

Speech: Promoting Our Prosperity

I'm delighted to join you today for the final session.

Over the last two days you've been discussing a security landscape that is becoming increasingly unpredictable and uncertain.

Recently the independent reviewer of terrorism law (Max Hill QC) said the danger of attack is as great as at any time since the 1970s.

Yet we don't just face problems from the asymmetric threat of Islamist extremism but also from Russian aggression and cyber warfare.

At the same time, we're preparing to implement the decision of the British people to leave the European Union; stepping back from the EU while stepping up our commitment to international security.

IMPLICATIONS FOR UK DEFENCE

What do all these events mean for UK defence policy?

The short answer is that, despite big changes, the important things are staying the same.

Our three National security objectives listed in 2015's Strategic Defence and Security Review – to protect our people, project our influence, and promote our prosperity – remain right for today.

We're one of only five NATO nations meeting the 2 per cent target and we'll continue investing in defence equipment: using our growing budget and £178bn 10-year equipment plan to spend on world class capability such as Dreadnought submarines and carriers, frigates and F-35.

Above all, we're determined to become, what our Prime Minister calls, a "global Britain", working with our NATO allies to front up to aggression from a position of strength, while joining forces with our bi-lateral friends to bring a tapestry of capability to bear on international problems.

RELEVANCE FOR DEFENCE INDUSTRY

But what does all this mean for the Defence industry?

Rest assured, we're more aware of your value than ever.

And nowadays we're not just looking for you to devise new game changing technologies, making the most of autonomy, cyber and big data, to keep one step ahead of our competitors.

Nor are we simply expecting you to focus on value for money as the demands on our budget rise.

We're also turning to you to enhance the UK's prosperity.

Our SDSR was the first time we officially recognised promoting prosperity as a national security task.

Now that strategic exports are a core activity for MOD, we need your help increasing defence sales and inward investment.

It's a lot to expect but the good news is we're here to help.

That doesn't mean we're going to retreat into a protectionist shell.

We don't believe in propping up inefficient industries

Instead, we believe in the power of free markets to push our companies further.

So we're going out of our way to create a can-do, pro-growth culture.

In three ways:

1. INNOVATION

First, we're investing in innovation.

This is an area where Britain traditionally has had strength in depth.

We gave the world radar, the jump jet and the world wide web.

Today we're leading the way in wing design and intelligent systems.

Tomorrow we will have produced dragonfly drones and sub-orbital engines.

But we can't rely on natural talent and serendipity to see us through.

So six months ago, we launched our innovation initiative.

It's all about pushing the boundaries, making defence more open to risk and new ideas.

Consequently, we're speeding up the time it takes for suppliers to turn concepts into capabilities.

We've set up an Innovation Fund worth around £800m over 10 years to pump prime investment into advanced new solutions, such as laser directed energy weapons and unmanned rotary wing technologies.

And we're running a set of competitions to develop leading edge capabilities in everything from rapid and automated integration of new sensors to machine learning algorithms.

Last week we unveiled the next stage in our plan.

Professor Hugh Durrant-Whyte has become our new Chief Scientific Adviser, with direct accountability for the defence research programme...which is 1.2%

of Defence's annual budget.

He'll be working across defence and internationally to stimulate defence innovation, commission research, and use technology to keep our people safe.

At the same time, we've been gearing up our new Defence Innovation Advisory Panel, with high-profile appointees including astronaut Major Tim Peake; outgoing director of GCHQ, Robert Hannigan; and the founder and chairman of McLaren, Ron Dennis.

These inspiring individuals will challenge the Defence status quo...ensuring we become innovative by instinct.

2. INDUSTRIAL STRATEGY

There's a second way in which we're creating a pro-growth culture.

We're tapping into the broader currents of Whitehall's industrial strategy by strengthening clusters of defence capability around the country, in Scotland, the South West, the North West and North Wales.

We're determined to make this a country that works for everyone.

Sir John Parker's recent report suggested how we could use such centres of expertise to improve our shipbuilding capability: embracing digital engineering and proposing the creation of a Virtual Shipbuilding industry model.

In other words, rather than a single shipyard building a ship from scratch, a vessel would be built in blocks by different sites across the UK as we've done with carrier, ensuring high productivity, competitive cost and a dramatic reduction in build time.

Sir John's report will inform our shipbuilding strategy due out in the Spring.

But switch domains from sea to air and you can already see what stronger clusters will mean for the UK.

Over in North Wales, Government and business joined forces and last year won the F-35 Maintenance, Repair and Overhaul contract award.

Their bid was so compelling it established Britain as a hub for all European F-35s: sustaining, in turn, potentially thousands more high value jobs across the supply chain, generating hundreds of millions – and potentially several billions of pounds of revenue – supporting hundreds of jobs in Wales and extending Britain's reputation for excellence worldwide.

I'd like to thank all those who helped make it possible.

It was a truly team UK effort.

3. PARTNERSHIPS

But this brings me to my final point.

Creating a pro-growth culture, means strengthening partnerships between Government and industry.

So we'll be looking to you to collaborate more – sharing the risk and reward of research and development.

We want you to build exportability in as standard from the outset, placing even greater emphasis on the use of modularity and open systems.

And we'll be looking for you to follow Boeing's example and increase bid opportunities for UK suppliers – large and small.

Significantly, Boeing recently announced their first European manufacturing facility will be in Sheffield.

You help us and we'll help you.

That's why we're making sure our refreshed industrial strategy will continue supporting the growth and competitiveness of UK companies.

It's why we're reaching out to imaginative industries outside defence...to import new ideas and ways of working. This time last week I was in Farringdon, chairing the Small Business Forum at a digital start-up company.

It's why we're working day and night alongside our colleagues in the Departments for Exiting the EU and Business, Energy and Industrial Strategy to address issues that affect industry after we leave the EU; whether it's Defence exemptions from EU regulations on movement of goods or access to skills and experience.

And it's why we will continue to tirelessly bang the drum for British business at home and abroad through export support; our expanded Defence attaché network; and speeches like this.

CONCLUSION

So despite mounting pressures, exciting new possibilities are opening up.

