New Civil Engineer

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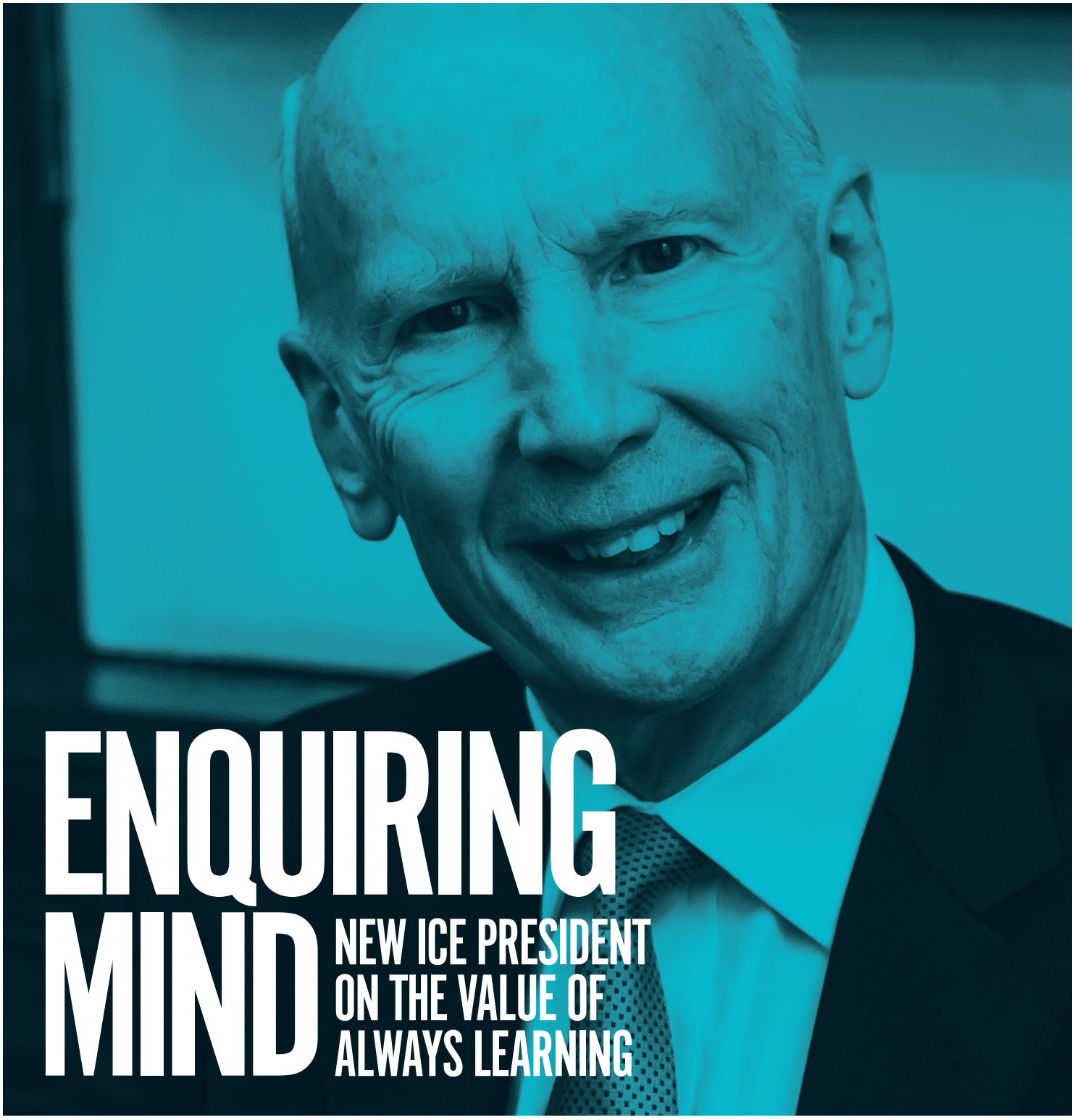
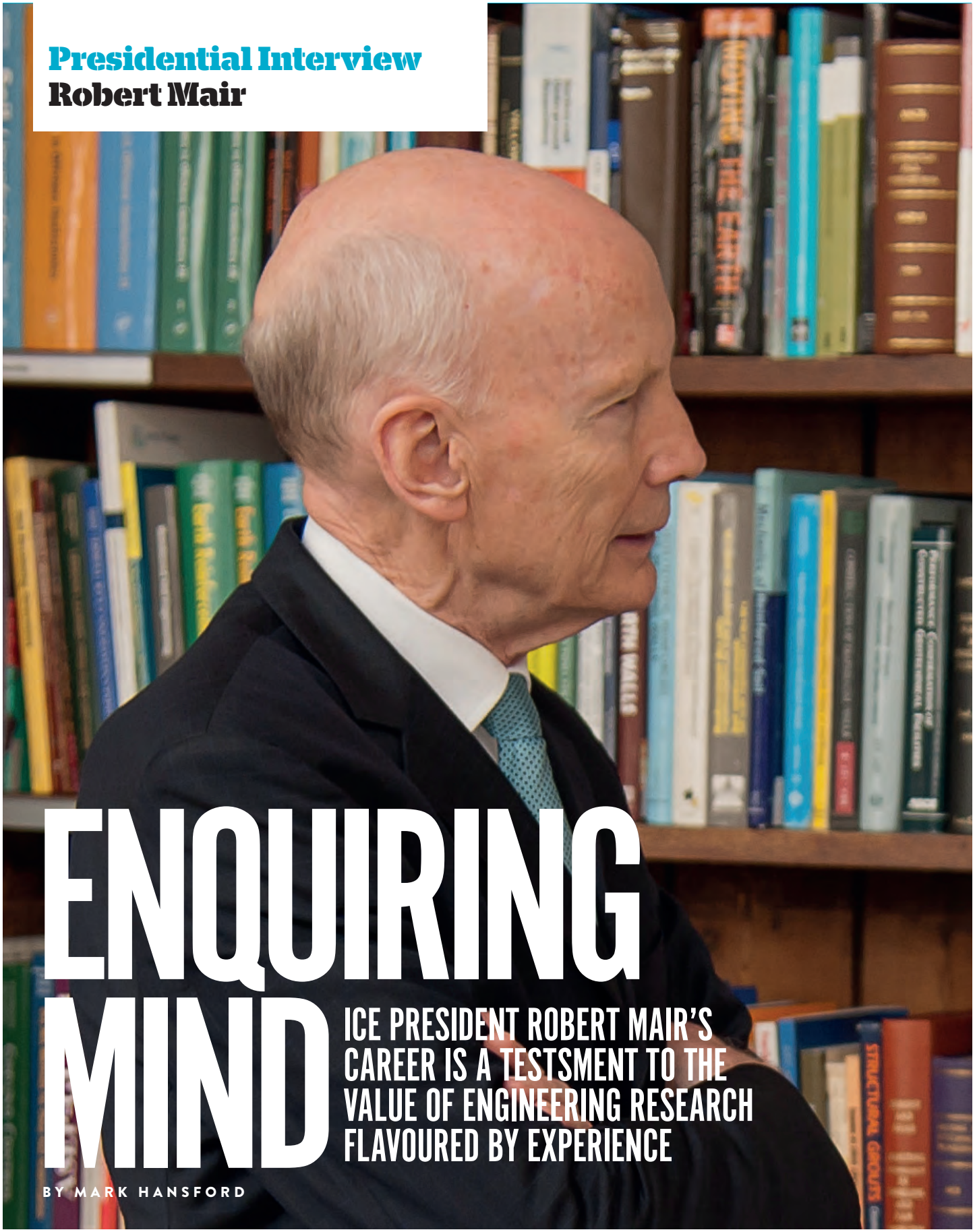


