



Science and Technology Committee

Corrected oral evidence: Delivering a UK science and technology strategy

Tuesday 1 March 2022

10.15 am

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Members present: Baroness Brown of Cambridge (The Chair); Viscount Hanworth; Lord Holmes of Richmond; Lord Krebs; Baroness Manningham-Buller; Lord Mitchell; Lord Patel (co-opted); Lord Rees of Ludlow; Baroness Sheehan; Baroness Walmsley; Baroness Warwick of Undercliffe.

Evidence Session No. 3

Hybrid Proceeding

Questions 16 - 22

Witnesses

Sir Adrian Smith, Director and Chief Executive, Alan Turing Institute; Dr Paul Bate, CEO, UK Space Agency; Chris Wigley, CEO, Genomics England.

USE OF THE TRANSCRIPT

This is a corrected transcript of evidence taken in public and webcast on www.parliamentlive.tv.

Examination of witnesses

Sir Adrian Smith, Dr Paul Bate and Chris Wigley.

Q16 **The Chair:** Good morning, particularly to our witnesses. Thank you very much for joining us today for our inquiry into delivering a UK science and technology strategy.

Before we start the questions, I would like to remind you that the session is being broadcast on the internet. A transcript of today's session will be sent to you in a few days' time so that you can check it and send in any minor corrections. If there is anything that you do not get a chance to say, we would be delighted if you would provide us with supplementary evidence in writing after the meeting. If there are things you think of afterwards or that you do not get a chance to fit in, please let us know. I remind my colleagues that we should state any conflicts that we may have before we ask our questions.

If that is clear for all our witnesses, I will kick off with the first question. We are very interested in understanding the science and technology and innovation landscape in the UK, whether the Government have the right links and levers to deliver their objectives and whether their various objectives are compatible. Of course, the public sector research establishments are a very important part of that landscape. They are also a very complicated part of that landscape, from our perception, because they are an array of very different kinds of organisations that we lump together under this term. It would be really helpful if you could briefly tell us about your organisation's core mission, how it fits into the R&D landscape, how it is governed and how it relates to government.

Let me start with Sir Adrian, since he is our virtual witness. Adrian, the floor is yours on this one.

Sir Adrian Smith: I am the director and chief executive of the Alan Turing Institute, which is the UK's national institute for AI and data science. Should it be of interest in part of the questioning, I also chair the board of the UK's Diamond Light Source synchrotron at Harwell, but I take it that I will focus mainly on Turing.

I offer a disclaimer. Turing is not a conventional public sector research establishment. It is a joint venture with limited liability and charitable status. It has three ambitious overarching goals. One is to advance world-class research in AI and data science and to apply it to the big challenges that face us nationally and globally. Another is to train the leaders of the future. There is a great dearth of expertise and volume of people who get the whole transformational world of digital data, the data science and the AI. Also, a lot of what we are about will fail, in the same way as we had problems with GM crops and MMR vaccines, unless in some sense we lead the public conversation and create sufficient public awareness of, interest in and acceptability of the potential transformative effects of data science and AI.

Those are our overarching goals. To achieve them, we have a major brokering and convening role in bringing together stakeholders across the UK, working with universities, other research organisations, industry, government and the third sector, the whole point being to try to maximise the impact of data science and AI for the public good. We are a joint venture that was originally founded between five university partners and the research council, the EPSRC. We are a company limited by guarantee with charitable status. That may be relevant and makes us slightly different from a number of other public sector research establishments.

Chair, is that enough to kick off the proceedings?

The Chair: That is great. It helps us to make a start on the complexity of this part of the landscape. What policy levers do the Government have to influence the work that you might do in the Turing? You are clearly rather important for the Government's new science and technology strategy priorities.

Sir Adrian Smith: Technically, of course, we are an independent research organisation. It is important that we have intellectual control over the research and innovation direction, but part of our remit is to respond to major challenges. Obviously, a lot of those challenges are thrown up by government and policy.

We have a public policy programme, which interacts with many of the government departments and agencies when it comes to exploring how data-driven policy, implementation and so on should run. That looks at important issues of standards and regulation going forward. We also have major programmes in AI for science in government itself and defence and security.

There is an enormous amount of interaction with government and agencies, so in some sense there is great awareness of the need for us to respond to the challenges, policy and otherwise, of government, while, of course, intellectually owning our research and innovation agenda to achieve that. We interact with practically all government departments through our public policy programme, so we are closely in touch with the issues of policy development, policy implementation and the potential role of data, data science and AI in that world.

The Chair: Thank you very much. Can I move to Dr Bate? Of course, all three of you are here because your organisations align well with the Government's science and technology strategy.

Dr Paul Bate: I am the chief executive of the UK Space Agency. The UK Space Agency is an arm's-length body. It is an executive agency of the Department for Business, Energy and Industrial Strategy. Our governance therefore involves a steering board as well as that direct relationship with the sponsoring department.

We have a vision, a mission, which is to inspire and lead the UK in space, for the benefit of our people and our planet: to harness the power of space for the good of all. In order to do that, we have been looking,

certainly since I joined about six months ago, and prior to that, at what we can uniquely offer to the UK space sector.