And by working together to build a winning mentality and develop a pro-growth culture we will do more than enhance our capability, more than increase our prosperity, more than inspire a new generation of innovators.

Together we will emulate the effect of that famous F-35 contract in Wales and send the strongest of signals to the world that our great defence industry and our great global nation are very much open for business.

Speech: Animal research: then and now

Animal research: then and now – Paget Lecture 2016

In doing research in preparation for this lecture, my chronic bibliomania turned out to be rather useful. A few years ago, whilst I was undertaking a review of STEM education for the government of the time, I discussed this with the late, great Lisa Jardine. She told me that I should look at the Cavendish Royal Commission Report on Scientific Instruction from 1870 to 1875. To my delight, shortly afterwards, in the Chatsworth Attic Sale, a copy of the Cavendish Commission reports, all 8 of them, appeared and I duly became the owner of the Duke of Devonshire's personal copy of his Royal Commission reports.

Royal Commission

But Victorian Royal Commission reports are nothing if not deeply specialist; they are neither distinguished by their typography or by their illustrations. So they are of relatively little financial value. This particular lot was padded with a string of other equally esoteric Royal Commission reports, which meant that the transport costs were almost as great as the costs of the books themselves. Amongst the other reports I acquired was the 1876 Royal Commission on Vivisection. I also acquired at the same time the 1849 report on the Application of Iron to Railway Structures; I am looking forward in due course to lecturing on this topic as well. Both of the first 2 of these reports have turned out to be extremely useful, and many of the arguments that they contain are as valid today as they were 140 years ago.

Although references to animal research have existed in popular culture since at least Shakespeare's time, from the 1850s onwards, concomitant with the rise of physiology and also stimulated by the discovery of the anaesthetics, chloroform and ether, there was debate in both the public and specialist press about the propriety of experiments on living animals. The appointments of Professors of Physiology at a small number of British Universities fuelled the debate.

At the meeting of the British Association in Edinburgh in 1871, Sir James Paget, father of the Stephen Paget, whom we commemorate tonight, laid a series of resolutions which were passed. These included the following: Firstly: No experiment that can be performed under the influence of an anaesthetic ought to be done without it; Secondly: No painful experiment is justifiable for the mere purpose of illustrating a law or fact already demonstrated.

So the Royal Commission, initiated on 22 June 1875, purpose was to:

Inquire into the practice of subjecting live animals to experiments for scientific purposes, and to consider and report what measures, if any, it may be desirable to take in respect of any such

practice.

The Royal Commissioners included Thomas Henry Huxley, who was also part of the Commission on Science Instruction. The report itself was issued on 8 January 1876, and commendably is only 15 pages in length, but for those of us that worry about evidence-based reports, it was backed up with 6,551 paragraphs of evidence. It makes fascinating reading.

The list of witnesses is extraordinary. Sir James Paget was joined by some of the founding parents of physiology, including William Sharpey and J Burdon Sanderson. Other luminaries who gave evidence included Joseph Lister, Charles Darwin, Sir William Gull and a panoply of the great and the good of 19th century science and medicine.

A few quotes from the report itself will suffice to indicate its general tenor.

It has been proposed to enact that the object in view shall be some immediate application of some expected discovery to some prophylactic or therapeutic end, and that any experiment made for the mere advancement of science shall be rendered unlawful. But this proposal cannot be sustained by reflection upon the actual course of human affairs.

Knowledge goes before the application of knowledge, and the application of a discovery is seldom foreseen when the discovery is made. 'Who,' says Helmholtz, 'when Galvani touched the legs of frogs with different metals, and noticed their contraction, could have dreamt that ...all Europe would be traversed with wires, flashing intelligence from Madrid to St Petersburg with the speed of lightning...'

Of course that was right then, and it is true now. It is a nice enunciation of the justification and the importance of the conducting of basic research led by curiosity in to answering important scientific questions.

So then as now, in the Commission, the Report and the evidence, examples were given of discoveries important to the advancement of human health. These included the discovery of the circulation of blood, the discovery of the lacteal and lymphatic system of vessels, and Sir Charles Bell's discovery of the compound function of the spinal nerves.

Sir James Paget identified the challenge of discovering an antidote to snake poisons, citing the "many thousands of your Majesty's Indian subjects who perish annually from snake bites." Indeed, less than 20 years later Cesaire Phisalix and Gabriel Bertrand, together with Albert Calmette presented to the French Society of Biology on the 10 of February 1894 their independent work on the development of an anti-venom against Viper venom and Indian Cobra venom respectively. And it was only a few years later that Vital Brazil, head of the Butantan Institute in Sao Paulo, developed the first antisera to South

American poisonous snakes.

Amongst the witnesses was Charles Darwin, and to quote him briefly:

The first thing I would say is that I am fully convinced that physiology can progress only by the aid of experiments on living animals. I cannot think of any one step which has been made in physiology without that aid.

Darwin was then asked:

Now with regard to trying a painful experiment without anaesthetics when the same experiment could be made with anaesthetics or, in short, inflicting any pain that was not absolutely necessary upon any animal, what would be your view on that subject?

And his reply:

It deserves detestation and abhorrence.

But the evidence that probably had the greatest impact of all was that of Dr Emanuel Klein, a physiologist working as an Assistant Professor in the Brown Institute. He appeared completely insensitive to the suffering of animals.

Huxley wrote to Darwin on October 30th, after Klein had provided his evidence:

The Commission is playing the deuce with me. I have felt it my duty to act as counsel for science, and was well satisfied with the way things are going. But on Thursday, when I was absent, (Dr Klein) was examined; and if what I hear is a correct account of the evidence he gave, I may as well throw up my brief. I am told he openly professed the most entire indifference to animal suffering, and he only gave anaesthetics to keep the animals quiet!

I declare to you, I did not believe the man lived, who was such an unmitigated cynical brute as to profess and act upon such principles; and I would willingly agree to any law that would send him to the treadmill.

The impression his evidence made on Cardwell and Foster (two of the other commissioners) is profound; and I am powerless (even if I desire, which I have not), to combat it.

