

Construction as Theatre

Live event held 9th July 2020

Beautiful sculptures and buildings provide a wonderful experience. Can they be equally fascinating during construction?

Watch Sculptor Antony Gormley RA, designer Thomas Heatherwick RDI and our Deputy Chair, Engineer Tristram Carfrae RDI, discuss this absorbing subject, in a live event hosted recently by Sarah Douglas, editor of Wallpaper.

<https://www.arup.com/perspectives/construction-as-theatre>

The trio took attendees on a behind-the-scenes look at some of their most famous projects: The Angel of the North in the UK, The Vessel in New York City, and La Sagrada Familia in Barcelona.

Antony Gormley, Thomas Heatherwick and Tristram Carfrae answer questions from the event:

The way you talk about the construction process is exciting, you can clearly see the passion so much so, that it appears an art form. How would you suggest displaying this art to an audience?

I think that this is the topic at hand, and that there are many possibilities ranging from: getting the audience involved with the construction process; or holding performances within the construction site; through providing a viewing area and orchestrating the construction process; to simply making a really good film of the process.

Do you think the concept of Construction as Theatre would benefit from adding e.g. special lighting or music? Also, in what ways can we make refurbishment as theatre e.g. when redeveloping office spaces or airports?

I think the term construction includes adaptation and refurbishment. And the first thing would be to involve creative people, to improve the theatrical properties of construction.

Have you spoken with any theatre-makers about construction as a theatrical event? I design and build scenery for theatre and opera, and my first question when working is "what story are we telling?" What story is architectural construction telling? Is there a narrative? by building bleachers to watch construction, are you actually creating a general "entertainment" instead of true theatre?

I must now confess ignorance in not understanding the difference between entertainment and theatre. Perhaps the title for this event should have been 'Construction as Entertainment'?

What potential might there be to use construction sites/projects as 'temporal stages' in which other art forms can interact and respond to different stages of construction? Could other artists even be involved in conceptual discussions, shaping opportunities to bring life to structures before they are completed?

Yes, it would be brilliant if they were.

These projects are such huge parts of peoples' lives and full of stories, much like a 'play'. How do you think the presenting of these 'plays' will affect public opinion of construction, and will it encourage and excite people to pursue construction?

I hope that it would transform construction's reputation, from necessary nuisance to public benefit. I also hope that this would draw a wider range of people into construction.

Construction as a theatre is a great concept. A show at a theatre has so many levels of performance; acting, dancing, music, lights and so on. Putting the pieces together on a construction site is maybe equivalent to mime? What are your ideas about how the 'full' show can be created so it has maximum effect? Does it also provide the opportunity to enhance diversity within engineering and construction by moving from STEM to STEAM and utilising skills from the arts industry?

As per previous answer, I see a great opportunity to broaden the range of people involved with construction. Please note that you listened to a STEAM panel this evening.

Following with the analogy of construction as theatre, it seems like there is a duality between construction being either the 'stage' (the space in which things will happen) or the 'play' (the action or spectacle itself), or at times both. What are the thoughts navigating these two aspects?

I simply see both as opportunities. Each, or both, to be pursued as best fits any particular construction project.

All of the projects we see here are pre-fabricated and assembled on site. Do you believe that this is a key component that makes "Construction as Theatre" possible?

In monuments like the Alignments at Carnac, New Grange or Stonehenge, the collective energy and collective will of the early farmers was brought together to make places of connection between human and sidereal time. The sense of common purpose would have allowed the repetitive rhythmic labour of digging, hauling, stacking to have ritual resonance. With the Angel, I hoped that the repetitive tasks of industrial fabrication would become the Gregorian chant or mantra of the work. It was assisted by digital design, but hand built.

Modernist assurance of the value of machine making tends to re-enforce function over feel and repeat over riff. Buildings can make you feel joy or dread. It seems to me that any maker of structure should favour joy and make our machines sing for us.

For Sagrada, I think that offsite fabrication and onsite assembly gives greater scope for construction as theatre, but it is not necessarily a pre-requisite.

Interestingly each example, Sagrada Familia, Vessel and the Angel of the North all feel they have a spiritual dimension/ role to play. They act as places of meaning for individuals and society. Thinking about other (much older) examples like Stonehenge or the Giza pyramid complex, their magic and resonance seem to be naturally linked to the impossibility of their construction. I wonder whether these types of things become Construction as Ritual or Symbolism instead of theatre.

The raising of the body of the Angel with the choreography of the three teams; the engineers in red, the lifting crew in yellow and the mechanics in blue and the fitting of the feet to the foundation template with the tightening down of the fifty odd massive nuts with long handles torque spanners.