# ENQUIRING MIND

## NEW ICE PRESIDENT ON THE VALUE OF ALWAYS LEARNING

**Presidential Interview**
**Robert Mair**



# ENQUIRING MIND

## ICE PRESIDENT ROBERT MAIR'S CAREER IS A TESTSMENT TO THE VALUE OF ENGINEERING RESEARCH FLAVOURED BY EXPERIENCE

BY MARK HANSFORD

Robert Mair is not a typical academic despite his educational background. Yes, he grew up in Cambridge. Yes, he then went to Cambridge University as a civils student. Yes, he has a PhD – from Cambridge. And yes, he has spent the last 20 years back at the university as head of civils. But before that he was firmly in the construction industry, first in design offices, then on site, then in research labs, before, finally, entering the boardroom as owner and director of his own specialist design house. That has accounted for well over half of his career and informs his work in academia to this day. For Mair, a practical man at heart, academic research must have practical application.

"My first 27 years were in industry and they have very much shaped my whole academic research agenda and made sure I've addressed some topics of real value," he says. "I've looked at problems I would like to see solved."

Latterly, those problems have been those of getting the most out of ageing infrastructure assets – and exploring the role of sensor technology in that. But initially it was pioneering work in tunnelling in soft ground, and in compensation grouting in particular.

And that all stemmed from his first job, with Scott Wilson Kirkpatrick in London, way back in 1971. Scott Wilson Kirkpatrick was a large international firm of consulting engineers and in 1973 he was posted to Hong Kong, where he spent what he describes as three "exciting and very formative years" designing a new container terminal and then supervising construction on site.

It leads to his first words of advice to any budding engineer: get yourself posted abroad. "I would say to anyone to try and get as much experience as you can, with as much variety as you can, as quickly as you can. And you can get fantastically concentrated experiences if you go overseas," he suggests.

