COUNCIL FOR SCIENCE AND TECHNOLOGY

Science Landscape Seminar Reports: Robotics and Autonomous Systems (RAS)

Background to the meeting

This seminar is one of a series convened by the Council for Science and Technology (CST), which is working to provide a map of the UK Knowledge Landscape as a whole. This mapping includes all areas of research carried out by academia, industry, charities and others.

The seminar series has brought together diverse sets of experts to discuss eight parts of the research landscape in depth; these areas are roughly aligned with the UK government's eight great technologies.

The aim of this work is to provide decision makers with a clearer picture of the whole landscape and enable better strategic decisions to be made. We would also like the reports to prompt communities to think more about what they can do to ensure their areas continue to make the best case for themselves and operate in a coherent way. The seminar series is limited in scope, but has revealed the importance of a clear articulation of the strengths and requirements of different parts of the UK research landscape. Specific research communities may wish to hold further sessions of their own.

The discussion took place under the Chatham House rule. This document represents the views of this group and is published alongside an infrastructure resource (see below) which reflects the seminar's view of the Robotics and Autonomous Systems (RAS) landscape.

This meeting addressed RAS research and development, and was asked to consider:

- Strengths and weaknesses of Robotics and Autonomous Systems research in the UK;
- How the UK compares internationally; and
- What future concerns exist for the discipline.

1. Infrastructure list

To seed discussion, attendees were provided with a draft list of infrastructure relevant to Robotics and Autonomous Systems. The list is not exhaustive but does provide a summary of some of the key facilities for Robotics and Autonomous Systems research in the UK. It was updated in the light of discussion at the seminar to include, for instance, a section to reflect the importance of SMEs in this area and some key SMEs and trade associations that were felt to be missing. The infrastructure list is available at: www.gov.uk/government/publications/science-landscape-seminar-robotics-and-autonomous-systems.

2. Strengths and weaknesses in UK robotics and autonomous systems

Seminar participants identified the following areas of strength:

- There is already a strong customer base for robotics research and development, and a wide range of industry groups are ready to explore what these technologies can offer.
- The UK research base for robotics research is of a very high quality.
- Interdisciplinary work is a strength. In some cases it seems that funding panels have been impressed by the links that research groups are making between robotics and human factors, particularly the division of labour between automation and human beings.
- The existence of high quality robotics clusters makes communication between parties easier: one result of this has been a much better understanding of gaps in our own knowledge and expertise, which helps industry target new areas for development.
- Fragmentation has reduced in other ways over the last two years. There is now good cross-cutting communication between government departments, academia and industry. This network has been stimulated by Innovate UK and the Knowledge Transfer Network, including the Special Interest Group for Robotics and Autonomous Systems.
- There is still work to do, but if the community continues to improve its effectiveness in bringing the right groups of people together, value chains for robotics research will emerge naturally. These are the chains of activities that firms perform to deliver a valuable product or service to market.

However, attendees felt that there were some key weaknesses which need to be overcome. The gaps identified (many of which include their own opportunities) are:

- Interdisciplinarity, which is in many ways a strength but can make some processes more challenging, particularly access to funding in the UK compared to the rest of Europe. Some consideration of how funding structures might facilitate and reward cross-subject working would be helpful.
- The lack of a supply chain in the UK in many areas: Switzerland, Germany and Canada are believed have better provision.
- Academic researchers need to have a better understanding of the challenges faced by industry where robotics and autonomous systems research could help. Improved appreciation of these challenges could mean more research innovations are taken to market.
- The character of the UK market. There are fewer SMEs in this sector in the UK compared to the rest of Europe. This adversely impacts on our ability to establish new supply chains.
- The need for better understanding of enabling technologies. A clearer picture of how technologies from outside the sector might contribute to robotics would allow novel collaborations in the subject.