But the Royal Commission report duly, and I think inevitably, concluded that legislation was necessary. And to quote again:

What we would humbly recommend to your Majesty would be the enactment of a law by which experiments upon living animals, whether for original research or for demonstration, should be placed under the control of the Secretary of State, who should have powers to grant licenses to persons and, when satisfied of the propriety of doing so, to withdraw them. No other persons should be permitted to perform experiments. The holders of licences should be bound by conditions, and breach of those conditions should entail the liability to forfeiture of the license, the object of the conditions should be to ensure that suffering should never be inflicted in any case in which it could be avoided, and should be reduced to a minimum where it could not be altogether avoided.

This was the first statement, in a way, of the 3 Rs. The government listened. The result was a Bill placing animal experimentation in Great Britain – akin to the study of human anatomy – under the supervision of the law. This was enacted as the Cruelty to Animals Act on 15 August 1876. Of course this was by no means the end of the history. There was another Royal Commission between 1906 and 1912. And finally in 1986, the 1876 Act was replaced by the Animals (Scientific Procedures) Act. The big change here was that it authorised animal experimenters by means of a personal license, but an additional project license that defined the categories of purpose. That of course is where we are today.

It is an enormous privilege to be asked to give the 80th Paget Lecture this evening. Stephen Paget, in whose memory this series of lectures was instituted in 1927, was a tireless advocate for the value of properly conducted animal research. His work to found the Research Defence Society in 1908, during that Second Royal Commission on Vivisection, was a turning point in the national debate around animal research.

The Research Defence Society was formed to:

...make known the facts as to experiments on animals in this country; the immense importance to the welfare of mankind of such experiments and the great saving of human life and health directly attributable to them.

Stephen Paget would find today's discourse as familiar as we find the arguments of the 1870s.

Science meets values

But this is not a lecture on history. The introduction is intended to show that all of the concerns that continue to rear their head about research using animals have a very long history. And these concerns sit at the interface between the conduct of science, the application of science and the human values held by individuals and societies in different parts of the world.

So what are the core arguments around animal research? In truth they are still the same as those articulated clearly in the 1870s. They are fundamentally utilitarian arguments about one sort of value – the value of scientific research in discovering the secrets of human and animal biology in health and disease. This work brings with it the potential to prevent disease, through vaccination for example, or to treat it, as with the use of insulin in diabetes. That value is balanced against another sort of value, which is our relationship with other species, and the extent to which we are prepared to cause harm to other species to bring benefits to ourselves.

I fear that all too often discussions about science are conflated with arguments about values. So we end up with arguments that are framed as follows: The proponents argue for the necessity of animal research if we are to progress in our understanding of health and disease, and to discover new preventive and therapeutic approaches. Opponents of animal research argue that the research is scientifically invalid, that the results are not transferable from one species to another and that experiments cause unacceptable suffering.

But this is not the real argument. It is an argument that is being conducted at cross purposes. The reality is that there are some who believe that it is simply wrong to experiment on animals, whatever the potential benefit. Equally there are some in the scientific community who do not recognise that, in the face of all of the benefits that they perceive from such research, that it is reasonable that some people oppose the use of animals in research from the perspective of their personal values.

In fact, it is much more complicated than this because many who do not like the idea of animal research express gradations of concern about research on other species. These concerns are based on judgements of a perceived hierarchy. This hierarchy is partly based on perceptions of the capacity of different species to experience pain or suffering. Or on the basis of their evolutionary relationship to humans, so there tends to be less concern about invertebrates – with the exception of cephalopods – and successively more concern moving from fish to mice to rats to rabbits, with cats, dogs and non-human primates the objects of the most concern.

This complexity means that animal research is a topic where the institutions of science meet the institutions of democracy fairly and squarely. It is an area where the arguments will continue and the opposing cases will need to be made and remade. We live in a plural democratic society, where different citizens hold different views based on differing moral precepts. Ultimately it is for democratic governments to decide on the acceptability and conditions under which research on animals is undertaken and how this should be regulated. And this is an area in which the UK is a global leader.

Transparency and communication

My life in science started with experiments on the genetics of the fruit fly in school laboratories in the 1960s, dissection of frogs and extremely smelly formaldehyde-pickled dogfishes, which provided ample confirmation to me, if

it was ever needed, that I was neither going to be an anatomist nor a surgeon.

It was medical school that provided my first insights into research on mammalian species, studying immune responses to mice to chemically induced tumours as part of my Part 2 Pathology course in Cambridge. And participation as a medical elective student at the Karolinska Institute in research on a strain of mice, called C3H/HeJ. This strain of mice shows no response to exposure to lipopolysaccharide, which is a component of many bacterial cell walls that is a cause of the damaging inflammatory response suffered by animals infected with certain bacteria.

My task, as an elective medical student in a couple of months, was to work out the explanation for this failure of responsiveness of the C3H/HeJ mouse to lipopolysaccharide (LPS). I isolated lymphocytes from these and control mice and checked whether they would respond to stimuli other than lipopolysaccharide, which they did. But I did not get anywhere near to uncovering the explanation for how they failed to respond to LPS. Nor, I have to confess, did I understand at the time the importance of these particular mice and why it mattered to discover the explanation for lipopolysaccharide unresponsiveness. So you can imagine my fascination when Dr Bruce Beutler was awarded the Nobel Prize in 2011 for discovering that these mice were genetically deficient in a protein called Toll-like receptor 4.

This is an important part of the innate immune system that confers inherited resistance to bacterial and other infections – and is a member of a group of proteins that have been conserved over a very long period of evolution, with very similar Toll receptors present in those fruit flies that I studied at school. This and related discoveries has opened up a whole new field of research into our immune responses, in both health and disease, and is a good example of how apparently rather basic research enquiries, in this case firstly in flies and then in rodents, turned out to have important utility in understanding the mechanisms of ill health.

So, whilst the arguments about animal research have been conserved through the generations, there is one important respect, in which the landscape for animal research has changed significantly during the last thirty years or so. For a long time, the laws that ensure that animals used in research are treated as humanely as possible have been enforced. However, the laws protecting scientists from illegal harassment by extremists were not. That asymmetry has disappeared in recent years. Scientists can practice their legal experimental work confident that government will support them against extremism. Since the days of a brave few, who were prepared to talk openly about their research on animals, more and more scientists are willing to make the case in public for the research that they do. Animal labs and their host institutions are increasingly open, and the sky has not fallen in. It is worth reflecting on how remarkable that change has been.