In gaining that kind of experience in Hong Kong, Mair first experienced the civil engineering thrill of seeing his design actually being built. "There is nothing to beat the satisfaction of that," he says.

## ROBERT MAIR CV

**1968**
Reads engineering at Clare College, Cambridge, specialising in civil engineering

**1971**
Joins Scott Wilson Kirkpatrick's London office

**1973**
Posted to Hong Kong designing and supervising construction of new container terminal

**1976**
Seconded to Cambridge to do PhD in tunnelling in soft ground

**1979**
Rejoins Scott Wilson Kirkpatrick. Projects include study for Baghdad metro

**Continued on next page**

But there was, equally, a sharp learning curve, he says, moving on to words of wisdom number two: get out on site.

"It was a very humbling experience when you see your initials on the bottom right corner of drawings that someone is saying don't look very easily buildable," he recalls. "It is very important to work on site at an early stage in your career as the way you think about design is so transformed," he says.

In Hong Kong in the early 1970s the Hong Kong Government was just beginning geotechnical investigations ahead of building the first of its metro lines. There were huge uncertainties about feasibility of creating tunnels so close to, and beneath, Hong Kong's iconic high rise buildings. Scott Wilson Kirkpatrick was involved and here began Mair's lifelong passion.

He was swiftly seconded by Scott Wilson Kirkpatrick to Cambridge University in 1976, at the age of 26, where he was tasked with helping with research into soft ground tunnelling, a project funded by the UK government through what was then the Transport & Roads Research Laboratory.

"It changed my life," he says. "That three year period really shaped my career," he adds. The lab had just invested in a centrifuge and testing problems of tunnel stability and ground movements caused by tunnelling was an ideal application for it, explains Mair.

He used the research as the basis for a PhD which he received in 1979. The results were adopted by the industry worldwide.

With that work complete he briefly rejoined Scott Wilson Kirkpatrick before, in 1983 and while still in his early 30s, he embarked on his next big challenge – co-founding and co-running his own company, Geotechnical Consulting Group (GCG).

It was, he says, in many ways a new breed of engineering organisation. Closely linked to academia, especially Imperial College London, GCG specialises in applying latest developments in academic research to geotechnical engineering and major civil engineering projects.

It started small, with Mair and his co-founders David Hight and professor Peter Vaughan of Imperial working above a Morgan garage in Kendrick Mews, South Kensington. And it remains small to this day, deliberately so, says Mair.

> **"Try and get as much experience as you can, with as much variety as you can, as quickly as you can**

"When we set up GCG, we quite deliberately decided it would never exceed 50 people," he states. The concept of a specialist firm of experts was modelled on barristers' chambers and the ideal remains intact today. "It is a very effective model, I believe," observes Mair. Clients, consultant and contractors come from all over the world to tap into their expertise – all seeking specialist solutions to a geotechnical problem.

And the success of it leads Mair to his third top-tip: stay abreast of developments in research coming out of academia. "There is a lot emerging and so the young engineer keeping him or herself abreast of new techniques is important," he says.

To Mair, GCG was about more than keeping in touch. For him, it was the perfect way to fulfil his ambition: "I wanted to stay at the cutting edge of geotechnics rather than becoming a manager," he recalls, "although I of course was. But I still spent a lot of time in the technical."

Mair's "technical" was, naturally, underground construction – how to design and construct tunnels in urban areas, often in very soft ground, without risking instability and causing damaging settlement. And it is with that, and compensation grouting as a means of protecting buildings and structures from the effects of settlement caused by tunnelling, that Mair really made his name.

Compensation grouting involves the drilling of steel tubes radially, deep underground, usually from a vertical shaft, between the foundations and the tunnel to be constructed. The tubes can be drilled up to about

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60m from the shaft; they have many holes in them. Very comprehensive monitoring/measurement of the building is undertaken, and as tunnelling work approaches, grout (liquid cement) is injected from the tubes to compensate for the ground movements that occur, reducing movements affecting buildings.

It began, as so many clever things do, with London Underground (LU). He had already worked on a number of LU projects including Angel station in Islington, where his escalator, threaded between piled foundations supporting a major building, still holds the record of the longest in London.

But Waterloo station was the breakthrough for compensation grouting, where it was used to protect the existing station – and the Waterloo & City line – from settlement as a new 10m diameter escalator tunnel was installed to service the then new Eurostar terminal. It was quite an act of faith from the client, recalls Mair.

"The settlement was going to be significant and compensation grouting was a first," he observes. But it worked. "It was a seminal moment and a vindication of new ideas that made the business of building tunnels near buildings safer and more predictable," he says.

And it certainly got Mair and his team noticed. "A lot of designers and contractors for the Jubilee Line Extension came round and looked at it," he recalls. The method was adopted and used for the "ultimate test" – Big Ben – which was successfully protected from leaning thanks to compensation grouting.

