12 QUESTIONS FOR JAMES O'CALLAGHAN

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On the 22nd of March we had the opportunity of having a very insightful interview with James O'Callaghan, currently Visiting Professor at Delft University of Technology. Read further to dive into innovative glass structures, sustainability, collaboration and the future of young engineers.

1. A lot of people consider glass structures, and especially the Apple stores, as your trademark. How did you first get involved with structural glass?

I first got involved with structural glass in 1995, which seems like a long time ago now. I was involved because I worked for a structural engineering company in London, called Dewhurst Macfarlane & Partners, very much at the forefront of exploring what you can do with glass structures. A little bit like Rob Nijsse here, Tim Macfarlane was my mentor at the time and I was playing around with his ideas about using glass as a structural element. I suppose because I was working with him, completely coincidentally, I began to understand the idea and saw the potential in it. What I was most intrigued about was the development of the connections. I saw that these were a more important aspect of structural glass design than the elements themselves. That drew me into it more and more and then we were lucky enough, within my time, to do some pretty iconic and valid progressive structures. Which then led to Apple, when I was doing my own practice, and years later that sort of theme in my involvement in engineering continued through them. The reason that glass is with Apple is not because they came to us about glass. In fact, it is because we brought glass to them.

2. So how did the approach happen? Was it the architect that came to you with a glass idea or was it the other way round?

Yes. Well, the architect certainly came to us with an idea about the retail space that we were looking at, and how to make the most of that space. The concept of the glass came out of that. It started off as a steel stair, with glass elements in it, and it evolved into a fully glass structure, really through Apple's determination that they wanted it to be more ambitious than perhaps the ideas presenting a steel and glass stair. So, they drove it to that point, but they only did so on the basis that they knew they could get there, because they had the right people, the architect with the right idea, and the engineer with the right knowledge to be able to make that happen. So it was a very collaborative process, really, to get to that point. You can't do things like that without a brave client, without a great supply chain and people to work with, architects, designers, etc. Thankfully, all those people came together and that's how it started!

3. Would you say this is your most ambitious design to date, the design that you started with, or have there been more ambitious ever since?

That's a very good question. You know, you can always look at things in perspective but of course, when we first did it, it was an incredibly ambitious thing. It's a very good question about whether anything we do today, will ever feel like as it did back then. The sure answer of course is no, everything we do now has that history baked into it and that experience baked into it, so we are able to push the boundaries a little bit more each time. So of course what we do now is far more technically ambitious than we did then, but does it feel like it is? Well, maybe not.

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4. So what is the most ambitious design you are working on these days?

Well, we are working on a number of projects that we cannot really talk about, most of the things that we do these days we must not talk about to respect the wishes of our clients! We are working on some rather big ideas, taking the same ideas, and making them bigger, on bigger buildings, with more transparency, higher complexity; in the way in which we connect things and we deal with energy, solar gain and things like that. We are doing a very nice project in London, one thing that I can talk about, for two glass bridges between two existing buildings. It is a box bridge, a roof of carbon fibre, walls of

glass, and a deck of stainless steel. None of this is cladding, all the elements working as the envelope and as the structure, so the result was a very fine, very thin profile. So that one is in the public domain, other things are a bit more protected I am afraid.

5. Since you mentioned sustainability, are you concerned with sustainability in your work and how does this reflect in the glass structures?

Yes! I think the sustainability theme has been around for a long while, but it certainly gathered momentum in the last few years, so that it now impacts pretty much everything we are doing. So what we found is that we have been focusing on glass and the structural performance of glass, the size, the transparency and we have met a point at which the control of energy is currently prohibiting further development without more of a development on how we control the energy within buildings. So now, we definitely have a focus on how to make our buildings more sustainable in terms of their energy. I think it is firstly about the whole building's design, how a building can be 'intelligent' in terms of the use of light and recognize that south facing glass buildings in the northern hemisphere are not going to be easy. Of course the technology on the glass itself needs to be improved, to find more effective coatings and ways of controlling heat. We are no longer trying to find more complex mechanical shading devices, the world has enough of those already. It is more about how we can make glass take that role and how you combine that with more intelligent architecture.

6. What is set as the final goal in structures like this? Is it only directed towards maximum transparency or are there other objectives?