In doing so, it is quite important to note that there have been two very important reviews on space strategy. There is the space landscape review, which had a number of recommendations, including that the high-level policy and strategy role on space be split off. That used to be carried out by the Space Agency and is now carried out by the sponsoring department, BEIS, with the agency focusing more on delivery of the Government's ambitions. That is one of our fixed stars, if you will pardon the pun. It is one of the things that we navigate against. We have also had the publication of the national space strategy, back in September last year, which set out the Government's civil and military ambitions in space. Of course, we take our lead from that, as we deliver significant components of it.

The consequence of all that and of the comprehensive spending review, which sets our budget, is that, in consultation with industry and academia, we will focus on three particular areas in order to deliver the mission or purpose.

First, we will catalyse investment in the UK space sector. Catalysing is important, because other modern spacefaring nations such as the French, the Germans, the Japanese and the Italians often tend to spend more on civil space. Consequently, we as an agency have a unique role to play in bringing in more capital from around the world and more contracts in order to support the space sector.

We also have a role in the delivery of missions and capabilities. We are involved and have a leadership role in 17 different science missions, predominantly through the European Space Agency. That is the second component of our role.

Thirdly, we champion space, both for the public at large, to help to explain the benefits of space down on earth, and for children, particularly girls and children from disadvantaged backgrounds, so that they recognise the opportunities of STEM—science, technology, engineering and mathematics—study, using the unique inspiration that space brings. We also champion space for sectors such as the financial sector and agriculture that are not space dominated but can benefit from space data. Those three parts of our role are the focus of all our work going forward.

The Chair: Excellent. Thank you very much. I turn to Mr Wigley.

Chris Wigley: I am chief executive at Genomics England. I will touch on our mission, our governance and some of the strategies that are in place.

At Genomics England, we have articulated our mission as being to bring the benefits of genomic medicine to everyone. In order to try to deliver on that mission, we do two big things.

Big thing number one is that we work with the NHS to provide whole genome sequencing-based diagnostics for people who are sick. Typically, those are people with rare diseases or cancer. Often, particularly for rare diseases, this will be a solution to what people call the diagnostic

odyssey, where those with a rare disease go to one specialist after another. Whole genome sequencing can short-cut a lot of that diagnostic odyssey, which is great. In the cancer space, it is often about understanding the specific nature of the tumour: comparing the DNA of the tumour with the DNA of the human and then using that to guide diagnosis and treatment for that person. So big thing number one is working with the NHS: real patients, live systems, turnaround times that we need to hit and so on.

We can then de-identify and aggregate all those datasets—the genomic data, the clinical data and the operational data—and make them available to researchers in our research environment. So big thing number two is working with the research community to develop new insights into genomics and how the body works, new diagnostics, new drugs and new therapeutics. We have just under 4,000 researchers registered in our research environment. Hand in hand with the participants whose data it is, we have developed a system where the researcher comes to the data. We talk about this as being a bit like an aquarium; you can come in and admire the fish, but you cannot take the fish away with you. That work happens in a trusted research environment.

Critically, we can feed insights from that research back into healthcare. There is a reasonably rapid updating every year of the National Genomic Test Directory, so there is a route to bring those insights back in, whether it be for an individual patient or for new treatments and so on. A patient may not have had a diagnosis when they were in live care, but a research team may have found out something about their condition.

Healthcare service delivery and research support are the two big things that we do. We work hand in hand with patients, who govern access to their data in the research environment.

In governance terms, we are a company that is owned by the Department of Health and Social Care. The sitting Secretary of State is our sole shareholder. We have a board that is chaired by Baroness Blackwood, who is a member of this committee. The intent of setting up Genomics England as a company, rather than as part of a government department, was to give us the ability to hire, move forward and do things in different ways. We may want to come back to that when we talk about different structures.

The strategies that guide our work are, in particular, *Genome UK: The Future of Healthcare*, which came out in September 2020, and the *Life Sciences Vision*, which came out in the summer of 2021.

The Chair: Do you see yourselves as a research establishment?

Chris Wigley: Yes. We both do and support research. The model that I sometimes use as a mental model is a bit like the BBC: we provide the infrastructure for broadcasting, make some programmes and support other people in broadcasting their programmes.

The Chair: Thank you very much.

Q17 Lord Rees of Ludlow: I would like to follow up on how your organisation relates to government: what works well and what does not work so well. In particular, how do you secure funding for new and ongoing projects? What approvals are needed? Are they unduly time consuming and vexatious? There will probably be different answers from the three different witnesses.

Sir Adrian Smith: What works well is that in its short life Turing has come to be seen as a trusted national institute. It has become a natural front door for many seeking to understand the potential and transformative effects of AI and data science, so there is no shortage of interest.

Some of the problems are to do with funding, but some are also to do with awareness and capability within government departments: the actual awareness of what AI and data science can do in the policy space. Of course, if we create that awareness and mutual interest, we have the problem of funding. There are myriad opportunities where the Turing could work much more effectively with government departments and agencies, but those departments and agencies do not themselves have the funding to take things forward. A lot of it then reverts to funding issues.

The core funding of the mainstream Turing organisation came partly from EPSRC and partly from our five founding university partners, which were subsequently extended to 13 university partners. However, that becomes a very transactional relationship. In a sense, the universities are paying as if it were a subscription model, which gets in the way of strategic working, and the lack of core discretionary funding makes it difficult to be strategic.

There is enormous potential for better working with government. We already have very successful work in AI science in government, defence and security. As I said, our public policy programme interacts with many, if not most, government departments. The problem at the end of the day is having the awareness and absorptive capacity within government departments to understand the potential of the digital data, data science and so on, and the funding to follow up. There is no shortage of good will and interest, but funding mechanisms create problems.