It established his and GCG's reputations. Both have now advised on many tunnelling projects worldwide: in Amsterdam, Barcelona, Bologna, Florence, Hong Kong, Rome, Singapore and Warsaw to name just a few. Mair himself chaired committees, founded and chaired international conferences and, significantly, sat as the only Englishman on a French government commission of enquiry into the collapse of the Toulon Tunnel in 1997 – a failure of enormous cost and consequences.

Bringing that all to an end to return, in 1998, to academia and Cambridge was, he admits, a big change in his life. The man who persuaded him was vice-chancellor Alec (now Lord) Broers.

What convinced him was Broers' desire to bring industry-focused research to Cambridge. An easy hook for someone like Mair and he took the bait, taking the job as as professor of geotechnical engineering and head of civil engineering. He made it work in a big way, obtaining funds for a new geotechnical engineering building and building the university's geotechnical research group into one of the largest in its field in the world – 50 PhD students, from many different nationalities, examining many different topics.

He is now known mainly as the head of the Centre for Smart Infrastructure and Construction (CSIC), a spin-off from Cambridge which exists to find revolutionary new uses for sensors to monitor the behaviour of bridges, tunnels, buildings and many

## ROBERT MAIR CV

**1983**
Founds Geotechnical Consulting Group

**1988**
Becomes professor of geotechnical engineering and head of civil engineering at Cambridge University

**2001**
Elected master of Jesus College, Cambridge

**2011**
Founds Centre for Smart Infrastructure and Construction

**2015**
Appointed cross-bench member of House of Lords

Mair is passionate about the role of technology and structural health monitoring in infrastructure

types of infrastructure. It is a major endeavour, collaborating with more than 30 different companies. And again the focus is on the practical application.

It's working well, with CSIC kit now being used on over 100 sites. "It's been very rewarding as the main aim was to get it adopted by industry," he observes.

Which is good, as sensor technology is, he believes, firmly the future. "Modern civils projects will very soon be routinely incorporating structural health monitoring, so we know what our infrastructure is doing and how it is performing," he explains.

"It won't be far in the future where it will be standard practice that designers are asking clients what sensing equipment they want," he adds.

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"That is a big step change in civil engineering," he continues. "More often than not we have created wonderful structures but we don't know how they are performing."

This is such a step change, he says, because not only does it inform the maintenance regime but, more fundamentally, it allows engineers to improve their designs. "This is important," he emphasises.

He is clearly passionate about structural health monitoring, and is also passionate about where UK engineering's role in it sits on a global scale. "We are world leading in this," he says. "Last year we had a conference at Cambridge and we had hundreds of delegates from around the world.

"Cambridge is world leading and the UK is world leading," he stresses.

It should come as no surprise therefore that Mair sees this as a time of opportunity to sell the industry better. "I feel very strongly that we are at the right time for the adoption of new technologies. Sensors, yes, but a whole lot of other technologies such as robotics and 3D printing that project the hugely exciting opportunities available and dispel any image the public may have of us being old and slow when actually we are new and fast."

It is this advocacy of engineering, and science in general that got Mair, then an ICE vice president, in 2015, appointed as a cross-bench member of the House of Lords.

Lord Mair was named as one of four new non-party political peers following a recommendation from the House of Lords Appointments Commission, a recommendation stemming in no small part from his role as chairman of the Science Advisory Council of the Department for Transport and the hours of evidence he gave to both Commons and Lords committees studying the Crossrail hybrid bill.

He plays down his peerage; indeed his main observation is that it is worthy of remark that a civil engineer has made it into the Lords.

"There aren't enough of them," he observes. But it does mean he has a special role to play, and one he welcomes. In the Lords he sits on the science and technology committee and is actively engaged. "Whenever there is an opportunity to speak about infrastructure, or science and technology, or universities; that's where I play my part," says Mair.

The latter subject – universities – naturally is close to his heart, and how they work with technology is something that concerns him.

"The group I am in has chip designers and computer scientists working with great civil engineers.

"That has implications for future civils courses," he stresses. "There is going to be a greater need to introduce computer science and sensing technology and a lot of thought is needed about how to do that."

This is, perhaps, the hardest question of all – how to make a future civils course broad enough to cover all the bases but not so general that, in Mair's words, graduates are unable to deal with anything.

For the answer Mair returns to his roots and the words of professor Charles Ingels, himself an ICE President in the 1930s and another prominent Cambridge academic.

"He said the most important achievement was to give students 'right habit of mind'," Mair quotes him as saying. "That is to help them understand from first principles the working of things, and in doing so give them the capability and flexibility of mind that they turn their skills to anything."

And that, really, is Mair's final top tip for a successful career: "Never stop having an enquiring mind," he concludes. N