United Kingdom Atomic Energy Authority (UKAEA) and Remote Applications in Challenging Environments (RACE) – Written evidence (AUV0032)

This evidence is submitted by Dr Rob Buckingham FREng, Head of RACE.

RACE, the centre for Remote Applications in Challenging Environments (www.race.ukaea.uk) is part of the UK Atomic Energy Authority (www.gov.uk/ukaea).

Other evidence that is relevant but not repeated here for sake of brevity includes:
- UK RAS Strategy, July 2014
- RACE submission to the HoC S&T SC, April 2016
- RACE submission to the CCAV Call for Evidence, July 2016

Key message

In order to lead, the UK should establish world class, real, permanent test facilities for robotics and autonomous systems. They will provide a forum to assess the impact of robotics well beyond driverless cars. They will attract and fix global talent and global investment in the UK. This is achievable and fundable. This market is moving at pace so time is of the essence.

“Freedom of Movement”

There are two dominant models of transport usage. The first is to buy a bicycle, motorbike, car, lorry and just go, anytime, anywhere.

The second model is mobility as a service. Hailing a cab or buying a ticket for a boat, plane, train or ... SpaceX. Jump in, sit back, take in the view and arrive in style.

Life is a journey. How we travel is part of the adventure.

In one hundred years time we will be using autonomous vehicles. It seems unimaginable that we will not have the computers, sensor and software to solve the remaining challenges. We can see an end state.

But when will the transition occur and which of the many final potential scenarios will win out?

We don’t know.

We don’t know which multinationals will dominate the supply chain. Maybe none that exist today.

In a period of immense and serial disruption there is a role for government (of and for the
Is this role that of an observer only?

Is this role that of a regulator?

Is this role that of an investor?

Of course government will be a user.

My personal view is the UK will do well to stay in the leading pack of nations and that this will be enough. We should however aim to be #1 in certain elements of a RAS-enabled economy, based on our current capability and our ability to recreate ourselves by investing in skills and identifying future opportunities.

In my evidence to the HoC S&T SC on Robotics and Autonomous System I used the phrase 'stick and stay in the U.K.' In an age when technical experts work globally we need to find ways to make the UK attractive for long term research and innovation and commercial operations. Features of a successful strategy include consistent funding and clear annunciation of a shared vision. In the UK RAS Strategy we suggested investing in tangible and intangible ‘RAS-assets’: using ‘immovable’ infrastructure and national regulation to create environments where complete solutions can be implemented. We need numerous ‘living labs’. The fact that global automotive OEMS are planning to conduct AV testing in the UK is a sign that this strategy has merit.

Over the last year I have led a project called PAVE: People in Autonomous Vehicles in Urban Environments. Our partners are Amey, Siemens, Oxbotica and Westbourne Communications. We have used the UKAEA’s Culham site (10km of roads within a fenced government owned site with 2000 working adults) to test Oxbotica’s driverless vehicles that are at the heart of the Milton Keynes and Greenwich AV projects.

http://www.bbc.co.uk/news/technology-36810842
https://www.youtube.com/watch?time_continue=11&v=UxJlr378u00

We have also been engaging with different stakeholder groups, the public, the UKAEA’s employees and ‘interested organisations’ including local government and public services.

The excitement around Driverless Cars is palpable but there are also lots of questions and concerns. For the public, cars are the first robots. This is the first time the public will engage with the next generation of robots on a regular basis. Not only that, we will climb inside these machines and instruct them to take us to our destination.

How we respond to these machines will affect how our society develops. The user interfaces that we will be developed may well read and copy human emotion and be much more
intuitive, using the latest ‘artificial intelligence’ algorithms to make decisions. But the impact goes well beyond mobility. The sensors in the cars may well be used to collect health data, which could be a component of a move toward increased responsibility for our health and preventative, lower cost healthcare. It is also expected that driverless cars will increase mobility for the less mobile with consequent impact on quality of life, especially into older age. We also recognise that intelligent mobility is a key part of future community design with changes in ownership and usage impacting on house design and transport policy.