Dr Paul Bate: Our funding is relatively simple, in that we get all our money from the Government and the taxpayer. We are therefore part of the comprehensive spending review. We will shortly find out our allocation for the next three years, there being a comprehensive spending review this time around.

That said, the one really serious advantage is that we can put forward the programme of work that we think is most important in space, but there is a single convening department that can look across both the space environment and the broader science and innovation environment within the sponsoring departments making recommendations to their Secretaries of State. Therefore, when the settlement is made, it is made in the knowledge that it is not a space-only transaction. That is a good way in which the Government are convening the wider set of funding.

When I started this job, I spent most of my first three months visiting universities and companies to ask them what was working and what was not. The biggest issue on the funding side was one-year settlements and the consequences of that for grant funding. Often grants were not even awarded at the beginning of the financial year because grant calls were taking some time. By the time the applications were opened and had been assessed and completed, people in research organisations or wherever they might be were finding it very difficult to put together good applications to spend the money well. Having a three-year settlement this year is really valuable for us as an organisation and for the space landscape.

There is another opportunity. We are not the only funders of space by a long chalk. We work closely with STFC, which is the predominant research council involved, and Innovate UK. There are lots of people who have budgets that contribute to the RD&I effort in space. Now that we are very close to knowing or, in some cases, know the settlements, we have an opportunity to come together as organisations involved in funding RD&I in space to make sure that we use the money in the best way possible.

Lord Rees of Ludlow: The ESA mandatory subscription must be something over which you have some control, and it is very long term.

Dr Paul Bate: A little over 70% of all the money that the Space Agency received in the current financial year passes through to the European Space Agency, as you say. That is about £380 million out of a total of £534 million. However, not all of that is mandatory. We have discretion over how much we put into the European Space Agency.

Chris Wigley: I do not think that we could exist unless we were part of government. In that sense, that is something that works well, because it is existential.

Britain has an incredibly proud history of funding research in genomics, we could argue, from Darwin to Rosalind Franklin, Crick and Watson, Sanger and so on. That funding has been sustained, which is one of the reasons why I would argue that we are genuinely world leading in this space, both in genomic research and in its application in medicine. In that sense, although we always have to continue to make the case, funding is a less direct issue for us. It is more about the nature and timing of funding. I echo Paul's points about the need to kick off any given year at a run if we want to get something done in that year.

I will stick with the things that work well with government for a minute. A big part of that for us is trust. As a government company, we can be demonstrably trustworthy as regards not having other agendas. That is a big part of our relationship with patients and research participants.

The convening power of government is great. We have a very complex ecosystem of academic partners, technology partners, sequencing companies, biotech companies and pharma companies. As we saw during the response to the pandemic, the ability to convene that whole

ecosystem around a common mission is a great benefit of our relationship with government.

What areas could be improved? For us, it is about finding a way to tailor what are generally a good set of best practices on governance. Here are a few examples to try to bring that to life. One is recruitment. As a government body, we are trying to recruit people from Google Health, the big pharma companies and the big technology companies. Almost everyone senior who has joined us in the two years in which I have been chief exec has taken a very large pay cut to do so. That is great, because we can inspire people with the mission and so on. At the same time, people have families and kids and want to go on holiday, so we can stretch that elastic only so much before it breaks. Some ability to recruit in a different way for the right kind of talent profiles would be great.

We do a lot of public dialogue and engagement on data and the use of genomic data. It is incredibly sensitive. For example, in this spending review we have just been funded to do a project on exploring the benefits of newborn sequencing, which involves very sensitive data from brand-new babies and so on. That sometimes gets bracketed as marketing spend in the allocations. We have to try to explain that it is not marketing spend but spending on public dialogue about highly sensitive datasets. We get there, but all those conversations take time. That timing point is critical for us. As Paul said, it is March 2022, but we do not yet have the final settlement from the spending review. Then we need to put in the business cases to spend the money that we are allocated in the budget. Before we know it, we can be six or nine months into the financial year. That timing point would make a massive difference to us.

I can offer some suggestions. There are models where, for example, a portion of funding can be pre-cleared while we get other pieces through, so that we can start to move. There is also something on linking accountability and authority. If we want to make an organisation or a set of leaders accountable for something, we need to give them some element of authority to move on it.

Lord Rees of Ludlow: I would like to ask the other two witnesses a follow-up question. Again, it relates to staffing. The PSREs have a range of missions. Some are doing things like academics, where the output is scientific papers. Some are doing very long-term science. Some are doing projects of various kinds. The motivations of the staff are different. Their average tenure is different. Could the other two witnesses comment briefly on the question of retaining and motivating staff?

Sir Adrian Smith: Because Turing is not a public sector research establishment in the conventional sense, we are not subject to pay controls and constraints, which is not the case with the Diamond synchrotron, for example.

Some of these things come back to the fact that, if we have aspirations globally to be a great scientific nation, there is a global competition for talent. The whole issue of looking at what makes it possible to recruit and retain to be competitive is really important and is very different across different kinds of institutions, with different governance and different

kinds of constraints. I do not have the pay constraint in Turing, but I have the strategic investment constraint that, unlike universities, we do not get QR, so I do not have core discretionary funding to be strategic. I have to get all money on a transactional basis.