Huge progress has been made in opening up animal research to public scrutiny, particularly in the academic community. However, the argument hasn't been won in all parts of the animal research community. We must continue to make the case to our peers for intelligent transparency. Too often the answer is still

to hope that no one asks questions of us, rather than to open the doors and show there's nothing to fear. But importantly, this openness cannot and should not be left to the academic community alone. Industry needs animal research. Industry voices would therefore be a persuasive part of making the public case for why animal research remains necessary.

In 2012, following discussions between the Science Media Centre and the Wellcome Trust, a further series of discussions, in which Geoff Watts played an important role, which led to over 40 organisations working in the biosciences in the UK signing a Declaration on Openness on Animal Research. That included a commitment to developing a Concordat which set out how they would be more open about the ways in which animals are used in scientific, medical and veterinary research in the UK. In 2014 the Concordat was launched and now has 108 signatories.

I think the individuals who have been willing to stand up and to make the case for animal research throughout the years can claim a great deal of the credit for the state that we now find ourselves in. So it is only right that we celebrate their achievements this evening. It is a very good opportunity to thank the successor organisation to the RDS, Understanding Animal Research, for the work that you do. And Fiona Fox and your colleagues at the Science Media Centre – also thanks for your work on encouraging openness. The Concordat has, I believe, been helpful. I would encourage every institution involved in animal research to sign up.

But amidst the fervour for encouraging openness and much more communication, I believe there is occasionally some danger of over-reaction. We want volunteers for communication about animal research, not conscripts. Not everyone is able and willing to communicate effectively. The modern channels for abuse are manifold and a thick skin is needed by those who communicate in some of the more controversial areas of science.

Indeed, enthusiasts for science communication often fail to recognise that it is not a 'singular thing'. Science communication comes in many forms. It is much easier to communicate science discoveries such as the Higgs Boson or to enthuse people about space science, than it is to communicate the role of science in areas where there are conflicting human values. That is not to say that it is easy to explain the Higgs Boson. But here the challenge is not the general public, but actually other particle physicists, who are all too ready to shoot down some hapless colleague who does not fully communicate the arcana correctly.

It reminds me of when I went on the Today programme a few years ago to talk about the potential importance of a new genetically modified potato that was resistant to potato blight. I explained that blight was caused by a fungus that could devastate potato crops. On that occasion it wasn't anti-GMO activists who objected to my interview. It was a letter from a gardening pundit who accused me of extreme ignorance in calling potato blight a fungus. Because it is, in fact, an oomycete, which Wikipedia will tell you is:

A distinct phylogenetic lineage of fungus-like eukaryotic micro-

organisms.

They didn't actually teach me that at medical school, and indeed I don't think it was even known when I was at medical school! But I am not sure that the point of the interview would have been enhanced by this particular element of taxonomic rigour.

The reality is that scientists who participate in public discussions on embryo research, animal research, GMOs, pesticides, climate science and the like will have an utterly different experience from those that talk about science in areas that are not value-laden. And indeed scientists sometimes fail to recognise that how science is used is a topic for all of society, and as scientists, our views do not trump the views of others.

Trust and standards

But please do not think that I am making a case for any kind of 'post-truth' approach to science communication. I am absolutely not. One of the big challenges for science is to become even more rigorous in the way that we conduct research and communicate its results. Indeed I think one of the problems in the way in which science is communicated is the over-emphasis on the reporting of the 'latest paper' on x or y, rather than on what the body of the scientific evidence shows. Frankly, this causes endless problems to those of us that are involved in providing science advice to government. By and large, we are not that interested simply in what the latest paper shows, especially when it's apparently equal and opposite to the paper that was published last week. What we care about is the totality of evidence. What do we know overall, what do we not know and where are the uncertainties?

Where animal research remains necessary, we must clearly and confidently explain why. But we should hold ourselves to the same standard of evidence in communication as we'd expect in our science itself. We mustn't be seduced by our own PR. And here I have a challenge to this audience: To what extent have we as a community, ever subjected our claims about how vital animal research has been to human health to the same level of scrutiny we'd apply to those claiming to have discovered a new cure? And I think if not, we must. A Cochrane-standard review of the contribution of animal research to advances in health and wellbeing over the last 20 years or so would be a valuable contribution. That is a challenge to you as an audience tonight.

Developing and maintaining a supportive environment for research is both more difficult and more necessary in animal research, than it is in less controversial branches of science. People talk a lot about trust so animal research must command public trust. But as Baroness O'Neil is always saying the corollary of trust is trustworthiness. We earn trust by being trustworthy. We cannot be complacent in our maintenance of what we have earned. Therefore the animal research community needs to behave in a fashion that is irrefutably trustworthy.

Set in this context, a robust regulatory environment is not a burden to be borne by those who would do animal research. It is an integral part of the

case we make to the society in the UK. Members of the public can be confident that we are trustworthy precisely because we are so carefully regulated and because we obey those regulations. It follows that we, as a research community, must share responsibility for how we are regulated.

I know my colleagues in the Home Office would welcome more dialogue with the scientific community. However, it would be a mistake for us to interpret that as an invitation to dictate to the Home Office what we want, or for special pleading. As the Chief Inspector in the Home Office, Dr Culverwell in the 1940s, pointed out once to some unfortunate colleagues:

No one ever tells the Home Office what to do.

Rather we should approach discussions with the Home Office in the spirit of partnership, politely suggesting improvements which would better ensure animal welfare and promote the best science.

This brings me to an issue which should be close to the heart of any scientist. We can never be complacent in the pursuit of rigour. As scientists, we must constantly ask ourselves “does this study meet the highest standards of work?” And we must be ruthless in challenging where we see this is not the case: in the work we do ourselves and in the wider research community.

