Where the smart money is

Future technology: sensors

By Ben Cronin


Photo: ©CSIC

Fibre optic sensing technology could help us to build and maintain infrastructure more efficiently. With costs coming down five-fold in three years, the number of potential applications is growing.

It would be hard to ignore the University of Cambridge's Centre for Smart Infrastructure and Construction (CSIC) and the research work it has been conducting in over 50 demonstration projects around the world. Most famously engineers from the university installed hundreds of cameras and wireless and fibre optic sensors in parts of The Royal Mail tunnel In London earlier this year to detect any disturbances caused by the Crossrail excavation being carried out underneath.

The good news for the engineering community is that the university continues to be on the lookout for new projects and partners to conduct similar pieces of research so that it can find new ways of applying real-time monitoring to the way we manage new build projects and legacy assets. CSIC's mandate, as its director Jennifer Schooling is quick to point out, is to help introduce innovation into an industry that is understandably risk-averse and conservative.

"The context is that we operate in an industry that has very tight margins and is governed by safety and reliability concerns – and rightly so," she says. "But we are also facing increasing constraints on budget and the requirement is to get more out of our infrastructure and sweat the asset more.

"There's a real challenge for the industry in implementing innovation while trying to build and or run infrastructure that has to meet a service remit. So we are funded to work in that space, drawing the best ideas out of research but also taking ideas from other industries and technology partners and applying them as well."

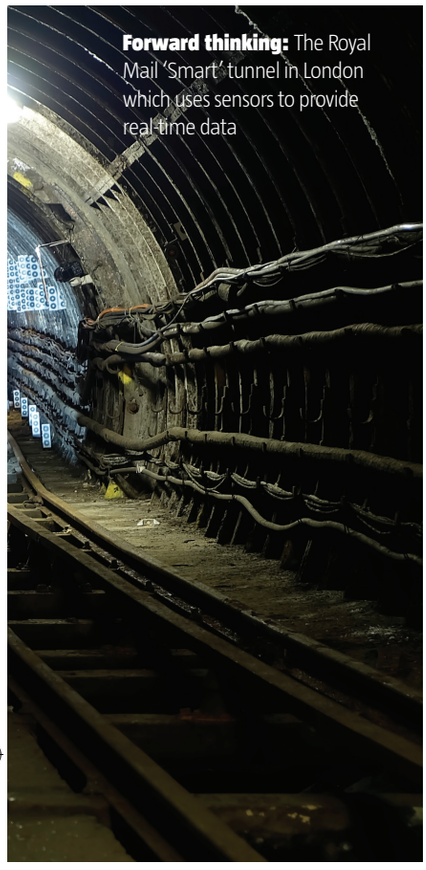
The other objective of the university's work – which is funded jointly by the Engineering and Physical Sciences Research Council (EPSRC) and Innovate UK – is of course to drive efficiencies in civil engineering and bring more work to the supply chain. "There's the ultimate client who wants knowledge and then there's the people who are going to create the sensors, install them, and interpret the data about the infrastructure asset," says Phil Keenan, business development manager for CSIC. "Everybody benefits – and that's why Innovate UK funds us, because they want to see that value creation."

The immediate worth of the network of sensors for the Royal Mail tunnel project was to provide project managers and the owners of the tunnel with real-time data to understand the stresses and strains within the structure, but Schooling isn't alone in trying to imagine further applications for the technology.

"There's a challenge with collecting and managing data in a way that is accessible and meaningful to our future selves or our 'work descendants' "
Jennifer Schooling, CSIC

"In the longer term there's an opportunity to use those kind of sensor capabilities to help with things like how fast should your tunnel boring machine be going, should we drive it faster or do we need to slow it down based on real live data of what's happening to the adjacent structures," she says. "But the other thing it's providing is insights into the performance of cast iron tunnels. A lot of London Underground's assets are cast iron-lined tunnels and until now there hasn't been the technology available to actually monitor and understand the way they behave."

Schooling also points to the work that CSIC has done with Thames Tideway installing fibre



Forward thinking: The Royal Mail 'Smart' tunnel in London which uses sensors to provide real-time data

optics sensors in an 18m shaft at the Abbey Mills site, also in London – a project which went on to win the Fleming Award. "They're going to have 12 or 14 of these and the same design is being used for all of the shafts," she says. "Our work has helped to confirm that actually the way the shaft is designed and built means there is very little movement adjacent to the shaft and that can be used to reassure third parties and will hopefully speed up the process for getting approval."

Longer term, however, Schooling would like to see the sensor technology used to create greater maintenance and operational efficiencies for civil assets. "In order to get more out of our infrastructure we need to have a very good understanding of how those assets are performing. Can we design them to be more efficient in terms of use of materials but also operation and maintenance?"

"It is said that between 10% and 20% of the investment and the time and the data generated by a structure or asset happens in the construction phase but then the remaining 80 to 90% comes during its lifetime which is going to be at least a hundred years – it might even be 150," she says.

Keenan thinks asset owners will have to weigh the cost and benefits of using a real-time sensor-based 'predictive' maintenance approach against the costs of our current 'speculative' scheduled maintenance approach.

"In only three years of operation in our centre we've seen the cost of fibre optic sensing drop by over a factor of five," he says. "We should do a retroactive study of the collapse of the sea wall in Dawlish and show the fines that were encountered in denial of service to the South West and the economic impact. If we could compare it to how much it would have cost to have been able to warn them about any potential problems and allow remedial action to take place, I think it would be very interesting."

Schooling concedes that for the technology to be really useful, end users will not only have to be able to interpret the data in the present, but also for generations to come. "We should consider BIM in all this. Data is no use until you turn it into information on which useful decisions can be made," she says. "We've got to develop dashboards and data analysis tools to help the engineer make an informed decision.

"There's also a challenge with collecting and managing data in a way that is still accessible and meaningful to our future selves or our 'work descendants.'

In the past, information records for our infrastructure have been entirely paper based and a lot those data archives have been lost over time. Modern digital capabilities for gathering and storing and manipulating data offer us the opportunity to look after our infrastructure in a much richer way."

Deep data: Fibre optics sensors have been installed in a 72m deep shaft at the Abbey Mills site in London

Photo: © Thames Water

WORKING IN PARTNERSHIP WITH INDUSTRY

Phil Keenan, business development manager with CSIC says the research body's remit is a mixture of several functions.

"Some of our work is about helping to understand how structures behave and making that information available; some is about developing sensor technology and another part is working with SMEs or other organisations and industries that already have sensors technology and learning how we can apply their learning to engineering," he says.

Much of the fibre-optic technology being applied in projects like the Royal Mail tunnel was first used in the oil and gas industries in the 80s and 90s. At the last count CSIC was working with 42 different partners on 50 projects but Keenan says that it would be interested in establishing even more partnerships. "We're interested in both new build and retrofit applications for the technology but would like to hear from more companies that are interested in testing the sensor technology in road and bridge projects," he says.

"We can only drive innovation forward in industry by working hand in hand with industry, so we're very open to others who may want to work with us and grateful to those who already work with us. But it's also about not just the work we do immediately but also getting that work further out into the industry and getting it adopted by industry which is a job that at some point others take over from us."

CSIC doesn't charge its industry partners for collaborative demonstration projects but asks for a contribution when it installs instrumentation on a scheme.