



# Government Office for Science

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Dear Chris

Thank you for your letter of 6 August 2013 on strategically important and vulnerable subjects (SIVS). I was pleased to read that the evidence the Government Office for Science provided in 2011 was used to inform your advice to government. As in the 2011 response, I have sought the views of our network of Chief Scientific Advisers (CSAs) on the subjects they consider to be strategically important and vulnerable.

## **Science, Technology, Engineering and Mathematics**

I have set out below the specific areas that my colleagues have reported back on. They cover a variety of science, technology, engineering and mathematics (STEM) disciplines and it is clear that core to all of these is a foundation of good general STEM skills at all levels of education.

### **Engineering**

Engineering is widely considered to be a vulnerable area of skills and shortages in this subject have been widely publicised in recent years. Returns from Ministry of Defence (MOD), Department of Energy and Climate Change (DECC), Department for International Development (DFID) and the Department for Business, Innovation and Skills (BIS) reflected this concern. MOD highlighted specific issues in numbers and quality of electrical engineers, electronic engineers, systems engineers and radio frequency engineers. They also recommended that all engineers would benefit from having done two to four systems related modules as part of their degree.

### **Nuclear science and engineering**

Nuclear science and engineering remain an area of concern; these skills are key to maintaining operational capability for nuclear technologies, including power plant, and innovation in their supply chain. Development of the UK skills base will continue to be strategically important because of the need to operate current nuclear power plants and decommission legacy plants, as well as the anticipated need to deploy a new fleet of plant and supporting infrastructure. DECC have recently engaged with academics on this issue at the Nuclear Academics Conference, where the importance of these subjects to the UK skills base in enabling delivery of the UK's energy strategy was highlighted.

DECC understands the major challenges around these disciplines are attracting and retaining the necessary skills in UK industry. These subjects attract a high number of foreign students, who may not necessarily pursue careers in the UK. Furthermore, a relatively high number of postgraduates who study nuclear science or engineering often choose not to move from academia to industry in the UK.

The Health and Safety Executive (HSE) highlighted nuclear physics specifically, and most of the technical specialisms within this including: nuclear data, criticality, fault studies, radiological protection, waste management, emergency arrangements and other areas covered in safety assessments.

### **Food security, agriculture and environment**

Colleagues in DFID, the Government Office for Science and the Food and Environment Research Agency (Fera) highlighted subjects of importance within the biological sciences. The Foresight report on *The Future of Food and Farming* discussed the shortages in agronomy, agro-ecology and soil science. DFID highlighted agricultural and nutritional science, climate science and energy research as strategically important subjects and made the following comments about how we can address the concerns across STEM areas:

*"The UK must continue to ensure we have sufficient capacity and capability in key areas of national and international interest. With a growing and increasingly urbanised global population, the continuous and heavy demands on global resources (food, water, energy, land) and challenges associated with climate change and natural disasters, it is fundamental that UK continue to develop its expertise in key science, engineering and technical fields."*

Additionally DFID felt that the subjects of Urbanisation and Infrastructure research were areas of vulnerability.

Similarly, HSE said that practical agronomy and particularly plant pathology expertise remained an issue as these subjects have wide implications for crop protection.

Fera reported the continuing difficulty in recruiting toxicologists, eco-toxicologists and taxonomists of all types (again this was also reflected in our 2011 return). MOD included microbiology in their response.

### **Mathematics, algorithms and data analytics**

Several respondents commented on the importance of mathematical ability and the need for people proficient in analytics and algorithms. The Prime Minister's Council for Science and Technology wrote to the Prime Minister in June 2013 on the subject of algorithms and I have included an extract below which summarises the issues around skills development well:

*"First and foremost, we need to develop the workforce of the future and to equip the general population with the know-how to be critical consumers of the information economy. Education and skills training are paramount needs of this fast developing area of technology. It is the availability of skilled people that will determine the future capability of the UK to develop the information economy. These are the people that will deliver the ambitions of the Government's set out in the Information Economy Strategy. But it is also important to note that there is a global skills market for those with advanced ICT skills, and the UK should position itself to compete effectively in this market as both an importer and exporter of education and skilled people.*

