

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

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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}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}Xe MRI is limited due to the intrinsic combination of compartmental (tissue/RBCs) ^{129}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 Leonett	Design Thinking	Cranfield University
Grace Louise Duan	Innovation Design Engineering	Royal College of Art and Imperial College London
Steph Jump	Innovation Design Engineering	Royal College of Art and Imperial College London
Vedika Lall	Global Innovation Design	Royal College of Art and Imperial College London
Jasper Mallinson	Innovation Design Engineering	Royal College of Art and Imperial College London
Hunaid Nagaria	Innovation Design Engineering	Royal College of Art and 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 Imperial College London
Alexander Spencer	Innovation Design Engineering	Royal College of Art and Imperial College London
Eve Townsend	Innovation Design Engineering	Royal College of Art and Imperial College London
Jacob Wellsbury	Innovation Design Engineering	Royal College of Art and Imperial College London
Benjamin Williams	Innovation Design Engineering	Royal College of Art and 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.jpcllett.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 Sr_2RuO_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 jatrophanes 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 jatrophanes 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 Canghai, 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 CO₂ (2021: 1,601 tonnes) vs the MSCI AC World (TRI) USD of 7,990 tonnes of CO₂ (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 CO₂E/\$M Sales) of the companies in the underlying ETFs was 131.5 versus their index of MSCI World (ETF) 148.2 T CO₂E/\$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.)

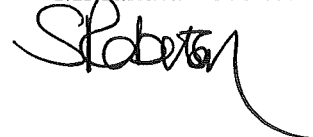
The law applicable to charities in England and Wales requires the Commissioners to prepare financial statements for each financial year which give a true and fair view of the state of the affairs of the Commission and of the incoming resources and application of resources of the Commission for that period. 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 Funds 2022 £	Unrestricted Funds 2021 £
Income from:			
Donations	4	3,300	3,000
Investments	5	2,386,031	2,256,608
Other	6	4,217	58
Total income		<u>2,393,548</u>	<u>2,259,666</u>
Expenditure on:			
Generating funds	7	799,328	643,883
Charitable activities	8	5,470,448	4,538,642
Total expenditure		<u>6,269,776</u>	<u>5,182,525</u>
Net expenditure before gains and losses on investments		<u>(3,876,228)</u>	<u>(2,922,859)</u>
Net gains / (losses) on investments			
(Losses) / gains on property		(170,900)	1,213,607
(Losses) / gains on investments		(15,619,781)	13,616,698
Total of net gains / (losses) on investments		<u>(15,790,681)</u>	<u>14,830,305</u>
Net (expenditure) / income		<u>(19,666,909)</u>	<u>11,907,446</u>
Other recognised gains and losses			
Actuarial gains / (losses) on defined benefit pension scheme	14	13,087	(3,432)
Net movement in funds		<u>(19,653,822)</u>	<u>11,904,014</u>
Reconciliation of funds			
Total funds brought forward		150,029,559	138,125,545
Net movement in funds		(19,653,822)	11,904,014
Total funds carried forward		<u><u>130,375,737</u></u>	<u><u>150,029,559</u></u>

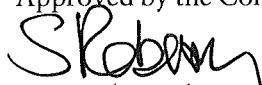
The notes on pages 53 to 71 form part of these accounts. Notes 1-2 provide details of the Commission's objectives and accounting policies.

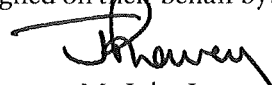
Royal Commission for the Exhibition of 1851