As I’m sure everyone in this audience agrees, there can be no choice between high standards and high volumes of research. It’s the standards that trump everything. If we are to make the most of the funding available, the correct approach is to prioritise the best, most reliable work. This is particularly true if animals are involved. It is unethical and wrong to conduct poorly powered studies.

Experiments should always be designed to provide the best chance of generating robust and reliable results. That doesn’t of course take away the need for repetition of experiments, to confirm or to refute important findings. But ultimately, we will use the fewest animals in experiments overall if we optimise the experimental designs to give the greatest chance of reliable findings.

With that in mind, the ongoing work to standardise approaches around the world is entirely welcome. We should be proud in the UK, for having some of the highest standards for animal testing in the world. And where other countries’ systems meet those standards, we can use their results in our regulatory processes. This is both efficient and good for animal welfare. This is a responsibility for everyone in the scientific endeavour. It’s a responsibility for the funders of research, it’s a responsibility for the researchers themselves, and it’s a responsibility of those that peer review their papers and publish the findings to insist on the highest standards of work, and in doing so drive welfare internationally.

Whilst I don’t anticipate a point in my lifetime when animal research will be entirely unnecessary, we must continue to ask ourselves “is there a better

way?" Worldwide, the supply chain of animals for research is fragile. Global public opinion is quite hard to forecast and it may harden against testing. What pharma company would continue the expense and reputational risks of animal tests if they did not have to? What government would not welcome the avoidance of political controversy? What scientist would want to keep using an imperfect animal model if a more accurate alternative existed? The UK should continue to lead the process of finding alternatives. That means that the work of the NC3Rs, the National Centre for Replacement, Refinement and Reduction of Animal Research, is extremely important.

The extraordinary tools of modern biomedical research offer ways to unravel physiology at the level of the cell, the organ and the organism in ways that were inconceivable even a few years ago. In his philosophical poem, *An Essay on Man*, Alexander Pope wrote in 1733:

Know then thyself, presume not God to scan;
The proper study of mankind is man.

Our tools let us study man and woman in the most extraordinary detail and with minimal invasion. But not all of our tools can, or indeed should, be applied in humans. For example, the power of optogenetics to study neural circuitry, or gene editing to create an array of genetic variation, offers opportunities to ask important questions about for example the function and the malfunction of the nervous system in animals, in ways that simply cannot be achieved in humans. And these results are very important for our understanding of humans.

We are in an extraordinary time for science, engineering, technology and social science. The Government Office for Science periodically produces reports on [Technology Innovation Futures](#). Our most recent report concludes that what is happening at the moment is a convergence between technologies. For example, biology meets material science, engineering and 'big data'. So the opportunities and the importance of animal research remains as salient now as it has ever been.

But we should never forget that the pursuit of science requires a 'public license', not least because it is the taxpayer that funds much of our basic research. The return to the taxpayer comes in many forms. Of course, advances in knowledge matter in their own right. But ultimately they are not sufficient on their own. The public expects gains in health and well-being, and gains to the economy from the many billions of pounds that are invested in research and development.

Science, engineering, technology and the social sciences are at the heart of advances in industry and the economy. The UK is a world leader in the biosciences. In that context, animal research is an essential and integral part of the jigsaw of the UK knowledge economy.

Embracing openness

So I will end where I began. The lesson of history is that some things do not change, so we must be resolute in continuing to make the case for animal research. One hundred and eight years after the Research Defence Society was formed, their founding purpose to 'make known the facts' about animal research, needs but one update. We have learned as a community that 'knowing the facts' is not enough. People must be engaged, involved in and ultimately persuaded by the utility of our work.

In 2016, of all years, no one needs reminding of the dangers of assuming the wider public shares the views of experts. But furthermore, the claim of expertise needs careful examination. A true expert should behave with impeccable and dispassionate rigour, properly acknowledging uncertainty where this exists. I am not sure that all self-declared or indeed anointed experts always live up to these standards.

One cannot hope to convince everyone. However, on animal research, it is necessary in a democracy to bring on board the widest possible coalition of the public.

The age old arguments about the pros and cons of animal research have not been resolved, and maybe never will be. They sit at the heart of the debate about our relationship as humans with other species. And they tell us something important about one of the unique attributes of humans. The tiger does not debate whether it is right to bring down and strangle the gazelle with a bite to its neck. Eat or be eaten – nature, red in tooth and claw, but we humans have what appears to be the unique cognitive ability to consider our relationship with other species.

It is the essence of humanity that we care for each other in extraordinary ways and care for other species and our environment, though almost certainly not enough, given the environmental challenges that come with a global population of over 7 billion people. Alexander Pope reminds us of the paradox at the core of humans, even in an era of Enlightenment:

Chaos of Thought and Passion, all confus'd.

It was Hume that noted that the passions often trump reason. Scientists who are human and not, I would suggest, immune from passion, must continue to promote reason. So I think there are a few things I suggest that this mission, to promote reason, requires of the animal research community.

Firstly, keep talking to government about where the regulations could work better to ensure high standards of research and animal welfare, but challenge where you see examples of these standards not being upheld by the community.

Secondly, let us maintain the UK's position as a world leader in the most rigorous animal research, but also in the search for alternatives.

And thirdly, welcome scrutiny for the confidence it provides. Keep talking about what research is undertaken. Keep opening the doors. And let us submit our own arguments for the value of animal research to the same scrutiny we would apply to all of our scientific work.

We cannot fear openness, we must embrace it.

Thank you for your attention.

Speech: Minister Harriett Baldwin's address to the Make In India Conference

It's an absolute honour to be back here in India speaking at the Make in India Conference.

And it's great to be in Bengaluru –the aviation capital of India. I was excited to learn that almost two thirds of India's aerospace Industry is concentrated here in Karnataka and I'm hugely looking forward to seeing the best of it for myself when the Aero India 2017 Air Show starts here tomorrow.

What a great way to mark my first visit to India as Minister for Defence Procurement –and I look forward to many more engagements to come.

Collaborative Past

But whilst this trip is a first for me as Defence Minister – I'm very conscious it fits into an ambitious agenda of collaboration between our two countries, exchanging ideas, expertise and technology that really produces a benefit for our two countries, but also globally.

