

## **04: Materials, performance and geometry – the designer as toolbuilder**

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Our brief is really research and development that is project-driven, but we develop tools and techniques and work flow. Although we started out trying to master all aspects of geometry, as soon as we got into linking digital information with simulation the field expanded very, very rapidly. We are also trying to disseminate these skills and techniques throughout the office. What tends to happen is that a project has a kind of work flow - they start out doing some design, get into some modelling and then do some analysis, but at some point they have to get down to drafting and scheduling, get it out of the door and get paid for it. Meanwhile, we are trying to go in the other direction, so we are starting at the bottom with people who have only basic 2D skills, we are layering that with 3D skills, on top of that advanced curves and surfaces, then feature-sized adaptive components and Generative Components (® Bentley Systems).

We have a lot of things to deal with, everything from form-making to evaluation, but some concerns that run underneath are things like how we can actually harness complexity and how we can make more effective use of skills in the team, which is about distributed design. We have to think quite seriously, not just about the design of the building, but also about the design of logic because a lot of the things we do are to do with modelling intelligence. If you get that far, serious issues of managing work flow come up but ultimately the more you begin to get this right, the more the practice begins to behave as a kind of collective intelligence. This is very, very stimulating; this is where the real payback is.

We use a lot of tools and techniques - a lot of them are customised because when we are faced with new analysis problems there aren't the tools available in the market-place. The analysis tools that are coming in to us are growing very, very rapidly – particularly urban micro-climate analysis.

Currently we can generate far more options than we have time to evaluate, and that is a very big change, so this is really one of the driving forces and that is why we are devoting so much attention to generative techniques because it allows you to navigate up the nest levels and to get more control, so that you can have a directed approach.

Of course, all this has to work at the team level so part of the research that has come out this year is a new interface for project review. It is called Optioneer. It flashes up multiple option studies and you can navigate very quickly between different views and different options. It is stored as a kind of N-dimensional movie linked to a database, but it converts very rapid design sections. We have also started using it to trawl into a review session, not just geometry or visualisation but also analysis, so the whole design configuration is presented for what it is good at, which is really as a stimulus and as a focus.

Another aspect of research comes from our fascination with advanced interfaces and part of our work with UCL has been to collaborate in the ARTHUR project, which is an experiment in augmented reality. One of the nice things about it was all the people it brought us into contact with – particularly a small architectural practice from

Germany which was intentionally brought into the group as a kind of counterpart to our input.

The idea of harnessing complexity really throws up problems about the approach to rationale. I gave a presentation about a year ago to the Royal Society of Arts where I said you could look at it in terms of projects that are pre-rationalised, post-rationalised or embedded rationale. This was picked up by Mark Burry, who is Professor of Innovation at RMIT. Last week, back came an email from one of his students who was doing an amazing piece of research and he had actually taken that idea to give him a framework. The spin-offs from research, therefore, are quite amazing in the way they ripple around the globe.

What we are looking at next is the idea of smart planning systems so that an adaptive component will adapt to its context but it will also respond to its environment. This is a kind of generation system – it is not that we are trying to do people out of a job, it is just that we are trying to throw up possibilities where we can make very rapid comparisons in order to get a steer.

We used the same technique, applied onto what looks like a random freeform surface and, surprisingly, it seems to handle it just as well. If you were to actually go and look at it, most of you would probably start thinking this does not make sense because the panels cannot be flat – there they all are, perfectly detailed, nicely controlled, and they are all flat because the surface was generated with a macro that does a scale translation surface. We often try to embed our surfaces with rationale so that things like natural flat panel solutions are part of it, because all the time when we are trying to step down through the scales we are looking at this thing and we start with context, then we get down to carrier, then we get down to component. It is this ability to navigate the next level that is going to make a real difference.

We did some very early work using the design of logic at Beijing Airport. Currently there are 30,000 people on the site and the building is 3 km long – when you are at one end you cannot see the other; not just because it is so long, it is because the air pollution is so bad. This surface that was generated is also creating XYZ co-ordinates for 30,000 space frame nodes, so obviously the Chinese have the situation well in hand – they have 5,000 who do not need to do anything because all the rest of them have one node each.

In terms of this modelling intelligence we are doing a lot of work with Bentley Systems and looking at the new platform and Generative Components. Because of the things it offers us, being object-based gives a good handle into object hierarchy and properties. Most buildings are actually a dialogue between arrays, and collections and indexing allow you to actually address that. Constraint management has always been a strong part of our brief but we often need a softer approach, so the idea of a system that supports conditionals at its simplest level – if you find this do something, if you find something else do another thing - conceptually gives you the ability to do branching and that is eventually what leads to responsive architecture. We do a lot of managing work flow. Collective intelligence I have already dealt with, but links to digital fabricators are very important to us, both at the model building scale and at the construction scale, and our links to other specialist groups, inside and outside, are essential.

Smart Geometry is an organisation that was formed two years ago and really dedicated to bringing together the worlds of practice, education and research. We run very

experimental workshops. The last one at ACADIA in 2004 was very successful, and we are planning another one which will be in Cambridge in late January. If you have not heard of us, look at SmartGeometry.com. We had 12 tutors and 40 students. Interestingly, two of those students were actually professors. When we select people to come on the course our selection process is very simple; we just ask them to pose a problem and in this way we pick off who all the challenging thinkers are.

Having had the experience of the workshop at ACADIA, where the theme for the conference was *Digital Fabrication and Rapid Prototyping* and where one of the sponsors was Zecor, we now have our own Zecor 510 in the office. We do Space frames by the bucket-load, massing studies are also very, very useful to us. The machine prints at about an inch an hour so nothing can ever take more than one night; this has become part of our work flow and suddenly the magic is not locked in the box any more, it is out on the bench, which has totally transformed the way that we think and work and everybody loves it. We stack the machine up for an overnight run with six projects in it because if it is going to run all night it might as well process everything you can cram in there. Coming out of the system it is then sprayed with a fixer and then it is pretty well ready to go. We only use this for rapid proto-typing; we use it for what it is good at.

Most importantly I always try to think in terms of metaphor, that is why I like Design as Research, because we have our own set which are: geometry as a mechanism, sketch as a metaphor, rationale as a strategy, curvature as rate of change, rules as proportional relationships, architecture as a team game and the last one from my mentor, Tom Maver, computers as amplifies the intellect.

I am picking up on a quote which was “We must throw away the legacy of post and beam construction and start to see every point of curvature as a structural opportunity”. We have just amplified that because, to us, every point of curvature represents multiple opportunities and they are spatial, sculptural, structural and sustainable.