The primary area of interest for RACE is the use of autonomous vehicles (sometime called mobile autonomy) in challenging environments, particularly nuclear environments. The key drivers are decreasing cost and risks where the existence of an unavoidable hazard means that people are unable to or should not physically intervene. This is an area where we would expect people to remain ‘in charge’ although we expect that we will move from remote operation (working at a distance) to remote oversight, with increasing levels of autonomy being embedded into tools conducting the work in the challenging environment. The sectors for initial focus are nuclear, petrochemicals and space. RAS will also allow us to move out our temperate comfort zone increasing our ability to work in our oceans, polar regions and in space. By enabling access to these challenging environments RAS will increase opportunities for new activity, leading to economic growth and both wealth and job creation.

As one example, the nuclear industry will adopt robotics technologies in order to increase safety and productivity of operations in nuclear facilities. This includes decommissioning end of life facilities. Robotics has increased productivity in other sectors by as much as 10%. Applied to decommissioning which is >£100billion liability (=market opportunity), this likely productivity gain should justify significant investment. Life extension of existing nuclear assets and the complete lifecycle of new nuclear, both fission and fusion and both small (e.g. SMR) and large reactors, will be impacted by development of robotics and AI.

At a technical level all of these issues have one thing in common: increasingly capable sensors feeding complex software running on ubiquitous computing hardware making decisions. This reinforces the idea that cars are the first robots. The tech that will be developed for driverless cars is directly relevant to all robotics. We need to ensure that robotics technology does not become sector-siloed.

There will be changes in employment patterns. This is potentially an opportunity to ‘rebalance the economy’ if we can encourage more of our talent to focus on STEM subjects. We need to imagine a society in which digital professionals are the highest paid and the most valued by society as a whole.

Having spent my career working in robotics, I am increasingly in awe of what people achieve routinely. Our ability to adapt and create is unparalleled. We should see RAS as the next generation of human-made tools that increase humanity’s ability to achieving amazing things. It’s all about people...

The remainder of this evidence focuses on the questions posed around ‘Creating an enabling environment’.
Creating an enabling environment

1. The UK should invest in world class, real permanent test facilities. Robots operate in physical environments: e.g. roads, nuclear power plants, hospitals, and refineries. These environments have generic requirements (e.g. the need to localise and map) and specific challenges (e.g. pedestrians, radiation, patients and flammable products). Value can only be secured when complete solutions are available in the market. This means combining components to make systems and developing the operating principles and methods to deliver solutions.

2. Using driverless cars as one example: the focus to date has been on the car/pod and the agenda has been largely driven by the automotive OEMs. However, cars and other transport solutions in public and industrial environments operate within transport systems which have many components (many of which are hidden and highly interconnected). The interconnections between the mode of transport and their environment are a critical area that needs further attention.

3. There are a number of proposals in this area from around the country. Taking two from Oxfordshire: there are plans to provide a pod service in the heart of Oxford from the new railway station to the new Westgate centre and also in and around Didcot Parkway and Didcot Garden Town. Immediately these types of project are proposed it becomes clear that the mode of transport is only one issue amongst many.

4. The PAVE consortium, funded by CCAV/InnovateUK, has carried out research into testing public perceptions of driverless vehicles and the appropriateness of the UKAEA’s Culham site as a test location for autonomous vehicles before going into Oxford and Didcot. This work has, to date involved both quantitative surveys and workshops with the public, members of staff who work on site as well as local and regional stakeholders, including elected councilors, business representatives and technical consultants. This work, which is ongoing, has established that there is strong support to use the Culham site for long term AV testing (88% of a significant sample of respondents to an internal survey were in favour) and that the investment in Culham will lead to benefits for the wider region. There is strong support from the local and city councils (Oxfordshire County Council, South Oxfordshire and Vale of White Horse District Council, Oxford City Council) and backing from Oxford University, STFC, Satellite Applications Catapult, MobOx, Smart Oxford, Siemens, Amey and many more.

Reasons for investing to establish world class test facilities include:

5. Showing and demonstrating solutions in a realistic environment enables a conversation between stakeholders: regulators, insurers, users, investors, component and solution suppliers, and the ESPECIALLY the public.
6. Long term demonstration and test generates data that supports evidence based decision-making and investment.