We have fed off each other from business and cuisine to cricket...a game that we might have invented in the UK but one that you've unequivocally cornered the market in.

Which makes me wonder...how can we persuade Virat Kohli to become a fast jet pilot instead?

It goes without saying that our two nations enjoy a strong relationship: The UK diplomatic network in India is one of the largest in the World.

India is the third largest investor in the UK, whilst the UK is the largest G20 Investor in India. In fact one in 20 private sector jobs in India is in a UK company.

And India/UK bilateral trade in goods and services was an impressive

£17.5 billion in 2015 and growing at 3 per cent a year.

Just last Thursday the Indian Civil Aviation Minister and UK Aviation Minister signed a new deal to boost tourism and trade between Britain and India.

And of course our close bond was demonstrated at the highest levels in November, when our Prime Minister came to India on her first bilateral visit outside Europe.

Collaborative Present

But perhaps some of the best examples of our valuable bilateral partnership can be seen in the Defence Aerospace Sector.

The UK has been a partner of the Indian defence aero sector since the very beginning – giving us an unrivalled pedigree when it comes to the transfer and exchange of aero technology and skills between our countries. British aero companies, many of whom are now part of BAE Systems, have been active in India for almost one hundred years; and Rolls-Royce was among the first to work with Hindustan Aeronautics Ltd (HAL) in the early days.

In recent years, HAL has built over 100 Jaguars and nearly as many Hawks with the assistance of BAE Systems powered by Rolls Royce engines –and a relationship that as we've just heard continues today and one that I hope will flourish.

Meanwhile, both Rolls Royce and BAE Systems have explored or established joint ventures with Indian partners, to deliver support to the their products in India.

And I am delighted to announce and welcome today a joint venture between MBDA and L&T, a perfect example of the UK's willingness to invest in Indian Industry.

But what really excites me is not our collaborative past or present, but our future –which brings me to my main point today and indeed the point of your conference.

Collaborative Future

What makes the UK the ideal 'Make In India' partner in the Defence Aerospace domain is our nation's collaborative potential.

The opportunities are enormous. And we'll get a glimpse of them this week when we see BAE Systems and HAL unveil their Advanced Hawk Ground Demonstrator at Aero India 2017.

And there's more where that came from –with huge opportunities for India and the UK to work together on the Advanced Multi-role Combat Aircraft (AMCA) Engine as well the Starstreak Missile.

These are the perfect examples of the next stage of Make in India –industry

working together across borders to design and manufacture new technology rather than simply transferring it from one country to another.

New technology that will not only offer both partners defence benefits, but that will create export opportunities and joint economic growth and jobs.

These are the types of projects that really excite us in the UK –because in this increasingly complex and competitive world, the difference between surviving and thriving will be nations’ willingness to pool their resources.

Not just its critical technologies, but the innovative thinking, the skills and intellectual capital that drive them. And the good news is that our two nations are creating the mechanisms to do just that.

Mechanisms for Future Success

Our Capability Partnerships across the land air and maritime domains are giving our two nations an unprecedented opportunity: To develop a truly productive defence relationship through partnering on a range of strategic capabilities – including Aircraft Carriers, Frigates and Armoured Vehicles.

Underpinning those partnerships is our Defence Equipment Cooperation Memorandum of Understanding – an agreement that we’re in the process of refreshing and expanding...moving it away from simply looking at transactions and towards genuine joint capability development.

And shortly our Secretary of State for Defence, my boss, will travel to India to sign that refreshed Memorandum of Understanding as well as chair our nations’ annual Strategic Defence Dialogue: a dialogue that will build on the progress we’ve made to date in our Capability Partnerships.

Finally, but no less crucially, our countries are enjoying a close Defence Science and Technology relationship that is yielding results – one that has seen our two world class Defence research and development bodies: DSTL in the UK and DRDO in India –working closely alongside each other to distil ideas into reality...ideas that will ensure we can maintain our critical edge on the global stage.

This ambitious programme comes at a point when we are aligning even more closely, according with political and economic dynamics in our two countries and in the regions in which we are operating.

Just at the very moment when you are inviting the world to ‘Make in India’–and specifically today to “Make in Karnataka”–we in the UK are expressing our desire to be a more global Britain –an outward facing nation – one that champions business, innovation and free trade around the world.

As our Prime Minister Theresa May said when she met Prime Minister Modi in November: “More trade, more investment and fewer barriers between our two countries will make us all more prosperous, peaceful and secure. And with this unique partnership there is so much potential for us to advance those things.”

So yes, the UK may be leaving the EU, but we are stepping up our role in the world. I'm proud that the UK economy, the fastest growing major economy in Europe, is the most diverse on earth.

Conclusion

So, there you have it.

The UK Government and UK Industry stand ready, hand in hand, to work as your partners.

India and the UK are not just as strong, but indeed are an unbeatable combination.

Time and time again, we've proved our ability to innovate, develop, make and grow together.

And it's my – and my Government's – ambition to see our partnership become stronger and more successful than ever before.

So, I hope my visit here today will play its small part in achieving just that...

Helping us to become more secure and more prosperous...

Enabling us to realise our shared potential...

And allowing us to soar ever higher into the skies of our shared future.

Speech: Sustainable cities: building a UK partnership case for Karnataka

Ladies and gentlemen,

It gives me immense pleasure to be speaking here today at sustainable cities: building a UK partnership case for Karnataka.

I have been in Bengaluru for over a year now and I now know why it is called the start up city, innovation city and known by many other names.

In spite of the multiple names, the strength of a city is its people. I won't cite statistics in a room full of experts. We are aware that cities are growing at much faster rate due to inflow of people in search of better jobs, amenities and a better standard of living. But at the same time, this inflow is putting pressure on the available resources and that is why urban planning becomes crucial.

The choices that are made today on building designs, waste management, water, energy and food systems, urban ecosystem management, transportation, infrastructure development and retrofitting will have critical implication for future urban habitats.

It is therefore vital to have an integrated and innovative approach as we try to future-proof our cities in the light of changing climate, rising energy prices, increasing demand for water and space.