3. Skills

The need for the right skills mix is critical. A number of points were made in discussion:

- Many companies have to hire engineers abroad (India, Canada, the US and the wider EU); and,
- There is a clear need to train more UK-based expertise to ensure a strong domestic workforce in the subject, and the availability of UK nationals where there are strong cases for using UK-based expertise.

Participants proposed some specific actions that might help address this in schools and universities.

At school level:

- There is a need to inspire young people about the opportunities robotics affords very early in their educational careers. This would encourage students to study subjects relevant to robotics in university and may inspire more female students to study the subject. At present RAS is a largely male preserve.
- It is important to work with teachers, and to ensure that good quality hardware was available. One example was the use of Lego Mindstorm kits which are aimed at 14-16 year olds and allow pupils to build and programme their own robots. The kits' major advantage is that they allow schools to explore robotics without the need for teachers with specialist knowledge.

At university level, participants said that there was a need to:

- Take research concepts back into the curriculum and to teach these new ideas as soon as they emerge. This would ensure that the degree stays current and cutting edge.
- Ensure industry works with universities to shape degree structures and ensure that they effectively prepare students for practical work in this sector. There is some evidence of this happening; however, more could be done.
- Make better use of specific challenges, where students are able to fail and refine their ideas. These challenges are an excellent way to ensure that graduates emerge from their degrees with practical skills and the confidence to develop their ideas into marketable products.
- Increase the visibility of the RAS strategy, prepared by the RAS Special Interest Group, to give students a better understanding of what their degree might allow them to achieve in their career.

4. Demonstrators and regulation

The importance of demonstrators was also discussed at length. Verification, validation and certification centres all have an essential role to play in taking ideas to market. Some specific uses were highlighted:

- Demonstrators have different uses in different sectors. In the aerospace industry they are important for gaining trust in autonomous systems. In

medicine they provide a ‘safe space’ to test (say) an automated pill dispenser with reduced risks from failure. In building smart cities, they offer a place to test highly complex systems in a low risk environment.

- Demonstrators are also essential for new products to gain regulatory approval. If success is proven, the prospect for effective regulation is improved: for instance, if a vehicle could demonstrate several thousand successful driverless miles, there would be fewer barriers to a sensible discussion about regulation.
- The UK and the EU has few centres that are equivalent to the National Institutes for Standards in Technology (NIST) in the US. (NIST's mission is to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve quality of life). Similar UK-based centres may allow more testing of products and facilitate more products getting to market.
- There is a need for regulators to collaborate to reduce multiple approval processes: this can arise for instance in areas like assistive robotics where there may be parallel processes covering medical and robotics angles.
- Together, all these factors mean that the availability of more test centres, combined with the excellence of our research base, would attract still more business within and to the UK.

5. Future issues and horizon scanning

The seminar concluded with a short discussion of what the future might look like, and participants were asked to consider what issues, threats and opportunities might arise. The following points were raised in discussion:

- The reliance on EU funding for RAS research. At present, approximately eighty per cent of RAS research is EU funded. If this funding stream was disrupted then RAS industry and research in the UK may suffer as a consequence.
- Ensuring that government is an intelligent customer for RAS research and understands where available funding should be concentrated: industry and academia have a role to play in communicating clearly what the potential offerings of this research are. The RAS strategy is an excellent starting point.
- Public perceptions of RAS and the influence of science fiction and film on these ideas: in particular, there is a perception that greater automation will lead to greater unemployment and the need for economic measures to offset fewer workers in a ‘Second Machine Age’. Some of these concerns may dissipate as younger generations take over and social attitudes change, some may need to be dealt with through thoughtful public engagement.
- An ageing society that brings with it both threats and opportunities. There is likely to be an increasing need for assistive technologies. Regulation will play a critical role in determining the speed with which this need is met. Medical devices are (rightly) strictly regulated: within this framework we need to ensure that new technology can be adequately tested in an agile way to best enable it to get to market.

This publication available from www.gov.uk/cst

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