AN INTUITIVE ENGINEER

PAUL WESTBURY FREng

Paul Westbury FREng is a big sports fan and is invited to the opening fixtures at some of the most prestigious arenas around. That's because, as a director and partner with Buro Happold, he's had a hand in engineering the structures that hold up some of today's leading sports venues. Michael Kenward OBE talked to Paul, the Academy's youngest elected Fellow, about his intuitive way of working.

For someone whose engineering career developed in the computer age, and whose fascination with science and technology began with making his own communications system, Paul Westbury is a great believer in paper. It isn't long into our interview before he pulls out an A3-pad to illustrate a point he wants to make about his position in the merger of art and science, that is the overlap of architecture and structural engineering.

On the arts-science axis, he explains, science becomes more important as you move up the size scale. Artists, including architects, don't have any problems coping without science when they are executing paintings and sculpture, or even building houses and small buildings. But when it comes to skyscrapers, or massive stadiums, it takes a lot of science to achieve the architects' ambitions.

EARLY ACHIEVER

Much of that science is in the structural engineering that is Paul's domain with the engineering consultancy Buro Happold. Paul is the youngest person, so far, to have achieved the status of partner and director with Buro Happold, when he was just 30. He added to his tally of "youngest person" achievements when he became The Royal Academy of Engineering's youngest Fellow in 2003, at the age of 33.

A specialist in structures for stadiums, Paul has been responsible for some of the most visible structures around. Last year, Buro Happold finished a complete rebuild of the grandstand at Ascot. Most recently he was a part of the team leading the construction of the new Emirates Stadium for Arsenal Football Club in north London. He also led a team that prepared the engineering input for London's bids for the London 2012 Olympic Games and Paralympic Games.

Unlike skyscrapers, where the parts that hold them up are often invisible within the building, stadiums show off their structural details in great detail, as Paul illustrates with another quick sketch on that notepad. Yet had things gone according to plan, Paul might have ended up working at the other end of the engineering spectrum, on microelectronics.

UNDERGRADUATE CHOICES

When it came to seeking a place at university, Paul applied for courses that included electronics and computer science. Making communications systems was, after all, the schoolboy hobby that attracted him to science and engineering. But one of the universities he applied to was Cambridge, where he admits that he found the interviewing process simultaneously both "quite gruelling" and "great fun". Enough fun, obviously, to persuade him to accept the university's offer of a place.

Paul puts down the change of direction to the fact that at Cambridge, engineering students start off doing a general course. It is only after a couple of years that they begin to specialise, by which time Paul's thinking had changed. "As time moved on, I found I had a much greater affinity with buildings, especially their structures. As the choices slowly arrived in the course, I chose more and more 'structures,' and structures' theory."

