



Stockton-on-Tees footbridge and Halley VI photos and sketches courtesy of Expedition Engineering.

# 21<sup>st</sup> Century 'Engineer'

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CIVIL ENGINEERING students grappling with inverted matrices and elastic strain fields may look to Chris Wise, structural engineer and Director of Expedition Engineering, for inspiration. He believes that good engineers are not defined by their abilities to do hard sums, but by their imagination and experience.

Chris has worked around the world on landmark projects throughout his career. It took him less than 20 years to advance from graduate to board director at Arup, a global firm of engineers, designers, planners and consultants. He has received honorary distinctions in the fields of engineering, architecture, and design – all before his 50<sup>th</sup> birthday this year.

The Millennium Bridge is one of his favourite projects, together with the Barcelona Tower built for the 1992 Olympics, “we had a fantastic client... and it was one of those wild projects. As soon as people saw it at the beginning, they said, ‘over our dead bodies! We’re never going to let you do that!’ and we managed to persuade them”.

Designing the American Air Museum in Duxford, “we were trying to make a fantastic space where the architecture and engineering would be the backdrop to the exhibits. So we went for a really simple, classical vault and updated it. We used a lot of principles from gothic cathedrals. Just like the triforium of a cathedral, bringing in light from the top, we cut a big slot all the way around the outside which brought light into the middle, so we didn’t need to use artificial light most of the time. It uses the mass of the concrete to stabilise the day and night time temperatures, and has no heating or cooling. It was a massive thing 90 metres across, built out of two layers of 100mm thick concrete.” A project that started with a client “who was an enthusiastic amateur, and turning it into something that in the end won the Stirling Prize of architecture, out of his little pipe dream... that was fantastic.”

Outspoken by nature, Chris wants to explode the myth of engineering as a dreary profession, and raise its reputation beyond a mere service industry to architecture. “All the projects I have mentioned were engineering-driven. The key ideas come from engineering, and yet because there’s an architect, people assume that they must be responsible.” However, he believes that engineers are partly to blame for the profession’s image problem, “I think engineers are their own worst enemies. If they don’t want to take risks and responsibilities, stand up in public and speak for what they believe in, then in a way they shouldn’t be allowed to be put in that privileged position. But some engineers are prepared to do that, and there should be more. That’s what we’re trying to do here at Expedition Engineering; train people to have courage with their convictions, and think of engineering as something that includes architecture. It’s not the other way around.”

Expedition’s ‘walking building’, conceived for the British Antarctic Survey’s competition to design the next Halley research station on the South Pole, demonstrates his point. Short-listed to the final stage of three designs,

**“Science makes your ideas fit the world, and engineering makes the world fit your ideas.”**

the outcome had an unexpected twist. “We won it, but couldn’t get the money out of the Treasury to pay for our scheme. It would have been the world’s first walking building, a brilliant project if only – it’s sort of like seeing a girlfriend disappearing into the horizon after she’s chucked you, and you can’t quite understand why.” The scheme that cost the least amount was eventually announced as the winner, “but in the end, they didn’t even have enough money for that.”

Despite his success, Chris didn’t feel that his degree in civil engineering at Southampton prepared him for his career, “to be honest, with the exception of the third year project, I didn’t find it very useful.” Recalling the initial years of his career at Arup, he confesses to having “no understanding from university training of what civil engineers actually did. In fact I didn’t do civil engineering when I went there, I did structures, but I didn’t even realise that I was doing something different.”

Nevertheless, his third year project on the Salisbury Cathedral proved to be one of three formative experiences in his early career. He was mentored by the cathedral’s engineer, Peter Taylor, which was “one of the best things to have happened. I got to understand the medieval building... the feel of a space, its relationship to daylight, the link between structure and architecture, the use of materials, durability.” Sport also played a part, “I learned an awful lot about how to work in engineering through playing rugby and cricket. You recognise that it’s never over till the end. You can’t do it all on your own, it’s always a group activity. The more you talk to each other, the more useful it is.” Even under adverse conditions, the team “never lost a game, which gives an enormous amount of confidence.” Finally, “going travelling for a year and a half was the next most useful formative thing.”

When it comes to educating 21<sup>st</sup> century engineers, Chris believes in imagination over calculation. In 1997 he became the first Professor of Creative Design at Imperial College’s Civil Engineering Department. Together with his colleague Ed McCann he developed a workshop based course. The class would be asked to find solutions to specific engineering problems – typical tasks were developing a concept design for a sports hall, or designing a building based on a one-word brief. Once, having built a catapult, their attempt to fire a muffin towards the library on the Queen’s Lawn caused worried

Photos from left to right: ‘Engineering man’ Chris Wise at the office of Expedition Engineering; Stockton-on-Tees footbridge; Halley VI walking building design. Side panel: Halley VI design sketches.