I go back to the Chair's original point. This is a very complex landscape that is very differentiated in the pluses and minuses for the different structures.

Dr Paul Bate: We also face that challenge. The space sector is a relatively well-paid sector, but we are under the same pay constraints as the rest of the Civil Service. We have some ability to offer discretionary pay for particular professions. However, it is extremely important to recognise in the Space Agency that it cannot be only certain professions that benefit from that. The agency works because it is a team. Space is a team sport. We have no desire to make things okay for some of our staff but not for others. It is a genuine issue for us.

Q18 Lord Krebs: As a prelude, I would like all of you to comment briefly on a point that arises from Lord Rees's question. The term "PSRE" is applied to a wide range of organisations, some of which, such as the British Geological Survey and perhaps the UK Space Agency, provide national infrastructure, and others of which, such as the John Innes Centre in Norwich, are carrying out fundamental blue-skies research. Is it a misleading concept to lump them all together as a single category? Should we not be thinking of PSREs as an entity?

Nevertheless, the Government are undertaking a review of the performance of PSREs. Would you like to comment on particular aspects of that? First, is the expertise in PSREs sufficiently utilised by government in policy-making? You have partly answered that, so you may not wish to add much to what you have said.

Secondly, how do you think that performance and impact of PSREs should be measured?

Finally, if we think about international comparisons, there are some European countries, such as Germany and France, that spend a much bigger proportion of their basic research budget in research institutes: the Max Planck Society in Germany, which carries out fundamental research not just in the natural sciences but across into the humanities and social sciences, and the CNRS in France. Do you think that that is a desirable model? Are you happy with the notion that fundamental blue-skies research in this country is done largely in universities?

Chris Wigley: Is "PSRE" too broad a term? I do not have a particularly strong view personally. As you say, there is probably a large amount of variation within that. It may be a helpful exercise at some point to consider what criteria drive differentiation. Is there a set of structures, like Linnaeus's classification of the animals, within PSREs that would allow us to say, "Right, we know that we have some mammals, some fish and some lizards, and we can treat them slightly differently"? I would hesitate

to offer a view on what those are, but they could be on the nature of funding, blue-skies versus applied research and so on.

Do we feel that we have enough input into government policy? Yes, I think that we do. The big pieces of policy in our space, which I mentioned, were the *Genome UK* strategy and the *Life Sciences Vision*. We were closely involved in inputting into and helping to draft those.

As regards metrics, I think this comes back to heterogeneity. For us on the research side, we measure a lot of our collaborations in the sense of how much fundamental science we are doing. We can always look at papers and things like that, which we know are an imperfect measure but give a sense of activity. Critically for us, an important metric is how much of that research work is feeding through into healthcare delivery, and we can measure that through things like updates to the National Genomic Test Directory. On the healthcare side, ultimately, it is about how many people we are helping, and that would be things like quality-adjusted life years.

Lord Krebs: On the point about other countries, do you think the UK could invest more of its fundamental research budget in PSREs? You may not have a view.

Chris Wigley: I do not have a view on that one.

Dr Paul Bate: Similar to Chris, I do not have a strong view personally or as an agency about the term. On the related point of being very clear about what each organisation is actually asked to do and how well it is delivering, that is extremely important. Since 2011, when the Space Agency started, it has grown a lot, but not necessarily always with complete clarity about the expectations. As a consequence, again when I am out and about, one thing people say back to me is, "You try to do a lot of things. Are you sure that you're focused enough on doing the most important?"

This question of what the organisations should be measured by is absolutely vital. That is right at the heart of what we are discussing with government at the moment. As the settlement for the comprehensive spending review is finalised, it allows us to publish a corporate plan, as we are required to do, for the next three years. That plan has to have the two components of what our objectives are and what our resources are to achieve those objectives.

Having said earlier that capitalising investment is a really important objective, I think it is very important that we are measured on it. We have started to suggest ways in which we can be thoughtfully and sensibly measured on that. There is a whole stream of work through the national space board, which was set up after the national space strategy, looking at the implementation of the space strategy, which looks carefully at what the performance measurement structures need to be right across the set of agencies and organisations involved in space.

Our expertise is used to inform policy-making. I would be very concerned if it was not. There are almost 300 people in the Space Agency. They are expert in what they do and many of them have devoted their lives to it.

We have extremely strong links to the academic community and to industry, and we have a number of committees that advise us. As a consequence, we have greater expertise than it would be reasonable to expect a sponsoring department to have, and our sponsors, the BEIS and the Space Directorate, are very respectful of that, and they come to us for policy advice. We have seen that not least this week, for example.

I do not have a strong view on the Max Planck Institute or CNRS models, and I would not comment on that.

Sir Adrian Smith: Before we assess whether we want more of this or less of that, the fundamental question is: what are we trying to achieve; what are these things for? If you look at fundamental discovery research, we have a pretty good track record in the UK through individual academics and universities. If we get into more strategic spaces and take something like what the UK's positioning should be in AI and data science, this is a fast-evolving field that is not settled. It is not like the genomics and the space, which have been around for a long time, where we may have a settled set of objectives. In the case of my own institute, we are, in a sense, making it up as we go along. We are trying to discover what the basic issues are in AI and data science, how to apply them, and the ethical and other issues that surround it.

