

Upfront

Digital design

Peter Ayres Guest Editor



Not so long ago, a journalist asked me an interesting question: “Do you believe the work of the structural engineer can ever be replaced by artificial intelligence?”. I think she was somewhat taken aback when I answered “Yes”.

But before the esteemed readership of this magazine floods Verulam with missives of indignation, let me explain that I qualified my answer; I postulated that while almost all the technical work undertaken by structural engineers at every level could, in theory, be overtaken by artificial intelligence (and that it would be highly complacent of us as a profession to assume our more “left brained” tendencies were irreplaceable) the *art* of the structural engineer would always remain.

Which begs the question, as structural engineers, what do we really mean by *design*? When I was at university over 30 years ago, much of our course work was taken up learning the hard, number-crunching ways of analysing structures, while “design” lessons generally involved practising the use of codes and standards to select and detail structural elements. For the 21st-century structural engineer, these are processes which can now be almost entirely automated. Our real value comes in understanding when and how to apply the increasingly complex tools at our disposal to deliver value and creativity to our clients and stakeholders.

So in this special issue of *The Structural Engineer*, we set out to describe how far our profession has come, and where it might be going, in the development of digital design tools, and what this might mean for structural engineers of the future. By way of introduction, we start with a historical insight into the use of computers in structural engineering by Allan Mann of Jacobs, including some fascinating recollections of predictions from the past (page 10).

We go on to present a collection of papers from across our profession exploring the methods and practice used by leading practitioners today, including some salutary lessons from Iain MacLeod of The University of Strathclyde on the importance of reflective thinking

(page 14). My AECOM colleagues, Jon Leach *et al.*, provide an in-depth description of the practical application of parametric design methods to optimise complex geometrical solutions (page 24), while Peter Debney of Arup offers a highly accessible introduction to the theory behind various optimisation methods, from simple quasi-Newtonian methodologies to state-of-the-art artificial neural networking (page 34).

As examples of advanced digital design in practice, we are treated to two fascinating project case studies: BuroHappold's City of Dreams Hotel in Macau (page 56), and Arup's Qatar Faculty of Islamic Studies in Doha (page 69).

A recurring concern expressed by many practising engineers is how student engineers can learn the fundamentals of structural engineering in a world where much of the work traditionally undertaken by graduates can be supplanted by technology. So in our fourth section, we explore how students should be exposed to software as part of their development, rounded off by an inspiring piece from Institution Past President Tim Ibell on how the digital revolution should allow a new kind of creative talent to emerge in the world of engineering (page 88).

We conclude with a series of short opinion pieces, including a typically thought-provoking contribution from Tristram Carfrae of Arup on the creative possibilities opened up by allowing engineers to “play” in a digital world (page 92).

I hope you will enjoy this special issue; I have certainly enjoyed editing it. I truly believe we are a creative industry. Technology is a tool, not an end in itself, and by choosing our tools wisely, we can continue to create and sustain better world.

Peter Ayres is a structural engineer and multidisciplinary team leader at AECOM who has delivered an extraordinary range of high-performance buildings in recent years, from the multiple award-winning Halley VI Antarctic research base to world-class sports venues in Russia, Brazil and the Middle East.

The Structural Engineer

- provides structural engineers and related professionals worldwide with technical information on practice, design, development, education and training associated with the profession of structural engineering, and offers a forum for discussion on these matters
- promotes the learned society role of the Institution by publishing peer-reviewed content which advances the science and art of structural engineering
- provides members and non-members worldwide with Institution and industry related news
- provides a medium for relevant advertising

The Institution

- has over 27 000 members in over 100 countries around the world
- is the only qualifying body in the world concerned solely with the theory and practice of structural engineering
- through its Chartered members is an internationally recognised source of expertise and information concerning all issues that involve structural engineering and public safety within the built environment
- supports and protects the profession of structural engineering by upholding professional standards and to act as an international voice on behalf of structural engineers

The Structural Engineer (ISSN 1466-5123) is published 12 times a year by IStructE Ltd, a wholly owned subsidiary of The Institution of Structural Engineers. It is available both in print and online.

Contributions published in *The Structural Engineer* are published on the understanding that the author/s is/are solely responsible for the statements made, for the opinions expressed and/or for the accuracy of the contents. Publication does not imply that any statement or opinion expressed by the author/s reflects the views of the Institution of Structural Engineers' Board; Council; committees; members or employees. No liability is accepted by such persons or by the Institution for any loss or damage, whether caused through reliance on any statement, opinion or omission (textual or otherwise) in *The Structural Engineer*, or otherwise.