during the year, as well as the small staff team, are provided on pages 67 to 69. Details of the Commission's professional advisers are provided on page 70.

### Remuneration

Commissioners are not remunerated in their role as trustees of the charity and do not receive benefits other than reimbursement of expenses incurred in attending meetings.

In order to maximise funds available for grant making, Commissioners are determined to keep staff numbers and associated office costs to a minimum. To attract and retain experienced staff of the right calibre, however, Commissioners recognise the need to set salaries in line with those for other grant-making charities in the London area, based on sector benchmarks and other publicly available data.

Salaries for all staff, including key management personnel, are reviewed annually by the Chairman of the Board and the Chairman of the Finance Committee as part of the performance appraisal process. Pay awards are dependent on performance and set based on increases in the cost of living and average salary increases for the sector. There are no automatic increments and no bonus scheme.

Commissioners recognise the importance of helping employees make adequate provision for retirement. All employees are therefore eligible to receive a 15% employer pension contribution to the pension scheme established for auto-enrolment purposes or a personal pension of their choice. All employees also benefit from a Group Income Protection policy that will cover basic salary and pension contributions if they are unable to work due to long-term illness. At their absolute discretion,

Commissioners may pay a nominated beneficiary a lump sum equivalent to 18 months' salary if an employee dies while employed by the Commission. All employees are also entitled to an interest free season ticket loan. All of the above benefits are available to all employees, including key management personnel. Employees do not receive any other benefits.

## Risk Policy

In discharging their responsibilities for the management of risk, it is the policy of the Commissioners to identify, analyse and seek to manage any risks to the ability of the Commission to carry out its role effectively and meet the obligations of its Royal Charter.

To this effect the Commissioners have given consideration to the major risks to which the Commission is, or may be, exposed. A full risk register has been drawn up, which is reviewed regularly. Insurance brokers have been appointed to advise on areas where risk can be effectively mitigated through insurance. Compliance risks are mitigated through taking and following appropriate professional advice.

The main remaining areas of strategic and operational risk and the steps taken to address them are summarised below. Actions taken to mitigate the impact of COVID-19 are described on page 10 above.

### *Investments: security, performance, liquidity*

The Commission has a diversified portfolio, both in terms of investments held and managers appointed. It has adopted investment and disbursement policies designed to maintain the real value of the portfolio over time and hence the support available to current and future beneficiaries. Sufficient liquidity is held outside the portfolio to meet short term commitments. Commissioners have delegated review of investment performance to a Finance Committee comprising individuals with relevant expertise.

### *Grant making: applications, assessment, administration*

Commissioners have appointed specialist committees to review fellowship applications, work closely with other organisations active in the STEM arena to avoid unnecessary duplication or administrative effort and have appointed a communications company to assist with marketing of the awards to ensure they are brought to the attention of eligible recipients. Commissioners regularly seek feedback from potential applicants and other stakeholders to ensure the awards remain relevant.

### *Legacy estate: character, experience, relevance*

Commissioners take an active interest in the estate, seek to facilitate relevant initiatives across legacy institutions and provide financial support where possible to ensure the estate remains a beacon of excellence and inspiration in the worlds of science, engineering and design.