You have to start with what we are trying to achieve and what things are for. In terms of discovery science research, the kinds of mechanisms we have at the moment, subject to funding, seem to me fine, but if we now have a new Office for Science and Technology Strategy, that suggests that we are going to identify a small number of things that are really strategic. If they are really strategic, we need to think about what the institutions, organisations, mechanisms or funding are that will achieve what we want to do strategically. I am assuming that part of Paul Nurse's review will ask those fundamental questions about whether we have the right delivery mechanisms for things that we want to be more strategic about, as opposed to basic discovery science. I am not sure, and I think it will be very interesting to see what comes out of Paul Nurse's review.

I do not have any particular prejudices, but I think there are really big challenges. There are issues of scale. Can we do odd little bits of three-year research projects? Does it add up to something strategic that will transform the world? There is short term versus long term. There is the question of who sets the strategy and so on. Do we have the right landscape for it? I really do not know.

As to metrics in the AI and data science world, we are still evolving, so it is quite hard to know exactly what the metrics would be. It is identifying challenges, rising to them and creating the talent.

If I might for a moment talk about the Diamond synchrotron, in the annual reports we have published a very serious set of metrics. Some of it is to do with international scientific excellence, because there is an international competitiveness about how you position yourself. Some of it is to do with throughput to industry, such as the metrics on beamtime that goes into industry, et cetera, et cetera. With all this, it is somewhat horses for courses, but the starting point should be that, if we are moving

towards a more strategic view of what we want to achieve in the UK, it would be right and proper to test the existing landscape against its ability to deliver those strategic goals.

- Q19 **Baroness Walmsley:** I have no relevant interests to declare. As you know, the Government have said that they want the UK to be a science superpower. In that regard they are indeed increasing departmental R&D budgets. What role would you see for your organisation in delivering the overall science strategy? Obviously, apart from getting more money, could you say what barriers your organisation would face in helping to achieve this mission?

Dr Bate, could you clarify a tiny thing in your earlier answer as to whether your three-year settlement, which you welcomed, is a rolling three-year settlement, or do you fall off a cliff in three years' time?

Dr Paul Bate: No, I do not believe we will fall off a cliff, because we would expect another comprehensive spending review, or at least a spending review in the manner that Governments have been carrying that out in the last 20 or so years. The difference in the last two years is that they have been one-year settlements and now it is a three-year settlement. I very much hope that we have another three-year settlement.

To your point on being a science superpower, we do so much of our science through the European Space Agency currently. It is worth saying that our funding cycles are different from the European Space Agency's, which has a five-year funding term. We make forward commitments, as we have to, and as all countries do.

It is worth saying that, since 2011, in all the core science missions that the European Space Agency has conducted, the UK has played a leading scientific and principal investigator role, so we have a really strong heritage. To go back to the 1980s, 13 of the 21 ESA science missions have had that same level of involvement. So whatever barriers there are, they are clearly not existential. We are finding really good ways to work.

On Christmas Day, the James Webb telescope finally launched from Kourou in French Guyana. That is the next-generation telescope to Hubble. Hubble was so transformational. My first ever piece of research was on the faint object camera for Hubble. It has a personal resonance, as I am sure it does for many members of the committee. That simply could not be done by one country and shows the power of international collaboration, in that case across NASA, as well as the European Space Agency.

There are four instruments on that mission, including the mid-infrared instrument, which is co-led by the UK, built in the UK, designed in the UK, with Gillian Wright being the PI. We have this heritage. Clearly, we are doing amazing things on core space science on astronomy.

As to the barriers, I guess it is the flip-side of being able to do these enormous global missions looking out further back into the universe than Hubble could using infrared. There are 22 member states in the European

Space Agency. Every time I am around the table with the other 21 bodies, apart from having a lot of sympathy for the chair I also recognise how difficult it is to reach consensus, to make sure we have the right funding. It is a necessary barrier that we have to be co-ordinated at that level, but the solution, in my mind, is that we maintain the work on fundamental science through the European Space Agency. We are also looking for bilateral missions as well as national missions, so that we do not have just the drumbeat of the big science, if you like, the global science, but there are also the medium-sized and smaller missions too.

Baroness Walmsley: Since Brexit, has that collaboration been difficult, or does it offer you future opportunities that you did not have before?

Dr Paul Bate: Because the European Space Agency is an independent body and is not part of the European Union, and it gets the vast majority of its funding from individual member states, it does not present the same challenges as it would for an operational European Union service such as Galileo. None the less, we have to recognise that it is a big shift. For some programmes, less on the core science side but on the operational side it is difficult. I mentioned Galileo, and there are ongoing conversations about the Copernicus earth observation missions. The Government have said they wish to invest a further €750 million and that is on the table, but it has not yet been accepted by the European Union. That is a problem. It is a problem for our scientists.

There are huge opportunities as well. It allows us to look further afield than we perhaps otherwise have done for our science, say, directly with NASA, or with the Japanese in the Indo-Pacific, or with the Canadians or the Australians. It is a world of opportunity, quite literally.

Sir Adrian Smith: In all fields of scientific discovery and technical translation, the world is being transformed and challenged by data, digital and the role of data science and AI in everything, as opposed to a box called data science and AI. We have to take that on board in looking at where we go nationally. There is data transformation even in the way we do science. We could debate the simple, old-fashioned view of science where you have a hypothesis, you collect some data and you decide whether the hypothesis is good, bad or indifferent, or, if you have certain quantities of data and clever ways of looking at the data, the data itself might tell you what is going on without you hypothesising. These are potentially fundamental challenges to the whole way we do science.