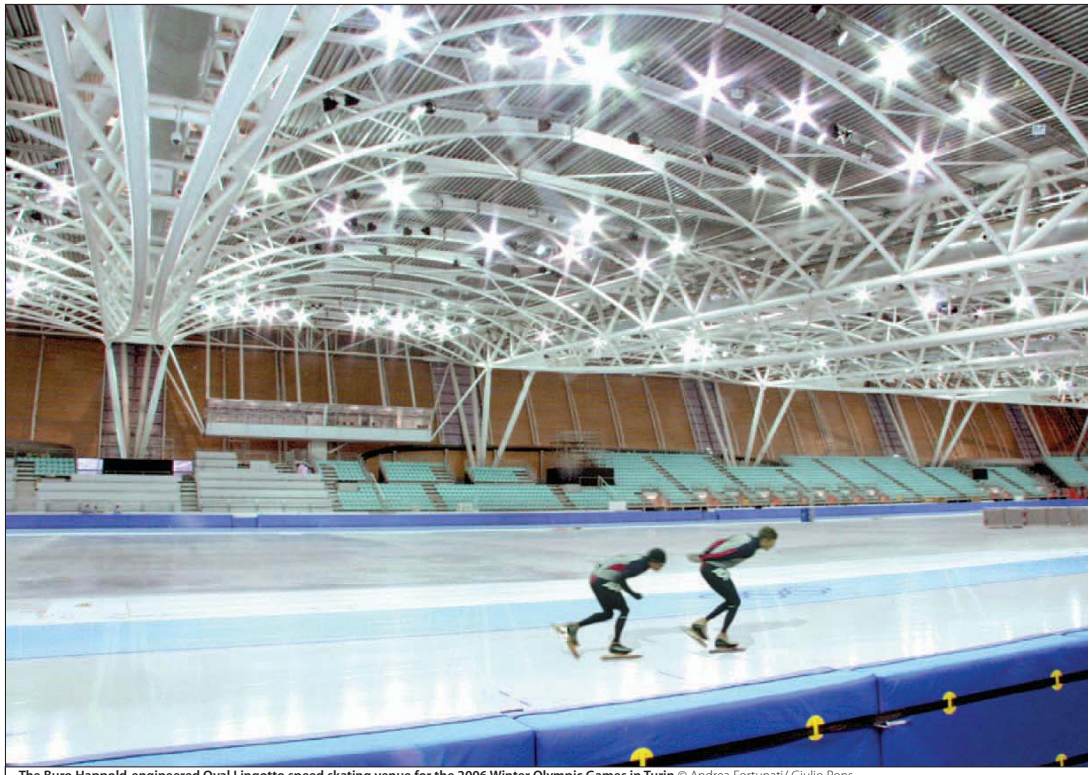
"I never looked back really," says Paul, "but had I not been given that opportunity, I wonder what might have become of me."

A TEAM PLAYER

Another Cambridge activity influenced that choice of career path: sport. Sport had always been important to Paul. At school he played rugby, cricket, water polo, squash and hockey, the latter for Warwickshire. He even admits that for a fleeting moment he had to consider whether or not to go off to play for the university's hockey team or to get on with his education. "It was the same day as my one assessed practical, in geotechnics, soil mechanics. I turned down my sporting opportunity." Now, he says, his sporting interest is mostly as a supporter, and, of course, in building places for it to happen.

One attraction of building stadiums is that you can actually see what the structural engineers have done. All those girders and struts are highly visible. Stadiums are also replete with another challenge that seems to appeal to Paul, their "boundary conditions". At first you might think that he is talking about the scientific boundary conditions that apply to these major structures, and his opportunity to push design and materials as far as possible.

Paul Westbury pictured beside the Millennium Dome at Greenwich. The Buro Happold team won the MacRobert Award for its innovative design of the 320m cable net fabric roof



The Buro Happold-engineered Oval Lingotto speed skating venue for the 2006 Winter Olympic Games in Turin © Andrea Fortunati/ Giulio Pons

ACHIEVEMENTS

Born **1969**. Graduated in **1991** with first class honours degree in Engineering Science from University of Cambridge. Joined Buro Happold's trainee engineer programme **1991**. **1993** gains a Master of Arts from University of Cambridge. In **1996** established Buro Happold's Special Structures group to tackle unusual and challenging design problems. **1995-2000** Project Engineer for the Millennium Dome in Greenwich, awarded MacRobert Award for Innovation **(1999)**. **1998-1999** Project Principal for the structural engineering design review of Sydney Olympic Superdome, Australia. **2000** became a partner and director of Buro Happold. **2000-2006** is Project Principal for the multi-disciplinary engineering design of Arsenal FC's Emirates Stadium. **2001-2006** Project Principal for the multi-disciplinary engineering design for redevelopment of Ascot racecourse. **2001-2007** Project Principal for The O2 Arena and entertainment complex beneath tented structure of the Millennium Dome. **2002-2005** Project Principal for the Olympic Skating Oval, Turin. **2002** appointed Fellow of the Institution of Civil Engineers. **2003** elected Fellow of The Royal Academy of Engineering. **2003-2004** Project Principal for the multi-disciplinary engineering concept phase of the Masterplan for the London 2012 Olympic bid. **2004** becomes Fellow of the Institution of Structural Engineers. **2005-2011** Project Principal for Lansdowne Road Stadium redevelopment, Dublin.