Balance Sheet as at 31 December 2022

	Notes	Total Funds 2022 £	Total Funds 2021 £
Fixed asset investments			
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>
Current assets			
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>
Liabilities			
Creditors: Amounts falling due within one year	18	(4,595,362)	(4,070,791)
Net current liabilities		<u>(2,917,065)</u>	<u>(2,088,174)</u>
Total assets less current liabilities		<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)
Net assets excluding pension liability		<u>130,732,737</u>	<u>150,428,559</u>
Defined benefit pension scheme liability	14	(357,000)	(399,000)
Net assets		<u><u>130,375,737</u></u>	<u><u>150,029,559</u></u>
The funds of the Charity:			
Capital Funds			
Balance as at 1 January		150,029,559	138,125,545
Movement in year		(19,653,822)	11,904,014
Balance as at 31 December		<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 Funds 2022 £	Total Funds 2021 £
Cash flows from operating activities		
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)
	<hr/>	<hr/>
Cash used in operating activities	(5,494,675)	(5,686,812)
Cash flows from investing activities		
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)
	<hr/>	<hr/>
Net cash provided by investing activities	7,388,235	6,644,948
Change in cash and cash equivalents in the reporting period	1,893,560	958,136
Cash and cash equivalents brought forward	3,078,970	2,120,834
	<hr/>	<hr/>
Cash and cash equivalents carried forward	4,972,530	3,078,970
Disclosed as:		
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
	<hr/>	<hr/>
	<u>4,972,530</u>	<u>3,078,970</u>

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	2021
	£	£
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	2021
	£	£
Licence income	4,217	58
	<u>4,217</u>	<u>58</u>

7. COST OF GENERATING FUNDS

	2022	2021
	£	£
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 (note 9)	Direct costs (note 10)	Allocated support costs (note 11)	2022	2021
	£	£	£	£	£
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 No.	2022 £	2021 No.	2021 £
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>

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 £	2021 £
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/>
	<u>189,060</u>	<u>199,839</u>

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 Exhibition Road / South Kensington Green Trail	25,000	30,000
Royal College of Art – Open resource for purposeful design / The empathetic engineer	15,000	13,500
Royal Geographical Society – Upgrading 1 Kensington Gore	-	155,200
	<u>1,190,000</u>	<u>198,700</u>
Less: Past awards written back where not utilised in full	-	(3,000)
	<u><u>1,190,000</u></u>	<u><u>195,700</u></u>

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

	Fellowships and studentships £	STEM education and outreach £	Support for legacy estate £	Archives and alumni relations £	2022 £	2021 £
Promotion and selection costs	84,721	-	-	-	84,721	85,323
Networking and educational events	62,907	161,712	13,882	5,217	243,718	116,506
Estate memberships, projects and advice	-	-	30,035	-	30,035	35,993
Archive supplies and acquisitions	-	-	-	6,457	6,457	4,898
Alumni website and expenses	-	-	-	6,175	6,175	6,785
	<u>147,628</u>	<u>161,712</u>	<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	Fellowships and studentships	STEM education and outreach	Support for legacy estate	Archives and alumni relations	2022	2021	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	2021
	£	£
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	2021
	£	£
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	2021
	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:

	2022	2021
	No.	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 Valuation 2022 (% p.a.)	FRS102 Valuation 2021 (% 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 CMI 2021 1%	S3PA 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 than husband	3 years younger 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 £	2021 £
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 £	2021 £
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>

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 £	2021 £
(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>

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 £	2021 £
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 £	2021 £		
(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>		
	93,179,598	94,413,971		
(b) <i>Geographic breakdown</i>				
	2022 £	2022 £	2021 £	2021 £
	Listed investments	Cash	Listed 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	2021
	£	£
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	2021
	£	£
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	2021
	£	£
Analysis of other creditors		
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 £	2021 £
Amounts falling due after more than one year		
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 commitment	2022 £	2021 £
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 £	2021 £
Carrying amount of financial assets		
Debt instruments measured at amortised cost (debtors excluding prepayments)	348,001	375,958
	<u>348,001</u>	<u>375,958</u>
Carrying amount of financial liabilities		
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 £	Income £	Expenditure £	Gains / (losses) £	Transfers £	At 31 December £
Unrestricted General	147,743,822	2,393,548	(6,269,776)	(15,777,594)	(132,921)	127,957,079
Designated – 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 FEng FICE MStructE 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 FEng 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 FEng

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
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
60 Victoria Embankment
London EC4Y 0JP

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
London WC2A 3LH

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instagram: <https://instagram.com/royalcom1851>