If we are to stay at the forefront of science, we need to be very clear that we are at the forefront of understanding how AI and data science is transforming science itself. That goes back to what you would expect me to say: the fundamental importance of having a national institute such as Turing, which can do the thought leadership in that space.

Going back to your general theme of public sector research establishments, at Turing we are systematically making links with the public research establishments to try to understand how they can best take on board this revolution of AI and data science in their own worlds, whether it be Rosalind Franklin, Royce, John Innes, Rothamsted, whatever. We have a role to try to maintain not just excellence in AI and

data science per se but the interaction and the use of extensive networks and convening power, and interdisciplinary challenge-led approaches, to understanding how this is going to transform the landscape. If we are going to stay ahead of the game globally in science, we need to stay ahead globally in AI and data science.

Chris Wigley: I guess the first piece is what it means to be a science superpower. Adrian used the word “scale” earlier, which we would have to see as part of that. For me, we can only achieve that scale through collaboration as an ecosystem. We are not a China or a US in that sense.

Another element to scale is that, if we want to be a science superpower, we need to be doing that from nose to tail, so to speak—from education, foundational science, translation and application through building vehicles to take the scientific insights and scale them. There is the old joke that the Americans are very good at turning science into money; the Europeans are very good at turning money into science. As a science superpower we would need to be good at both those things. Part of the life sciences sector deal, for example, sets targets on start-ups, scale-ups, large companies and unicorns that as an ecosystem we should be creating in this country. There are various examples of promising British companies that have been sold early and then scaled in ownership in other places. Through collaboration and through a focus on all the way from nose to tail is how we can do that.

The themes that are picked out in the current priorities on the environment, health, national security and defence, and the digital and data-driven economy, feel like very sensible priorities to me. Part of your question was what we see as our role in delivering that. Principally, as is probably obvious, it would be delivering the challenge on health and life sciences. Across any number of specific challenges like that, we need to be thinking about where we are building common infrastructure and common learnings, whether that is at the level of data and technology infrastructure, at the level of ethics, or our engagement with citizens and patients, and so on. We would hope to contribute our lessons and experience to those wider thematic pieces as well.

Q20 Baroness Sheehan: I would like ask each of our panellists about universities and your relationships with them. I have two specific questions to each of you. First, how well do you feel your organisation can establish links with universities? Secondly, what more could be done to facilitate this kind of collaboration?

Dr Paul Bate: We have relationships with many universities, contributing to space science and astronomy research in the main. We also recognise that the space industry has strong relationships with many universities. A number of them have deliberately focused on that translation, whether it is Strathclyde or Queen’s in Belfast. So, on the one hand, we are funders, directly or indirectly, of the universities.

To continue the example of the Webb telescope, we work hand in glove with the STFC, because although we fund all the instrumentation and contribute to the European Space Agency’s mandatory funding for the

space platform—in this case, the telescope—the actual exploitation of the data is paid for by the funding councils. In all cases, we have to have that strong and mutual relationship with universities to make sure that it is a coherent approach, and that we are not saying that we will fund all this amazing science and it turns out that we have the wrong scientists and we cannot make the best use of that data.

We are reliant also on many academics for advice back into the agency to help us to set our direction and to get clarity on each of the different elements of the work we cover. Earth observation is just one example where we have academic committees that are supporting us, as well as on exploration and on science.

The second part of your question was what more we could be doing. In the limited time I have been in the job, the biggest single thing—it has been hard during the pandemic—is just to be out there talking, and not expecting it all to be done via Zoom or Teams or for people to convene in London but to recognise that we are a UK space agency. That means that, if we want to talk to colleagues in Edinburgh, we should go up to Edinburgh, or Northern Ireland, or any region of the UK.

It is the recognition that an agency such as ours has to be part of the clusters that we talk so much about and that are such an important part because of the translation between industry and academia. We have to be based and we have to be constantly out on the road so that we understand delivery plans and can see what it is like on the ground. My experience is that people tell you a different story when you are in their home than if you are in a half-hour or hour meeting. That human connection is just so important.

Baroness Sheehan: Do you think that responsibility falls on you as an agency rather than the universities?

Dr Paul Bate: I think it is joint, but there are many universities, and we cannot expect them all to unilaterally find ways to interact with us. We have a group that brings the universities together on space science, but I do think it is on us as an agency to support and convene that.

Baroness Sheehan: Sadly, time is short, and so we have to move on. Mr Wigley.

Chris Wigley: I would say broadly that we have great interactions with universities. We work with over 80 universities across the UK. We have grouped those into thematic areas such as musculoskeletal disease or neurodevelopmental disease, which make a real difference to patients. We have seen collaboration between universities, and between universities and other organisations, grow and grow over the time that Genomics England has existed.

What can we do to be even better? I come back to the theme that if we want big things to happen we need the infrastructure to allow things to scale. As Adrian knows better than any of us, the amount of data that underpins all our activities grows and grows. Just at Genomics England we now have 53 petabytes of data, which is hard to conceptualise but, apparently, it is about three Netflixes, and every genome we sequence

and every image that we ingest is more and more. We are by no means the only organisation facing these huge challenges on data storage and cloud infrastructure. Is there something we could do for the entire ecosystem that could be beneficial? I do not know, but it is one of a number of areas where creating the railway tracks to scale great ideas into great outcomes would help.