What was/has been your favourite or most significant "scene"/moment of each of the "theatrical plays"/projects presented?

For Sagrada, the most significant scene was erecting the first panel on the Mary Tower and finding that we could indeed assemble panels successfully with +/-1mm tolerance and no adjustment. But I think the very best scenes are yet to come. I have no doubt that mounting the habitable cross on top of the Jesus Tower will be a highlight.

For Angel of the North, everyone on the site that day in February 1998 knew that they were being watched, not just by the gathered crowd, but also by the nation through the television crews assembled. There had been no rehearsal but there was a collective sense that this was a play and the real story happening simultaneously.

How do you think Gaudi would have reacted to how Sagrada Familia is now being constructed compared to how he originally envisaged? Do you think he would have been impressed or would he disapprove?

I think that he would have simply accepted it as “the way things are done today”. He was very progressive and, for example, used new-fangled reinforced concrete in the spires of the nativity bell towers in the 1920s.

Have accumulating changes in building regulations in Barcelona over the hundreds of years affected the design and the structure of La Sagrada Familia?

Yes they have, the most obvious example being the more recent requirement to design the church for earthquake loads.

What's the best construction method that can be used for high rise condos today? Or rather, what's being explored currently and will be applied in the future?

My observation is that construction methods vary around the world from RC frames, through precast concrete to steel frames with composite concrete floors and steel frames with timber floors. I have no doubt that timber exhibits many advantages: positive carbon, lightweight, easy to machine; but we need to do more full-scale fire tests in order to better understand its behaviour in fire scenarios.

Pavilions and temporary buildings are built up fast and dramatically. Do you find value in doing them? As a pavilion designer and builder myself, I am always asked if people can participate with me to construct them. If you had a very public project, would you be open to allow people to watch the build-up in action, or even consider the public to participate in making them?

Speed of construction is obviously beneficial in providing drama. But all construction can be made faster using an offsite manufacturing and onsite assembly approach. For specialist installations, I think we should explore the idea of public participation. We join with local communities to construct bridges through the charity Bridges to Prosperity.

Many children grow up wanting to be actors, do you think it might help boost those interested in working as engineers and architects if construction took the stage in this way?

I think that treating construction as theatre would make construction more attractive to a broader range of people.

Antony, how do you choose your landscape? Especially when you chose to exhibit your work on the ancient Island Delos.

Some sites are given, like the mound at the Teem Valley colliery site on which the Angel sits, others I have to find. On Delos it was a question of dousing the whole island and trying to understand not just its human and sacred history, but its geology and its relationship to the islands around it. Delos is an extraordinarily unlikely place for a site of national ritual life and the birthplace of a god. It is essentially a waterless, treeless rock surrounded by verdant islands on all sides. Placing more lifelike works both in the sea, and on promontories looking out across the sea to those other Cycladic islands, was the compliment to finding resonant sites within the ruins, that could act as foci for the contemplation of human history and its structures, sacred and profane.

It's interesting to hear Thomas and Antony talk about building/making at a person scale first, and to some extent as an individual pursuit. Should structural engineers be taught to operate at this scale on their own projects, before going to larger scales and group working?

As a structural engineer, I think that this is a very interesting question. I remain perplexed by the lack of interest in “making” (working at an even more intimate scale) in the structural community, let alone at a human/residential scale. We seem content with the elastic scale of the virtual world.

Creating, making things and getting fully and passionately involved is extraordinary! Personally, I'd love to be able to do/make more but with liabilities/etc it becomes a real challenging. How do you overcome this?

With courage to challenge the status quo if you see a better way of doing something.

Antony - do you still hear, or do you have a favourite example, of feedback from the local community on their connection to the angel? It was lovely hearing about how connected it is to its situation.

I am constantly delighted and encouraged by the affection with which the people of the Northeast have taken the Angel as one of their own. It is rarely alone in daylight hours. I have often been told that passing the Angel is the sign of homecoming for many. The fact that it has become a place where the ashes of loved ones can be scattered, and weddings performed makes it a place of remembrance and continuance.

Can the construction process be used to display a moral message, such as the importance and need for sustainable development?

It would be brilliant if it did. I think that offsite manufacturing and onsite assembly favours both construction as theatre, and the use of timber for example, can significantly reduce the embodied carbon of construction. Maybe every component lifted into place should have a QR code printed on it so that we can all “see” how much carbon is embodied in it?