I think maximum transparency is nice, but it is only maximum transparency when you want it; I mean nobody wants to live in a glass house! So it is the application, it is making this dynamic environment comfortable so that you have as much light as you want when you need it. That has got to be the goal for most glass applications. Of course, that is when we are talking about a building envelope, but we are also using glass in so many ways, such as a bridge or a staircase, which have more of a feature about them. So in terms of that point, the end goal is, without reinventing the material in itself (which would be great because it has so many flaws) how we can improve the connectivity and the opacity in order to get to a truly all glass structure. An all glass structure which can accommodate all form of geometry, in any complexity, under any load is where we are getting to.

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7. How does a brittle material like glass behave in earthquake sensitive areas? For example, in the case of the glass staircase in Los Angeles, the hanging construction allows for lateral sway. How much can the staircase deflect in lateral direction? How are the connections resisting these deflections?

The best performing seismic structures have the ability to absorb energy. So steel and concrete are detailed in certain ways to dissipate energy from natural accelerations in order for the structure itself to not be overdesigned to accommodate these significant forces. In glass you cannot easily do that because glass has zero plasticity. It is a 100% elastic material which means that it will 'feel' the full force of that earthquake and it can only be designed as such. The way you accommodate it is, in the case of a free standing structure, that you have to detail it such that the rigid elements can move and in turn dissipate energy, relatively to one another. That tends to be within the detailing of the connections, rather than in the glass itself. The staircase for example, is not a structural element; it is an element hanging within a structure, so its detailing has been made so that these movements can be accommodated. Firstly, knowing what the movements will be, what that means to the detailing, but also what that means to the forces that will get imposed on the glass. So it is kind of an iterative loop of understanding movement, detailing, and forces being put to structures as a result of this movement.

8. Where do you see glass architecture going in the future? Which seems like the most promising innovation?

We have talked a lot really in terms of what we see the future as. Glass is generally used as a building envelope material. That is where innovation needs to be, in more dynamic glazing. That is the only way we can start responding to the changing agenda of sustainability and the rapidly changing energy codes. Otherwise, in 10 years' time every building will have 40-50% less glazing, which is going to be not only more miserable for us, but also more miserable for the glass people, who will need to produce 40% less glass. So it is quite an agenda for them to be able to solve the problem too, otherwise the glass industry is going to be in decline for a long time. Those are real issues that are very challenging, because it took us 60 years to reach where we are, and we have to solve whole other problems within 10 years. Accelerating that technology in that period of time will be very difficult.

9. But as far as the structural properties of glass are concerned do you think there is room for improvement?

We have talked a lot about thin glass. That is an area we have been involved in for 3-4 years now. Finding applications for that has been difficult, but probably because thin glass needs to be combined with other elements, e.g. composites. We need to

find applications where we can use much thinner glass, which is lighter and more sustainable and therefore more transparent. You can combine it with other technologies, and since it comes from an electronics background, we should be embracing the fact that you can get 4K television which is basically on LCD glass, and yet we can barely put a frit on a window! So we have to somehow figure out how that technology moves from one to the other, in the built environment and how we can embrace that. There are a lot of great ideas. So I think that there is innovation in the material in terms of thin glass, and how you combine it with other materials.
With the glass itself – less so, probably. There could be, but it is an economic challenge to reinvent the way the glass is made, because it needs such a huge infrastructure that exists in float lines all around the world. Changing the recipe and changing the process is more expensive than inconceivable. But you know, it would be a good idea to do it. We are still making glass in the same way we did 60 years ago which seems to me fairly unprogressive. Relatively speaking, we managed to progress many things we can do with the raw material but we have not managed to progress the raw material itself. That is a challenge for the material scientists of the world to solve.

10. How do climate conditions affect glass structures, for example in climates with cold winters and warm summers? Is the extreme change of temperatures a problem for glass structures?