The UK supports the 'Make in India' campaign, as does UK business. The UK is also committed to supporting India's goal of '100 Smart Cities'. Karnataka is developing Mangaluru, Shivamogga, Belagavi, Hubballi-Dharwad, Tumakuru, Davangere and also Bengaluru as smart cities.

UK companies are keen to support India across the entire span of the four-pillar smart city framework/sustainable urbanisation. We have expertise in infrastructure – from smart transport and mobility to water and waste management – in digital – particularly in fin tech and e-commerce – and in design, professional services, healthcare and e-governance.

2012 London Olympics is a good example of developing East London on the principles of sustainable urbanisation where the Olympic Park was created on once contaminated industrial land. 240 electric and hybrid cars were used, food packaging used was compostable, sourcing of materials for various structures was sustainable, and water harvesting, natural lighting lightweight building materials were used. Post the games the waste generated was waste was diverted from landfill, with 62% of that waste being reused, recycled or composted.

- UK's capabilities lie in urban design, planning and architecture
- UK construction and civil engineering firms lead major urban infrastructure developments worldwide
- there are now over 3,384 low carbon emission buses in the UK. 1,500 hybrid electric buses and 15 pure electric buses also run on London roads. Around 3,000 buses are expected to run on biodiesel, renewable biodiesel from waste products, including cooking oil and tallow from the meat processing trade
- 3.6 GW is generated from off-shore wind, more than anywhere else in the world
- UK is the first developed economy to commit to phase out unabated coal by 2025
- UK remains committed to tackling climate change at home and supporting developing nations to deliver their own climate change goals

Sustainability requires holistic consideration of social, economic and environmental dimensions of urban challenges to develop solutions that meet future needs.

I look forward to hearing your views on sustainable solutions to developing sustainable cities in India.

Speech: First Sea Lord speech on the Royal Navy in 2017

After 23 years as a member, 2 on the Committee and nearly 6 on the Navy Board, it's a pleasure to attend Founders Day as First Sea Lord and to share a few insights with you as I approach my first anniversary in the job.

Over the past year, I've had the privilege to represent the Royal Navy extensively at home and abroad.

Last spring, the nation paused to remember the centenary of the Battle of Jutland. I met many descendants, including the family of Jack Cornwell VC, at the unveiling of his memorial in Leyton. His great, great, nephew, AB Alex Saridis, is now serving in HMS Iron Duke, proof that our career managers have a sense of history.

Later, I was in Liverpool for the 75th Anniversary of the Arctic Convoys, where I met some remarkable veterans of "the worst journey in the world." I also had the honour of presenting the Lord Mayor of Liverpool with her late father's Arctic Star.

In both cases I was reminded of how deep the British public's affection for the Royal Navy runs.

Then, towards the end of the year, I was in Auckland for the 75th Anniversary of the Royal New Zealand Navy. Even though that nation has successfully forged its own distinct place in the world, the familial bonds between our two navies are no less strong.

But, without doubt, the best thing about the past year has been hearing about the accomplishments of our sailors and marines.

One that sticks in the mind was the father of new-born twins who, in spite of the sleepless nights, had been inspirational in leading his department to design and train force protection teams for HMS Queen Elizabeth.

Another was a marine engineering submariner who worked in excess of 100 hours a week to bring a 30-year old Trafalgar-class nuclear submarine out of maintenance and ready for sea ahead of schedule.

Then there was the young Leading Medical Assistant from HMS Enterprise who led the triage process for hundreds of rescued migrants, dealing with pregnancies, gunshot wounds and everything in between.

That particular mission is ongoing. HMS Echo was the only ship from the EU's Operation Sophia on duty over Christmas, in which time she pulled another 500 men, women and children from the Mediterranean.

We can be very proud of the compassion and professionalism of our sailors and marines in responding to what is possibly the largest humanitarian in our lifetimes.

But if you worry that our fighting instincts are in some way being softened, I would simply point you to the Gulf, where Commander Amphibious Task Group, Commodore Andrew Burns, and his staff are leading CTF-50, which plans and conducts coalition strike operations in a region where the threat level has the potential to escalate quickly.

They are embarked in HMS Ocean, currently our largest warship – but the men and women of our smaller vessels are no less mindful of the seriousness of their responsibilities.

In the face of almost daily provocation, the young ship's companies of the Gibraltar Squadron – led by Commanding Officers still in their twenties – are exhibiting judgement and restraint beyond their years and, in doing so, have revealed a bold and assertive style of ship handling in the very highest traditions of the service.

I have every expectation that there is a future Nelson or Cunningham among them.

Everything I have seen and heard since I become First Sea Lord has reaffirmed my faith that our nation is blessed with the best sailors and marines of any navy, supported by the Royal Fleet Auxiliary and a Civil Service that remains the envy of the world.

Of course, you would expect me to say this, and this audience knows it anyway – many of you helped lay the foundations upon which today's Navy rests. But now, more than ever, we must ensure the nation understands how hard our men and women are working on its behalf.

Three Theatres

As for the operational context, I do not intend to dwell too heavily, because it should be plainly apparent from the newspapers, not least those images of the Admiral Kuznetsov belching out black smoke like a dreadnought of yesteryear as she steamed past our shores.

In the Atlantic, our commitment to NATO continues to grow. In Norway, the Royal Marines have been training the US Marine Corps in cold weather warfare. Underwater, the Deterrent edges ever closer to a half-century of unbroken patrol, while our attack submarines have been very busy indeed, in ways that many of you know well, and the rest will have to imagine.

As for the Mediterranean, for many of us it was a place where we enjoyed the company of FOST as we worked up to go East of Suez. Now, sadly, it has become an operational theatre in its own right, as we respond to the concurrent challenges of Russians, Radicals and Refugees, to borrow a phrase from SACEUR.

We've been leaning heavily on the Royal Fleet Auxiliary and on our survey

ships and patrol vessels in this theatre, and they have stepped up to the plate in the most remarkable way.

HMS Mersey, for example, will shortly return from a 13 month deployment that began in the Caribbean and ended 38,000 miles later in the Aegean; an astonishing accomplishment for a vessel under 2000 tonnes and a ship's company of just 52.

