OPINION: INFRASTRUCTURE, ENGINEERING AND CLIMATE CHANGE ADAPTATION

The effects of climate change are not easy to predict. Engineers need to embrace probabilistic methods and flexible solutions, and must be able to deal with complex risk scenarios.

Engineering the Future, a broad alliance of professional engineering organisations, publishes a report in December titled *Infrastructure, Engineering and Climate Change Adaptation*. Professor Robert Mair CBE FREng FRS and Peter Warry FREng, who contributed to the report, offer their opinion on the role of engineering in adapting to the effects of climate change.

Professor Robert Mair CBE FREng FRS

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While there must be effort on an unprecedented scale to reduce our carbon emissions by 80% by 2050, it is clear that we cannot focus all of our strengths on emissions. Even if we are successful in meeting this ambitious target, and in limiting the increase in global temperature, the effects of climate change will continue to be experienced over the coming decades with increasing intensity. Adaptation to cope with a changed climate is therefore crucial to preserving quality of life and the continuance of business and industry through increasingly extreme weather.

The Department for Environment, Farming and Rural Affairs is undertaking an extensive project on adaptation and The Royal Academy of Engineering, as part of the *Engineering the Future* group, has investigated the importance of engineering in adapting infrastructure for resilience to climate change. The consensus is that, whilst there is much that engineers can and must do, their work must be combined with changes in the regulatory and policy framework, and with a contribution on the part of wider society.

Although the expected impacts of climate change in the UK will not lead to conditions more extreme than those dealt with elsewhere in the world, countries so affected have had decades, indeed centuries, to build their infrastructure appropriately. In the UK, we need to adapt our infrastructure within 40 years, at a time when we will also be remodelling it to reduce carbon emissions. The engineering and economic challenges are huge.

There are specific technology areas that it would be valuable for engineers to focus on. Smart buildings and infrastructure will be a key development – using sensors to regulate services to match demand can help in both reducing carbon emissions and delivering resilient buildings. Adding systems such as grey water recycling to buildings will reduce stress on the water infrastructure. Creating natural ventilation for building cooling will be important for dealing with increasingly hot spells without putting strain on the grid, and cladding buildings with ivy can both insulate buildings and contribute to reducing the ambient temperature in cities.

Smart meters and a smart grid for energy, and intelligent pipework for the water system, are needed for better network management. Use of continuous monitoring to allow reactive and timely maintenance across all types of infrastructure can increase resilience.

Along with focusing on specific technologies, engineers have to learn to deal with the infrastructure as a system. There are many interdependencies between infrastructure sectors and failure in one area can quickly lead to cascade failure. A flood event affecting an electricity sub-station can lead to loss of power, which in turn can lead to loss of telecommunications thus affecting the transport system. What is required is better communication and sharing of information across sectors and more engineers with a cross-sector view.

The effects of climate change are not easy to predict. Engineers need to embrace probabilistic methods and flexible solutions, and must be able to deal with complex risk scenarios which involve a range of factors. Regulators too must be able to deal with probabilistic rather than absolute scenarios, and to treat infrastructure as a system of systems. Regulators must work together in planning changes required for adaptation and Government needs to make strategic decisions about the infrastructure as a whole. There must also be a process for dealing with the difficult decisions about where adaptation is necessary, and where the costs of resilience do not match the benefits.

Even if these changes are made by engineers and regulators, expectation management is required as effects of weather on the infrastructure may lead to degradation of service. A resilient infrastructure will cost more and a completely robust infrastructure, if achievable, will cost considerably more. Providers are unlikely to be willing to pay for adaptations unless costs can be recovered from customers, but will customers be willing to pay more for resilience? Given the high costs, those who depend on the infrastructure must accept that it cannot be completely failure proof in the face of a changing climate.

As well as conveying this message to society, we need a better understanding of the social changes which are likely as a result of climate change. For example, the net effect of increased homeworking on the energy, ICT and transport infrastructure are unknown. To what extent will electric vehicles be adopted, and can we provide the necessary charging infrastructure?

We can build a better, more resilient infrastructure, but it will be expensive, difficult and will require a strategic approach. The Treasury has produced the National Infrastructure Plan 2010, and this must be followed up with the detailed plans, policy and regulation required to encourage investment in adaptation measures. But we must all take responsibility for the demands we make on services and be willing to adapt our lives to a changing climate.

Further reading at www.raeng.org.uk/infrastructure

BIOGRAPHIES

Peter Warry is currently Chairman of four companies serving the energy and industrial sectors. He was a research engineer with the Ministry of Defence, and served in the Prime Minister's Policy Unit under Margaret Thatcher. He was Chief Executive of Nuclear Electric when it was privatised and was the first Chairman of the Science and Technology Facilities Council prior to which he was Chairman of the Particle Physics and Astronomy Research Council.

Robert Mair is Professor of Geotechnical Engineering and Head of Civil and Environmental Engineering at Cambridge University. He is also Master of Jesus College, and Senior Vice-President of The Royal Academy of Engineering. He worked in industry until 1998 and is one of the founding Directors of the Geotechnical Consulting Group, an international consulting company based in London and Hong Kong, started in 1983.