Yes, I think there is a number of problems. The glass itself is pretty stable at most temperatures where human beings live. So the substrate is fine. It tends

to be the materials we laminate with that have the problem, the polymers that bond the glass together. They have relatively limited temperature range. In fact, they are really problematic even within the temperature range we live in as human beings. So most of them at around 50oC change dramatically, and below 10oC quite a bit. While the ambient temperature is never more than 40oC in the desert, obviously the heat that the glass absorbs heats it up, so its temperature can reach 80-90oC, which actually is quite problematic for the interlayers that we use. Even now that is a problem, and there is not a solution to that yet. The highest bound interlayers are around 50-60oC, and the current polymer formulas do not seem to be changing that dramatically. Thankfully, that is not that extreme when you are using glass, but it is a challenge. In terms of physically responding to different climates it is again a question of how you are detailing it, and not using certain types of materials when you are in that type of scenario. There may not be an answer when you need to make a laminated roof panel in the middle of the Sahara Desert. Particularly if you are doing things on the glass, like putting coatings on it to keep the sun out and digitally printing it to reduce the solar gain. All you are then doing is actually creating something that is absorbing more heat. So the glass becomes hotter and hotter, so there are points when it just does not work. But you know there is not an awful lot of demand for glass structures in the Sahara Desert or the Arctic. Most of them are in areas in which we live, and thankfully we live in areas which do not have particularly extreme climates, from a temperature standpoint. From a wind and hurricane standpoint, the question is more relevant today, because the codes are changing. We are finding that we are designing structures to withstand higher forces, so as to respond within the codes, to what we see as natural progression in heavier storms, more wind etc. So again it is a mathematical issue. We end up with the glass getting thicker the connections getting bigger, as

you have to absorb more forces.

11. You have been working with some very demanding architectural designs. To what extend do you believe that the collaboration between architects and structural engineers can be productive and feasible?

I think it is beyond that. I think any architecture that does not have a productive collaboration with an engineer is not fulfilling its potential for good design. My whole working life has been fundamentally based on my relationship with architects. My understanding for architecture, my appreciation of architecture, my complete drive to make the ambitions of an architect work, and at the same time bringing pragmatism to that design, bringing economic feasibility to that design, bringing creative innovation to that design. That is what I believe structural engineers and architects should be doing together. Let's not forget that structural engineers and disciplines outside of architecture were once all within architecture. So to ask the question of it being feasible, you need to look back to the beginning and see that actually you were the same person. You still should be the same person, and if you are not then you are not doing your job properly.

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12. And a last question for us, young engineers. What would your advice be for young engineers in their beginning of their career?

Take up banking! (Laughs)

Actually some consider that change already!

Too many of you do that, which is a shame! It is far less creative. Perhaps in the good old days of banking when you could do anything, it was more creative. Nowadays it is not a creative field, there is too much legislation so it is not even interesting anymore. (Laughs)

It is a very difficult question actually, because I employ a lot of young engineers. I think that is very important to keep your knowledge broad. If you are in the field of Civil and Structural Engineering, look outside of what you are doing to what other people are doing, and let those influences come into what you are doing. I have obviously been working for many years now, to look back, to look at myself even at that period of time, I think that my sight was too narrow. I did not fully understand in the beginning enough about architecture. That came later in my professional development, and it would have been better if it was earlier in my development. At the end of the day, a big part of a structural engineer's job is to facilitate architecture, so you should understand architecture. If you are an architect, the converse is true. You should understand what your engineers are trying to bring to you earlier in the game. You can spend forever focusing on form and function and Rhino models, but I think it is quite of importance to have an appreciation of the wider role.

For me, as an engineer, I think is really important to be very strong analytically. The most successful engineers that I work with come at least from a very strong analytical background. That is something that is a building block, which you can work on. The element of creativity is also really important. Doing what you can to be as strong as you can analytically, but remembering that you are an engineer and an engineer is about solving problems. It is not about doing math or being asked how big is this beam, or how big is this duct, or how big is this pipe. It is about asking the question, about why you need the beam, or why you need the duct, or why you need the pipe. You cannot get through life just by sizing things. That is not really what the game is about.

Travel around the world, try to understand it. Understand how people do things in different parts of the world. I did that a lot. That benefited me hugely. I lived in Asia, I lived in America and I lived in Europe, and I worked in all those places, seeing how people engineer and solve things in different parts of the world. It brings you a much wider and diverse picture, to how you might go about doing things in your own little world. That helped me a lot.

Thank you for the advice and thank you for the interview also.