I should also mention our reservists – rarely in the limelight – who have been serving on Border Force Cutters in the Aegean. If your memories of the RNR are of weekends team sweeping with the 10th MCM Squadron, that's ancient history now. They are serving right alongside their regular counterparts in almost everything we do.

Finally, the Foreign Secretary recently told the Manama Dialogue that "Britain is back East of Suez".

He's not wrong – but, in truth, the Gulf has been the Royal Navy's 'home from home' for the past thirty-five years, and today, at any one time, we have a minimum of 7 ships and 1100 sailors and marines in the region, plus two naval helicopter detachments.

Royal Marines are a big part of our presence in the wider Middle East, with training teams visiting Kenya, Somaliland and Kuwait to name just a few examples.

I could say more about all three theatres – and our other duties– but, suffice to say, the world is getting less certain and less safe, and demands on the Royal Navy are growing.

Perspective

This brings me to the crux of what I want to say tonight, which is about our challenges and opportunities.

The word I keep coming back to is perspective – perspective on the kind of Navy we are today, and perspective on the kind of Navy we can be in the years ahead.

You will be familiar with much of the recent coverage of the Type 45 destroyers, which in many ways is emblematic of the challenges we face more widely.

This was the first new destroyer type in over thirty years. Almost every system on board was designed from scratch. In the end, the power and propulsion system fell short of what we hoped, but the air defence system turned out to exceed all expectations.

It's not ideal, but the money is now in place to put it right. Had the problem been the other way around, it would have been altogether more difficult to fix.

But the real truth about the Type 45 is to be found not in the pages of

newspapers but at the sharp end of operations.

Last year, HMS Defender spent over 100 days protecting US and French carrier groups in the Middle East without losing a single day of tasking to machinery defects.

Meanwhile, following attacks on coalition vessels by Houthi rebels, HMS Daring was quietly deployed to the coast of Yemen.

Her ship's company spent 39 days in Defence Watches and over 97 hours at Action Stations as they accompanied 650,000 tonnes of coalition shipping through the Bab-el-Mandeb strait at the height of the threat.

This kind of mission – in this kind of environment – is precisely that for which the Type 45 was conceived.

Where it matters most, the Type 45 has proved itself to be one of the most capable air defence destroyers in the world, and the escort of choice for our most important, and demanding, coalition partners.

We demand the best from our people and equipment and, in doing so, the challenges we face are those of a first rate Navy.

The same is true across the board.

The financial constraints we face are shared across the public sector, and the scrutiny, regulation and efficiency challenges by our partner navies.

Our most pressing manpower shortfalls are not unique to the Royal Navy either – many of the same issues apply to other technology-dependent organisations, and we are working with industry to bring forward the next generation of engineers to meet both our needs.

Yet despite these challenges, the Royal Navy retains a position of global leadership, as evidenced by the international success of FOST and BRNC, and our permanent leadership roles in NATO and the Middle East.

I was in Manila in the autumn to represent CDS at a US PACOM-sponsored conference of military leaders from the Indo-Asia-Pacific region. It was apparent that many of the most significant security issues in that part of the world are maritime in character, and our friends want to work with and learn from the Royal Navy – indeed, last year I signed a historic agreement for closer cooperation with the Japanese Navy.

So the Royal Navy still sets the international maritime standard and the demand is growing. This, more than anything else, is the measure of the kind of Navy we are.

Of course I recognise we have challenges. Much of my time is spent working with Ministers, the Head Office and my fellow Chiefs to put them right. But everything is relative, and my job is to lead the Navy to make the most of the resources we have – and the significant investment coming our way – in order to be the best Navy we can. I am grateful for the support, the

leadership and the commitment of my top team and Navy Board colleagues here tonight.

There's a lot of difficult work involved, but our efforts now will shape the Navy – and the UK's place in the world – for decades to come.

So as we grip these challenges, it's critical that we don't sell ourselves short, or lose our long term focus.

Because the single most important factor in our success is belief: our people need to believe in the Navy's future in order to believe in their own future within the Service.

But we can't do it alone. The Navy Board and I need you – our friends and advocates – right behind us.

Opportunity

In drawing to a close, let me add a final, personal, perspective.

The 35th anniversary of the Falklands Conflict is now just a few weeks away.

As the senior serving veteran, I am looking forward to playing my part to ensure the contribution, and the sacrifice, of all those involved in that extraordinary endeavour is recognised.

Today, we rightly marvel at the audacity of our accomplishment in that campaign, so far from home.

Yet, as many of you well know, the early 1980s was far from a happy time for the Royal Navy in capability terms.

The submarine force was growing but everything else was either shrinking or, in the case of our amphibious capability, about to go altogether.

That included my own ship, HMS Fearless.

So if you'd told 21-year-old Acting Sub Lt Philip Jones that in 35 years' time he would be leading the Royal Navy as it renewed the nuclear deterrent, commissioned two 65,000 tonne strike carriers and fifth generation fighters, reopened a naval base East of Suez, with a construction programme for submarines and frigates stretching far into the future, I'm not sure he would've believed you...but he would probably have been quite pleased.

Yet those are the hard facts of where we are today.

And the impending arrival of the Queen Elizabeth-class carriers is just the beginning.

Last December, the Prime Minister stood on the deck of HMS Ocean and told the assembled audience that the Royal Navy was central to her vision for Britain to forge a new positive, confident role for our country on the global stage.

The Government has stated – repeatedly – its intention to increase the

overall size of the Navy by the 2030s, and now the Type 31e programme is in train to do just that.

So, the vision for the Navy is clear; the equipment is on its way; and the possibilities are growing – what is required now is the sustained focus and effort to reach out and grasp the opportunity.

In short, I cannot remember a time when the Royal Navy has been more relevant to the UK's security challenges, or more important to our global ambitions.

I'm not alone – people are listening – and the real scandal would be if we allowed this precious opportunity to slip through our fingers.

So we mustn't be distracted from our course or dissuaded in our efforts.

We must be guided by the ambition that has been set for the Navy, and judged by our achievements on operations.

I am convinced that if we do these things, and do them well, then we cannot fail.

Thank you.