It is so exciting to hear about the work and experiences of everyone when being part of all these projects. I was wondering.... how would you argue the importance of all these type of projects for our society nowadays?

I think that we always need inspirational exemplar projects. Even if the “heavy lifting” is actually done by the more common types of construction.

I like the conversation about the stories around construction. I think that stories need a hero. Likewise, leaders are so important in construction. What do you think about construction leadership and do you think there should be more stories about problems on the site and the leadership involved with solving those problems?

We definitely need more and better stories. But I would say we need more wisdom rather than more heroes. Stories of problems are always beneficial but also very hard to promulgate publicly.

English Heritage open up their projects to the public by including public access walkways in their projects, could this be a model for large projects?

I think that is a brilliant idea. Even if you cannot give full access to the public, as we do at Sagrada, you potentially can find places that they can access.

Is the giant angel for using or for decoration?

The angel is for seeing and for being touched. Having been seen and touched it will then live in your mind. Material objects live in both the palpable and the imaginative realms, and in both places they change the situation.

How long did the giant angel take to build?

Six months to build, one day to erect.

What structural analysis software do you use to analyse and design something like Sagrada Familia?

We use OASYS GSA as our primary linear FE analysis, from which we abstract the forces in various components. We have developed a bespoke 3D thrust zone analysis to check the masonry itself. We also use LS-Dyna for nonlinear time-history analyses to check seismic behaviour. Our Catalan collaborators 2BMFG use ANSYS and other FE software that allows us to cross-check each other's work.

Do we know how the durability of a stone + steel structure compares to the traditional, all-stone construction?

All the steel embedded in the stone is a high-grade duplex stainless steel (1.4462 – 2205). We believe that this stone + steel hybrid should have similar durability to an all stone construction.

Why use lifting chains through the arches rather than designed lifting points?

The main lifting chains were attached to designed lifting eyes bolted to the steel anchor blocks. The chains through the arches were secondary back-up chains.

Can you really be called a truly great architect if your building is more than 100 years late, and who knows how much over budget, whatever that was? Surely, we all have to work to some sort of programme?

Even during his lifetime, it was acknowledged that the church would take several generations to complete, as its construction rate was dependent on private donations; so I don't think that it is either late, or overbudget. We are currently working to a 2026 completion date, but this may be affected by the Covid-19 pandemic.

Why not make few segments instead of 25t single piece because it was very challenging to hoist?

The Sagrada construction team prefer fewer, larger lifts – provided they are within the capacity of the tower crane. The 25T panels take a similar time to install as the 5T panels.

Greetings from Indonesia. What do you think is the best way to convince people in a third world country, who still think pouring concrete using in-situ casting is the best way and won't shift to using precast concrete?

Personally, I have little experience of construction in Indonesia. But in principle, we all should pursue methods of construction that are both faster and cheaper.

Have loadings been allowed in the foundation before construction begin?

Apart from the crypt, the foundations were designed for a full masonry construction. The prefabricated post-tensioned stone panels reduce the weight of the towers by a factor of three.

An excellent talk. I was wondering if the use of modular construction blocks as you showed in the construction of the Sagrada Familia could be combined with augmented reality, would it be feasible for example to overlay an AR representation of the final structure on to the construction site, available for anyone walking by as an app?

The Sagrada architects already use a lot of VR (as well as 3D printed models) during design. It should be technically feasible to extend these into AR on site.

In the scenario where modular components are being prepared off-site, are there any advantages in terms of decreased absolute amount of traffic to the site?

Yes, there are advantages in terms of city traffic, and in reducing the amount of site space used for construction, which becomes increasingly scarce as construction reaches completion.

Very interesting topic. How do you picture an audience in a construction site with so many safety rules? Sorry for my naive question.

I think that forays by an audience into an “ordinary” construction site might be rare and pre-arranged. But every site could have a small seating area just outside the site (or separated from the actual construction activity) complete with a temporary café.

Regarding Sagrada Familia, how faithful is the implementation of the towers to the original Gaudi design? How did the original geometry feed into the parametric modelling and fabrication?

The geometry of the towers has been extrapolated using Grasshopper and Rhino from one of the few surviving Gaudi plaster models of the Sacristy. They consist of intersecting Hyperbolic Paraboloids rotated about a vertical axis. The windows are formed by the generatrices of the Hypars.

Thank you Tristram for the presentation. I love the idea of inviting people to witness the magic of modern construction. My question - How can I and other students of architecture, engineering, construction and sustainability help the likes of Arup to create a mechanism to engage the enthusiasm of the community as creators? Thank you!

Please get in touch and let's see what we can do.