CONFINES OF THE ARENA

While there are certainly technical boundaries that Paul likes to explore, the other boundary conditions that he faces when working on such projects are the more prosaic roads, railway lines and rivers that often run around, and sometimes through, the sites he has to work on.

Take the Emirates Stadium for example. It didn't just have all those railways and roads to avoid, but Buro Happold also had to put up the stadium around existing businesses, including a waste transfer station. No chance, then, to tear everything down and build on an empty site. "While we were building the North half, the South half wasn't complete," explains Paul. They were moving the other businesses out. "We were putting a roof on the North stands without actually having built the support structure on the South."

"Every building has different boundary conditions," says Paul. So much so that they can determine the shape of the structure that you can put up. He illustrates this with more quick sketches of another sporting example, the Lansdowne Road Stadium, Dublin, the world's oldest international rugby ground.

ORGANIC STRUCTURES

Paul describes this project as "Petri-dish architecture". Once again, roads, railways lines and other bits of infrastructure restricted what Paul and his colleagues could do with the site. These boundary conditions played an important part in the decisions on what to put up. "It is another nice example of how boundary conditions can grow solutions. We didn't come along and say it will be thus. It grew itself from the site."

It is this need to think long and hard about what you can do on a site that makes Paul question computer generated architecture. Of course, he acknowledges, there is a role for techniques such as computerised modelling. But it has its drawbacks, one of which, paradoxically, is the speed with which things can happen.

COMPUTER AIDED DRAWBACKS

"That has got two bad side-effects," he says. "The first is that people often now model something before they think about it. It is so quick to get the answers now. It is almost like iteration by computer, which is disastrous. When it took two days to run one computer model, you made sure you were pretty confident about what was going to come out before you put it in!"

Go down that road, says Paul, and the computer can end up "with some very funny shapes and great inefficiencies". That is because you can leave the computer model to work out where all the loads will go in a structure. "You can end up designing by computer. The loads go where they go. I am very much an advocate of putting loads into places, rather than waiting to find out where they go and reacting to it."

JUMPING THE GUN

The speed of computerised modelling has a further drawback. Engineers can churn through design so quickly that customers expect instant results. One consequence of this can be that speed reduces the time that the engineer has in which to sit and think. This brings us back to Paul's sheets of paper and a constant refrain from his approach to structural engineering.

When beginning a new project, it is important, Paul insists, to start off with a blank sheet of paper. Engineers are great, he says, at getting very quickly to an answer to a client's problems. It takes them no time at all to come up with ideas.

"As an engineer you have been trained to think very fast, to solve problems incredibly quickly." An engineer has a palette of tools that they can throw at a challenge. Just pick from that and away you go. Not so fast – that is the way to churning out routine projects.

THINK TWICE

Starting with a blank sheet of paper opens up the imagination to new ideas. First though, you have to be prepared to "suspend disbelief", as Paul puts it. "A blank sheet of paper will cause a great deal of anxiety among lots of engineers," says Paul. They like to dig deeply into their knowledge of previous projects, familiar solutions and their standardised bits. But that path takes you down a predictable route to engineering that is little more than a commodity. When that happens, says Paul, "you fall into the trap of being seen as a commodity, then the value of your design will be what you can charge for it".

Think more imaginatively, says Paul. Show that your designs are efficient to construct, that you can reduce risks to the client during construction, and that your buildings are 'sustainable'. Design buildings that people like to work in. That's the way to prevent structural engineering from becoming a commodity.

SHARED CHALLENGES

You will only build that sort of building if you draw on the skills and expertise of a team, another of Paul's regular refrains. He doesn't want to fill those blank sheets of paper on his own. That is for the team to do. "The idea of single great engineers delivering jobs on their own is ancient. It is now done by highly specialised teams of individuals."

