Department for Transport

Position Statement on Automation and Connectivity in Transport Infrastructure Construction

DfT Science Advisory Council

Overview

The Department for Transport's Science Advisory Council (SAC) met on 1st March 2017 to consider the implications of robotics and automation in construction related to transport infrastructure.

The SAC considered the feasibility of using robotics and automation in construction in the UK and the opportunities that this could bring. The Council also considered how the UK's skills in science, engineering and advanced manufacturing capabilities need to develop and how the adoption of robotics and automation could transform the way in which the construction industry operates in the future.

Background

Robotic technology is becoming ever smarter, faster and cheaper leading to robotics and automation being called upon to do more; including picking, packaging, inspecting products or assembling electronics. However, the UK lags behind other countries. In Japan there are 213 robots per 10,000 manufacturing employees, Germany has 170, Sweden 154 while the UK has 33. Nevertheless, the UK has a greater degree of diversity as robotics are used in a wider number of sectors than some of the countries mentioned.

The advancement of robotics and automation has had a significant impact on manufacturing and production. In high value manufacturing, robotics and autonomous systems have allowed products to be built more efficiently and with a precision and speed that is difficult to achieve without robotic assistance. In the UK the use of robotics in the manufacturing sector is dominated by the automotive industry for both the original equipment manufacturers (OEMs) and the supply chain to achieve the quality and precision required in production.

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The use of Building Information Modelling (BIM) has significantly increased efficiency. BIM has enhanced the precision in how building elements are designed and specified, and provides valuable data on construction projects, identifies client and project objectives and improves risk management at the outset of major programmes and projects.

The drivers for this revolution are primarily economic, making it possible to be more productive, mobile and connected, enabling the UK to compete in a globalised world economy. However, this requires smarter procurement, increased digital skills and use of systems engineering.

Key Consideration/State of the Art

Advancing the construction industry in the UK is a feasible reality, however, increasing the use of robots will disrupt current design and construction practice. A concerted effort between design and construction is required. Construction can learn from other sectors and countries where application of robots is more advanced.

Modular construction can allow for new manufacturing techniques to pre-fabricate structural elements that can be installed quickly and efficiently. Modular, or offsite manufacturing, affords many benefits including construction of major components in controlled factory conditions, ensuring greater precision whilst reducing time and cost. There are clear savings for the construction industry on logistics which will impact on the level of emissions in the environment. Factory assembled products can mean faster and better quality builds e.g. in housing

However, 3D construction in a built-up urban area can also overcome challenges of pre-fabricated elements as well as save on transportation costs. At the same time, 3D or additive manufacturing can deliver high level precision specifications such as increased tolerances e.g. innovations in transport such as Hyperloop require a high level of precision within their infrastructure, which can be a challenge to achieve with traditional construction methods.

The Internet of Things together with advances in materials and additive manufacturing are opening up opportunities for construction to be smarter. Robots are control systems, with sensors, the end vector can potentially be any robotic feature enabling the creation of an autonomous system capable of doing any required task.

Smart asset management and design using embedded advanced sensors can allow whole-life performance monitoring, thereby improving efficiency without compromising the resilience of assets. The use of drones is becoming more widespread and includes opportunities for surveying, production of BIM models of existing assets, remotely controlled building applications such as precision painting and high hazard area operation. BIM enables digital design, planning and asset management and is driving the front end of manufacturing by taking digital design straight into manufacturing.

Challenges

The scale of transport infrastructure makes it an ideal candidate to develop robots, including drones and autonomous vehicles, that can undertake tasks with minimum disruption creating a safe environment and improving the quality of the infrastructure in an economic manner.

There are, however, many technical challenges as there are complex systems within the built and natural environment where robots will have to interface with people and vehicles in 3D space on bespoke projects. The built environment can be characterised as critical, social and domestic infrastructure. These complex systems require a multi-disciplinary approach. Infrastructure will need to become less bespoke and there is a need to review overly stringent specifications.

The SAC recognises challenges of transforming the construction industry to implement robotic construction. Technologies will have to come together which require new skill sets. A fundamental shift in education to develop digital skills through to cyber security skills are needed.

Standards and codes of practise are required to take account of the shift in culture, addressing the reduction in labour required and rebuilding of structures around people.

Conclusion

The UK is a leader in software systems in robots. Considering robots are control systems capable of doing any required task, robotics and automated construction processes present the opportunity to function in a variety of environments. These include in hazardous areas, on complex structures and in confined areas.

In order to be able to enhance robotics in construction, accurate digital representation of infrastructure is needed to develop elements precisely. The industry has to move to level 3/4 of BIM to ensure compatibility with the level of robotic precision. Industry must undertake design that covers the manufacture, assembly and maintenance of infrastructure throughout its life.

The SAC recognises the potential of robotics and automation in construction and the challenges faced by industry. The adoption of robotics and automation can transform the construction industry but this will require a pipeline of engineers and technicians with the necessary skills. Current design and construction practice is not appropriate for application of robotics routinely in construction because of the way design and construction are managed separately. A changed collaborative industry is needed. Overcoming this will, however, require innovative procurement practises and a clear assessment of the challenges of robotics, their current application in construction and identification of further opportunities.