*Algorithms know no geographical boundaries, but the economic benefits are most likely to accrue to those that develop them. Action is needed in schools, universities and the workplace."*

Subjects related to the skills required for data analytics were also identified as strategically important. These subjects are fundamental to building capability to take forward growth opportunities related to data analytics. Data science is an emerging discipline and one which is vital to making the most of the vast amount of data produced by a range of sources. Big data has the potential to deliver substantial benefits.

Evidence shows that there is potential for an increasing demand for individuals with these skills. It was suggested that some of these skills issues could be addressed by embedding data analytics across disciplines and ensuring that universities continue to work closely with industry on the design of courses.

## **Security**

The UK's national security infrastructure continues to rely heavily on the STEM disciplines. In particular, colleagues identified Big Data, algorithms and analytics as key areas, along with cyber security skills, and behavioural and social sciences.

In the area of cyber security skills the specific concern was around advanced networks and the need for individuals who are able to work with both hardware and software systems. In the behavioural sciences there is a particular requirement for those people who also possess a high degree of quantitative skills.

## **Data Scientists - including Geographic Information Systems (GIS) professionals, Linked Data and Data Visualisation specialists.**

Concerns were expressed about data scientists, in particular a lack of quantitative geographic skills and linked data and data visualisation capability. A lack of understanding of the intrinsic strategic benefits of these data sciences was highlighted.

## **International Development and Global Challenges**

DFID reported the need for undergraduate training to offer sufficient breadth and depth and ensure that the UK develops scientists and engineers who have a detailed understanding of global challenges; are capable of working across disciplinary boundaries; can identify knowledge gaps and inter-linkages; and have a strong foundation in basic science principles and methods.

They specifically highlighted that education research (understanding which interventions work best in delivering educational solutions to a target population) is an area where UK capability is weak. This is particularly relevant to developing countries but also important for the UK.

## **Safety**

The Health and Safety Executive identified a number of SIVS relevant to both its work and to economic sectors important to UK Infrastructure. These included occupational health and hygiene and a particular need for human factors expertise across a broad range of high hazard industries.

In common with MOD, BIS and others, HSE also identified engineering as a skills gap and specifically mechanical engineering, for example emerging gas industry and pipeline specialists; and electrical engineering, including power and control engineers.

MOD separately identified a need for individuals with skills in health physics and ergonomics.

## **Manufacturing and Materials**

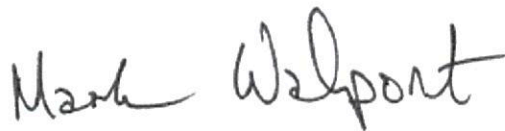
The Foresight Future of Manufacturing project is using the best available scientific evidence to identify important changes facing the UK manufacturing sector over the coming decades. One key issue being considered is what changes are likely to transform the role that people play in how manufacturing activities create and capture future value. The Report details that the future quality, quantity and utilisation of suitably skilled people will be critical in ensuring the future competitiveness of the UK manufacturing sector. Going forward the Report highlights three areas of importance which the UK will need to be addressed:

- Quantity: Increasing and diversifying the supply of manufacturing workers to avoid future shortfalls
- Quality: Equipping future workers with the deep technical knowledge and the generic skills and problem-solving capabilities that manufacturers will need.
- Utilisation: Ensuring that manufacturers utilise future workers effectively.

The project report will be published on the 30 October. I will forward you a copy.

In the area of materials, the following were identified as important: materials science and metallurgists; design engineers; corrosion engineering; and the petroleum, oil and lubricants areas.

If you would like further detail on the issues and risks of specific areas then please do not hesitate to contact me.

A handwritten signature in black ink that reads "Mark Walport". The signature is written in a cursive, slightly slanted style.

**Sir Mark Walport**