Sir Adrian Smith: Turing has excellent links with the universities. Currently we have serious engagement with 13 university partners. We work through secondments of academics called Turing fellows whom we bring together to work on big challenges. We are now trying to expand that network. We are now working with a further 25 universities in the UK, including those from the four devolved nations, to explore how best to work with them. Intellectually and practically in stimulating academic brainpower to come together, it is excellent.

As always, the problem is the financing. We were built on a transactional relationship with universities, which, as I have said before, gets in the way of strategic thinking, but if we can get a better financial model, our relationship with universities is very good. It is a two-way process. The academic firepower from the universities can be brought together to attack the Turing challenges, and we offer a number of enrichment and other possibilities to PhD students from around the UK.

Baroness Sheehan: There is a corollary to the question. As well as universities, how important do you think it is that you work with other non-profit organisations and innovative organisations? How can you push the frontiers of the work that you do and how can you encourage more of this activity?

Chris Wigley: We see other non-profit organisations as absolutely essential. I mentioned earlier the breadth of the ecosystem that we work with. We do a huge amount of work with some of the funding charities such as Cancer Research UK, the British Heart Foundation, Wellcome and others, and with the medical charities. I bumped into Helen Stokes-Lampard from the Association of Medical Royal Colleges in the corridor before this meeting. We work with the medical royal colleges and the rare disease charities, and so on. That whole sector is important as big players in the field of research in the way that Cancer Research and BHF are, and in creating a link for us to patients and participants—for everyone, I guess, citizens. That link, which has to be the foundation of the trust that we need to keep earning every day, is another vital role that those non-profit organisations can play.

Dr Paul Bate: We work with a number on the core research side, such as RAL Space at the Rutherford Appleton Laboratory, which does a lot of the infrastructure work and a lot of bespoke testing on behalf of the United Kingdom, and the National Physical Laboratory, but we also do a lot of work on inspiration and championing space. For example, the work the National Space Academy does in Leicester has an incredibly strong programme that reaches tens of thousands of children in individual interactions and structured week-long or longer courses, supporting that skills journey.

The Space Agency is really quite wide in its reach between bringing money in and its missions and capabilities to champion space, so we have a lot of opportunity to work with non-profits. It is worth saying that we also work with profit-making organisations. Great research and development and innovation are also done in the private sector.

Baroness Sheehan: Sir Adrian, would you like to add anything to that?

Sir Adrian Smith: We are the go-to place for conversations with public research innovation and non-profits. In addition to the public sector research establishments, we have a number of foundations—the Lloyd's Register, Gates, all the medical charities. We have 31 ongoing collaborations in the sector you are talking about.

Q21 **Lord Holmes of Richmond:** Good morning to the witnesses and thank you for taking the time. How important are your organisations' links with industry and how well are these links working?

Sir Adrian Smith: They are very important. Partnerships with industry provide the institute and its network with diverse routes to data and to challenges that are really important. We currently have nine strategic partners in Turing and 20 project partners. I will give you a couple of concrete examples. We are working with Roche, a major global pharmaceutical company, which is interested in the route to personalised medicine. It has enormous datasets; otherwise we would not be able to get into the playpen, as it were. Working with a company such as Accenture, which has numerous clients, gives us a one-stop shop to get into the problems and potential for data science and AI in a range of companies and interests. There is HSBC. Obviously, the flows in the financial sector are fundamentally important, both from the point of view of access to data, which otherwise we would not be able to get if we did not have partnerships, and the feedback into creating the awareness and the expertise back into industry.

Chris Wigley: Unsurprisingly, it is also vital for us. Very specifically in our world, academics and funding charities can create insights about the body and how it works, and can generate targets that may be relevant for therapeutics and drugs. It is only through partnership with biotech and the pharma industry that we can develop new drugs and new therapeutics and get them into patients. Although a diagnosis is critically important for a sick individual or a family with a sick kid, what they really want is a treatment that will help to improve the outcome or even, in some cases, cure the disease. We can only do that through partnership with biotech and pharma.

For that to work, we have to have demonstrable relationships of trust. I talked earlier about the aquarium model of the trusted research environment. That is one of a number of ways in which we work with our participants whose data it is—it is not our data; it is their data—to decide what work we do with pharma and the terms of it.

The access to that data is governed by a group called the Access Review Committee, which is independent of Genomics England and on which the participants' representatives have a veto. Because of that, and various

other governance measures, we have very happily collaborated with industry on hundreds of projects. We work with eight out of the 10 big pharma companies and lots of medium-sized biotech companies without controversy. There is no sense of anyone being exploited, because the people making the decision are the people whose data it is. We have to guard that trust very zealously; otherwise, we can fall into real problems, which would not be good for patients or research participants.

Dr Paul Bate: We work very closely both as a funder funding innovation and in the delivery of the missions and the capabilities that I talked about. This is industry both that has grown up in the UK and where global organisations have chosen to bring their R&D or their manufacturing to the UK. It is everything from players such as Spire Global based up in Glasgow, the satellite constellation, AAC Clyde Space, similarly, and Astroscale, which is taking a very active role in debris removal, keeping space safe for generations to come. There are also downstream players in the interpretation of the data, including companies such as CGI. That is on the innovation side.