7. Demonstration builds trust. This is vital for both public and private engagement and investment. We need to expresses our concerns and focus on real rather than hypothetical issues.

8. Testing in a real environment is essential for establishing and addressing weakness in the proposition that may be technical, commercial or social. Laboratory testing is not enough.

9. Open demonstration builds understanding at all levels: schools, universities, industry, and government. We need to explain the opportunity and the solutions – so that we remain an advanced technological economy ready to use the latest technologies.

10. Test facilities support skills training. Hands on exposure to robotics will encourage the next generation of entrepreneurs.

11. Test facilities attract global interest – e.g. the best academics and multinational R&D dollars will be drawn to facilities that generate activity (invention, start-ups, new products and services...)

12. Test facilities are geographically located. Test facilities act as nucleation sites for clusters, particularly if established close to global brands (cities, universities...).

13. Once established they are difficult to move. Long term facilities are hugely important to anchor a technology in a country and then attract and fix the more mobile aspects: software, finance, insurance, training, regulation.

14. Investing in test facilities is a cost effective, achievable ambition. The UK can develop these assets to encourage this technology to stick and stay in the UK.

15. Government involvement is essential for the following reasons:

16. The Government is able to seek assurances regarding widely held concerns including safety, ownership of data, privacy, security, regulation, cost, competition etc.

17. The Government will need evidence to support a conversation with the wider public and other stakeholders. Having direct and independent access to such data will increase the veracity of such data.

18. The Government will be a user of AV (e.g. DoH, DfT, MOD etc.).

19. Government involvement signals intent to 3rd party investors.

20. Government investment will create a valuable UK-owned asset.
PROPOSAL 1: Invest now to create world class real test facilities which have open access for developers and end users. Use existing, accessible Government owned infrastructure and facilities to enable maximum engagement and nucleate clusters.

21. CCAV is sending a very strong signal globally that the UK Government is engaged in shaping regulation to allow autonomous vehicles to be tested in the UK first. CCAV has already conducted an extensive consultation around the need for a ‘Flagship Test Facility for Autonomous Vehicles’. CCAVs evidence based proposals should be funded as quickly as possible.

PROPOSAL 2: Reinforce and build on CCAV to maximise impact and share learning across Government (health, defence, energy...)

What, if any, ethical issues need to be addressed in the substitution of human judgement in the control of vehicles by algorithms and Artificial Intelligence

22. We should be expected to ask whether driverless cars are safe or safer than current technology. In practice this issue will be rapidly resolved as the statistics show that autonomous vehicles are safer and insurance premiums (or cost of travel) reduce accordingly. Ensuring that the statistics are collected by trusted third parties and exposed to thorough scrutiny is a role of Government. There are perhaps parallels with testing a new drug. However, initial engagement should be light-touch.

23. The idea explored by some that software should or could make a decision to drive the car into a pedestrian and/or another vehicle raises some deeply philosophical issues, although further examination shows that these issues have been faced in other situations with our legal and insurance system adapting to manage, mitigate and share the risk. But, this question is itself based on a flawed understanding of what the new technology should offer. We should be writing and testing software to make sure that vehicles can stop before hitting anything. Vehicles will be able to sense the road conditions (weather, temperature...), each other (speed and path) and others including cyclists and pedestrians. Furthermore it is easy to imagine that each bicycle and pedestrian will be equipped with a beacon (i.e. a mobile phone). This raises questions about acceptable human behaviour (all pedestrians ‘must’ carry the requisite beacon) and how these ideas are socialised.

24. All of the above should be tested in representative environments.

PROPOSAL 3: Establish a high level forum to monitor, pre-empt and respond to social, legal and ethical issues.

About RACE

The UKAEA received £9.8million funding in 2014 from BIS and OxLEP (Greg Clark, City Deal) to establish a new centre for ‘Remote Applications in Challenging Environments’ – RACE. The
inaugural Director of RACE, Dr Rob Buckingham FREng, was a lead author of the UK RAS Strategy, July 2014, and the LRF Foresight Review of Robotics and Autonomous Systems, October 2016. Jo Johnson opened the RACE facility in 2016 and the team of 85 engineers represents one of the largest robotics groups in the UK focused primarily on remote handling and robotics for nuclear applications.

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