Then again, as in sport, there are teams and teams of engineers. On too many projects, says Paul, "the first time you meet is often on the first day on-the-job". People come together for one job, at the end they go off to do another job with another bunch of people that they have never met.

This approach is crazy, says Paul. He is a great believer in team continuity, not just within his own company, but with the architects, engineers, project managers and contractors.

INTUITIVE WORKS

This is one reason why Paul enjoys building stadiums. "One of the biggest attractions for me about spending time working in the sports market is that I get to work with certain people over and over again. I know how they think. That doesn't mean that you always come up with the same answers but it does mean that you are so much more efficient in what you do. You are respectful of what they can contribute, which means that you listen to them."

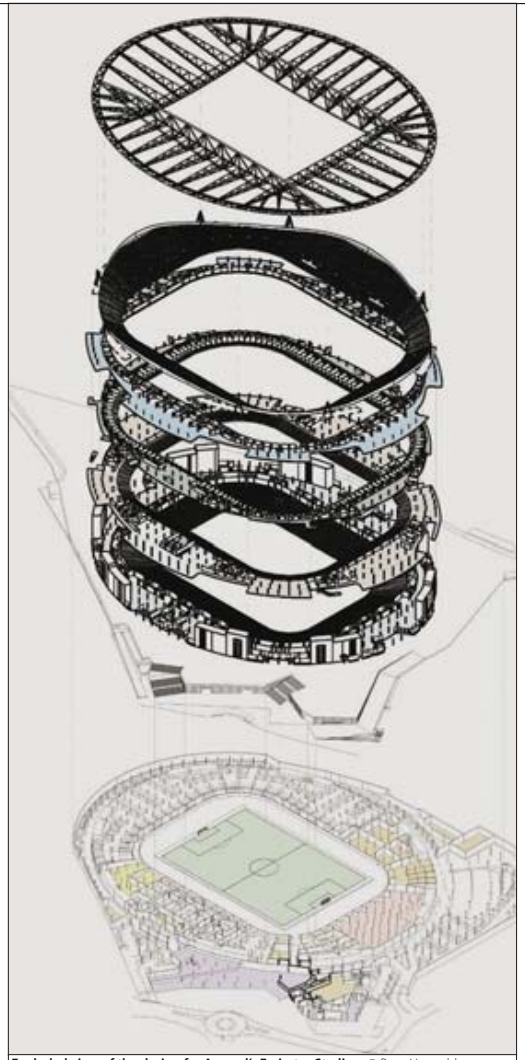
That makes the blank sheet of paper and the multi-disciplinary approach much easier. "You're far more willing to open yourself up to people that you know," says Paul. "It is a very much more non-adversarial approach."

You might think that this would give you an easy ride. Far from it, says Paul. "Because you're working in an environment where people know what you really can do, they expect it all the time. And because you are doing your best for your mates, you don't want to let them down, so you go the extra mile. What some people think is a protection racket is actually quite the opposite."

MORE THAN SPORT

Paul led the engineering team that helped to develop the Masterplan for the Lower Lea Valley – the overall concept for the wider area and its infrastructure, the urban design, before anyone starts thinking about the individual buildings and structures.

Paul's team actually developed two plans, one with and one without the London 2012 Games. We shouldn't look at the Lower Lea Valley solely in Games terms, he insists. "It is one of the most deprived areas close to a city centre that I can think of. The London 2012 Games will act as a catalyst for the regeneration of one of the poorest areas of Europe." The legacy, says Paul, will be "tremendous facilities and regeneration that will leave behind, we hope, a new revitalised area". It is for politicians to fight the battle to achieve that.



Exploded view of the design for Arsenal's Emirates Stadium © Buro Happold

BIOGRAPHY – Michael Kenward OBE

Michael Kenward has been a freelance writer since 1990 and is a member of the *Ingenia* Editorial Board. He is Editor-at-Large of *Science|Business* online magazine. Prior to this he worked on the New Scientist for 20 years and was editor of the magazine throughout the 1980s.