When we look at delivering missions and capabilities, the biggest capability we are looking for is the launch of small satellites from UK soil. We very deliberately set out to create a commercial launch market. Unlike a lot of other countries that have taken a more state-based approach, our whole proposition was to let that market grow and be sustainable commercially. Whether it is Orbex working with the spaceport in Sutherland at the top of the mainland in Scotland, SaxaVord working with ABL and Lockheed Martin in the Shetland Islands, or it is Spaceport Cornwall in Newquay working with Virgin Orbit, in all these cases we are providing money—£40 million already in grants—for launch from the UK. An absolutely core component of our work is to be funding industry.

Lord Holmes of Richmond: What policy or incentive change would further strengthen this industry partnership and your increased commercialisation?

Dr Paul Bate: Seeing contracts as well as grants is probably the single biggest thing. Again, this goes back to what I am told. For smaller organisations and industries, and for academia, grants may be absolutely right, but if you are looking to raise money on the capital markets or demonstrate that the Government are a viable customer and therefore you are more trusted, a contract is much more valuable. We are looking very carefully at how we can use contracts more.

Chris Wigley: For us a clear view on health data, its access by the life sciences industry and its protection from access from other areas of industry, and what a fair exchange looks like in that space, which we can only get to through public dialogue, would be massively beneficial for us.

Sir Adrian Smith: Working with some bodies that have histories of how they understand contracts and IP relationships. There is a lot still to be done to clarify the IP landscape.

Lord Holmes of Richmond: Great. Thank you all very much indeed.

Q22 Lord Patel: To an extent, most of the question I was going to ask has been answered, so I will change it slightly, but still focus on the theme of the question, which is the UK's place internationally in terms of competitors and collaboration in research and innovation.

To each one of you in turn, what can the Government do in policy terms that will improve the UK's position in research and innovation as regards competition and collaboration? The review that is being carried out talks about "own, collaborate, access". What does that mean in the context of the sectors you represent?

Sir Adrian Smith: One can debate metrics of various kinds, but, according to the Tortoise index, the UK is probably around third in the world in its research capabilities and current ability to attract and nurture talent in AI and data science.

Going forward, the key thing one would keep coming back to is talent and the flow of talent, and being internationally competitive in being able to recruit and retain talent, and not just as regards research; if we are to grow businesses, we need fluid career paths where people can move between academia and industry in a seamless kind of way. Ultimately, we need to test everything against what other countries are doing on investment and talent to ensure that we pull out all the stops to be competitive under all the headings that are relevant.

We have another thing going for us. If you think historically, the City of London in particular has been seen as a safe place to do business—safe financially, safe in terms of the law and regulation—and I think we have a fantastic opportunity in the UK to lead on things such as AI governance, regulation and standards, and position ourselves globally in that sense.

Dr Paul Bate: There is a lot of similarity to what Sir Adrian said. Talent is very important to competitiveness. Access to global capital, particularly for our industrial partners, is important. We need to see space as a total ecosystem, with manufacturing, design, launch, data and analysis—the things that we think classically about the space industry. But it is wider than that, because it is also about the regulatory environment. Having a really modern Space Industry Act passed into law in 2018 makes a huge difference, because people around the world can see that this is an enabling regulatory environment. The space finance sector, including the satellite insurance sector, makes a big difference, and there is the environmental and social responsibility that can be built into that. These are really attractive things globally.

Those things matter competitively but collaboration is also absolutely vital. I go back to whether it is bilateral collaboration, as with the French on the MicroCarb climate change experiment, or whether it is the big global collaborations such as Gaia, Planck or James Webb. We have to do both and we have to recognise that we can do both. Clearly, when it comes to collaboration, we need to make sure that it is collaborating safely and with our allies, because there is such a link between civil and military space.

Finally, on the “own, collaborate, access” point, that is the model that we use in space. We are looking at that for earth observation right now as well as positioning, navigation and timing.

Lord Patel: Chris, you have already covered quite a bit, but do you want to add any more?

Chris Wigley: The experience of the pandemic has shown us deploying “own, collaborate and access” in the space of genomics, and we should feel proud of that. The UK contributed more on viral sequencing than any other country in the world. We contributed more on human sequencing of Covid patients than any other country in the world. The healthcare service that we support—the NHS Genomic Medicine Service—is the world’s only national healthcare-scale whole genome sequencing service. So I think we should feel proud of that.

I would add a massive tick next to the talent box. I would add a massive tick next to the scale-up capital box. Perhaps to bring to life what collaboration looks like in our space, which I agree is absolutely vital, if we are looking at a rare disease patient, say, a sick kid, and we are trying to understand whether a particular variant in their genome is causing the disease that they have, we can collaborate with Adrian and his team on some whizzy machine learning for causality. But a lot of that is about needing large datasets, which are often global, to say, “Is this change unusual or is it common? If it is unusual, do the other people with this really rare variant also have this disease, and, if so, how can we best help them?” That kind of collaboration can seem abstract, but it can boil down to, “How do we help this sick kid in this hospital ward today?”

Lord Patel: I absolutely get it about rare diseases; we need much more international collaboration. Thank you all very much.

The Chair: Can I say a very big thank you to our three witnesses in this session? It has been very helpful. As I said at the start, if there is anything you would have liked to have said but did not get a chance to, or anything that you think might be helpful to us, we would very much appreciate it if you were to submit additional written evidence. With that, we will finish this part of the session.