## Commissioners and Committee Members

### President

HRH The Princess Royal

### Commissioners (and Board of Management)

Mr Bernard Taylor CBE DL FRSC *Chairman, Board of Management*

Sir William Castell LVO

Mr Stuart Corbyn FRICS

Professor Dame Kay Davies DBE FRS FMedSci

Professor Dame Ann Dowling OM DBE FREng FRS

Mr Jim Eyre OBE

Professor Sir Andrew Hopper CBE FRS FREng FIET

Professor Lord Mair CBE HonDSc FREng FICE FRS

Dame Alison Nimmo DBE MRTPI FRICS HonFRIBA FICE

Sir John O'Reilly DSc FREng FLSW

Ms Sandra Robertson

Professor Chris Wise RDI FREng FICE MIStructE HonFRIBA FRSA

Professor Dame Ann Dowling was appointed to the Board on 3 February 2020

Dame Alison Nimmo was appointed to the Board on 11 November 2020

Ms Sandra Robertson was appointed to the Board on 11 November 2020

Professor Sir Christopher Frayling retired from the Board on 1 January 2020

Professor Dame Lynn Gladden retired from the Board on 9 December 2020

### Ex Officio Commissioners

The Lord President of the Council

The First Lord of the Treasury

The Chancellor of the Exchequer

The Secretary of State for Business, Energy and Industrial Strategy

The Secretary of State for the Environment, Food and Rural Affairs

The President of the Institution of Civil Engineers

The President of the Geological Society

### Finance Committee

Sir William Castell LVO *Chairman*

Ms Sarah Arkle

Mr Stuart Corbyn FRICS

Professor Sir Andrew Hopper CBE FRS FREng FIET

Mr Nicholas Moakes CFA

Dame Alison Nimmo DBE MRTPI FRICS HonFRIBA FICE

Ms Sandra Robertson

Dame Alison Nimmo was appointed to the Committee on 12 November 2020

Ms Sandra Robertson was appointed to the Committee on 12 November 2020

Mr Adam Taylor-Smith retired from the Committee on 12 November 2020

## Science and Engineering Fellowships Committee

Professor Dame Kay Davies DBE FRS FMedSci *Chairman*  
Professor Gillian Bates FRS FMedSci  
Professor Mike Benton FRS FRSE  
Professor Martin Bridson FRS  
Professor Andrew Briggs  
Professor Neil Champness FRSC FLSW  
Professor Anne Dell CBE FRS FMedSci  
Professor John Dewey FRS  
Professor David Ewins DSc FEng FRS  
Professor James Feast CBE FRS FRSC  
Professor Douglas Gough FRS  
Professor Cyril Hilsum CBE FEng FRS  
Professor Jane Langdale CBE FRS  
Professor Stephen Muggleton FEng  
Professor Rachel O'Reilly FRSC  
Professor Sheena Radford OBE FRS FMedSci  
Professor Maurice Skolnick FRS  
Professor Trevor Stuart FIC FRS  
Professor John Wood CBE FEng

Professor Mike Benton was appointed to the Committee on 10 June 2020  
Professor Martin Bridson was appointed to the Committee on 2 July 2020  
Professor Sir Charles Godfray retired from the Committee on 5 June 2020

## Brunel Fellowships Sub-Committee

Professor Dame Kay Davies DBE FRS FMedSci *Chairman*  
Professor Dame Anne Dowling OM DBE FEng FRS  
Professor David Ewins DSc FEng FRS  
Professor William Powrie FEng FICE  
Professor John Wood CBE FEng

Professor Dame Ann Dowling was appointed to the Sub-Committee on 3 February 2020  
Professor William Powrie was appointed to the Sub-Committee on 8 October 2020

## Industry and Engineering Committee

Sir John O'Reilly DSc FEng FLSW *Chairman*  
Professor John Clarkson FEng  
Ms Naomi Climer CBE FEng FIET  
Dr Nicholas de Leon  
Professor Dame Ann Dowling OM DBE FRS FEng  
Professor Lord Mair CBE HonDSc FEng FICE FRS  
Professor Ron Pethig  
Dr Malcolm Skingle CBE DSc  
Professor Eleanor Stride OBE

Professor Dame Ann Dowling was appointed to the Committee on 3 February 2020

## Built Environment and Design Fellowships Committee

Mr Jim Eyre OBE *Chairman*  
Professor Rachel Cooper OBE  
Mr Robin Levien RDI+

Dame Alison Nimmo DBE MRTPI FRICS HonFRIBA FICE\*  
Dr Andrea Siodmok OBE EMPP FRSA HonDCL  
Professor Chris Wise RDI FREng FICE MIStructE HonFRIBA FRSA

Mr Robin Levien was appointed to the Committee on 23 June 2020  
Dame Alison Nimmo was appointed to the Committee on 11 November 2020  
Dr Andrea Siodmok was appointed to the Committee on 26 June 2020  
Professor Sir Christopher Frayling retired from the Committee on 1 January 2020

+Design Fellowship years only  
\*Built Environment Fellowship years only

## Staff

|                        |                                      |
|------------------------|--------------------------------------|
| Mr Nigel Williams CEng | Secretary                            |
| Mr Amahl Smith ACA     | Finance Director                     |
| Mrs Helen Harris       | Fellowship Programme Manager         |
| Mrs Angela Kenny RMARA | Archivist and Alumni Relations       |
| Ms Kat O'Dea           | Office Manager / Executive Assistant |



## Professional Advisers

### Bankers

The Royal Bank of Scotland plc  
South Kensington Branch  
29 Old Brompton Road  
London SW7 3JE

### Investment Managers

Schroders (C.I.) Limited  
Regency Court  
Glatigny Esplanade  
St Peter Port  
Guernsey GY1 3UF

### Surveyors

Cluttons LLP  
Portman House  
2 Portman Street  
London W1H 6DU

Charles Stanley & Co. Ltd  
55 Bishopsgate  
London EC2N 3AS

### Strategic Property Advisers

Cushman & Wakefield LLP  
125 Old Broad Street  
London EC2N 1AR

JP Morgan Asset Management (UK) Ltd  
20 Finsbury Street  
London EC2Y 9AQ

### Auditors

Moore Kingston Smith LLP  
Devonshire House  
60 Goswell Road  
London EC1M 7AD

### Legal Advisers

Farrer & Co LLP  
66 Lincoln's Inn Fields  
London WC2A 3LH

### Actuaries

XPS Pensions  
Albion  
Fishponds Road  
Wokingham RG41 2QE

### Insurance Brokers

Aston Lark Ltd  
9th Floor, Colman House  
King Street  
Maidstone  
Kent ME14 1DN

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