Chris Wise has engineered many iconic structures of our time. As Imperial College’s professor of creative design he conceived the award winning ‘Constructionarium’, before resigning over the curriculum.

security guards to consider evacuating half of the Sheffield Building.

Recognising that many students had no idea how structures were actually built, he conceived the idea of the ‘Constructionarium’. In partnership with College staff and the construction industry it has been developed into an award-winning education programme. At ‘Constructionarium’ students get their hands dirty for a week at a special construction site in Norfolk. They operate as a company to build reduced scale versions of real world projects, like the Canary Wharf underground station, or the double bow footbridge in Stockton-on-Tees. The programme has received industry and government funding to develop the site. Other universities, including Oxford and Cambridge, are joining the programme. As a testimonial to its success Prince Philip has requested a visit this year. “He’s coming down in a helicopter. It’ll be wild! We’re contemplating building him a wooden hut in case he needs to go to the loo.”

After several years of teaching, he came to believe that there is a large gap between what civil engineering students learn at university

**Losing Halley VI was “like seeing a girlfriend disappearing into the horizon... and you can’t quite understand why.”**

and what is expected when they start their professional life. “Engineering is not about the hard sums. In our company, we would employ people who are good at design, not theory, because we have very little need for that type of engineers. You can buy an analytical computer package that does the same work for £500.”

To address this, Chris and Ed initiated their own curriculum review and asked themselves,

“What should a place like Imperial be giving to its new graduates?” They looked at the existing curriculum, and consulted institutions, staff and students. Their recommendations included separate pathway options for third and fourth year students, to address the different needs of those going into ‘engineering science’ or ‘engineering art and practice’. Chris sees a fundamental distinction, “I wouldn’t call [‘engineering science’] engineering at all. That’s analysis. I’d say that’s a service industry to engineering. It’s an essential part of engineering but it’s not engineering. Engineering involves working from the fundamental design need, conceiving it, testing it.” He believes that within education, “lots of people are very good at being specialists, but very few understand engineering.”

In the end, Chris and Ed did not feel that their proposals were taken on board, and eventually resigned. “One of the beauties of going into academia is that you have a chance to reflect. But the reflection is absolutely useless if you can’t do anything with it. I couldn’t there, so I had to leave, which is a shame. The purpose of going to Imperial was to teach design. After a few years, it became obvious that you couldn’t do design in a curriculum that didn’t recognise that it was necessary. That recognition eventually triggered the crisis that forced us to leave. However, we left on the best of terms and we are still working with Imperial on the ‘Constructionarium’, which is gonna be fantastic this year.”

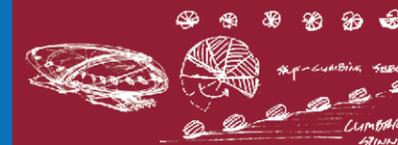
Chris believes that people confuse engineering with science. “Philosophically they’re completely different. Science makes your ideas fit the world, and engineering makes the world fit your ideas. Science is a tool that engineering uses.” He likes to think of engineering as an art, the word “*ingenuity* is the root of *engineer*. Unfortunately, it got lost because the ‘i’ got changed to an ‘e’, which is really bad.” ■

## Halley VI – a walking building

Expedition Engineering led the project to design a new research station in Antarctica. They put together a multidisciplinary team of specialist engineers and architects. Their proposal included the following:

### Movement

- The icy ground Halley VI will be built on moves towards the sea at 100m/year. Expedition looked at different animal movements and proposed a walking building solution. The legs step up and slide forward using a hydraulic mechanism, with an estimated top speed of 14m/hr, and a power usage equivalent to operating two kettles.



### Environmental factors

- The building exterior is cushioned by a ‘puffer jacket’ made from ETFE (ethylene tetrafluoroethylene). The jacket provides insulation and reduces heating requirements. It also creates an aerodynamic shape to minimise snow management.
- The current research station is powered by aviation fuel especially shipped to the Antarctic. Instead, Expedition proposed a sustainable method of converting available ice into water. Hydrogen is extracted from water by electrolysis and used in fuel cells to power the entire station. Water would be the only waste product produced.

### Live/Work space

- The architects carried out a space planning exercise and developed the interior into a living space. They also proposed that the space inside the ETFE jacket could be used as an exercise running track.

### Logistics of construction

- Making the construction simple was a survival requirement. If not completed within a set timeframe, “all the construction crew would die, because they couldn’t get back on the boat and they have nowhere to stay down there”. The building needed to be prefabricated into sections elsewhere, with furnishing and services installed prior to shipping. Upon arrival on site, a simple ‘plug and play’ configuration completes the construction.