

## SOLUTIONS

# Pumping up the drama

An inflatable extension to a German theatre, designed by a team from the AA's new Interprofessional Studio, had to overcome the attentions of a concerned local authority, reports **Amanda Birch**

Perhaps if the design team from the Architectural Association had simply described its inflatable structure as a "bouncy castle" it may not have had such a tortuous time getting planning approval.

The team had designed the temporary extension to a theatre for the central German town of Jena as part of a festival marking 90 years of the Bauhaus. But just a few weeks before it was set to be put up, the local council demanded a more detailed set of calculations together with a full 3D analysis model and a spreadsheet checking every element of the structure.

Through sheer determination to see the extension in place, the team, including Steve Webb, director of Webb Yates Engineers, was able to produce the extra material in time.

"The information we had to supply exceeded what we would normally produce in the UK," says Webb. "Maybe because it was to be attached to a theatre, psychologically it appears as a more permanent building and was therefore treated more seriously. There are also no codes for inflatable design and so everything had to be derived from first principles."

The German Crash! Boom!



The extension, made from 3,000sq m of PVC-coated polyester weave, is prepared for its inflation.

Bau! festival marked the Bauhaus anniversary with theatre, installations and workshops. All the projects focus on unusual ways of dealing with space — with the stage, the relation between action and perception, and interdisciplinary approaches between stage design, media art, and architecture.

The €30,000 (£25,883) inflatable was the brainchild of architect Theo Lorenz, course director of the AA's newly established Interprofessional Studio (AAIS), and urban designer Tanja Seims, studio master of the course. The course is for existing professionals in architecture-related fields such as engineering, the arts or design, who wish to move outside their existing professional lives, for the purpose of expanding their ability and experience through a multidisciplinary project.

On the first day of the AAIS course, January 12 this year, Lorenz and Seims set an exacting brief for their nine students together with five students from the AA's Emerging Technologies course: they had a week to decide a design process, determine the material the inflatable should be made from and find a suitable manufacturer. Other considerations were a very tight construction programme and the inevitable restricted budget.

To their credit they fulfilled the brief and chose Inflate, London-based designer of bespoke inflatables and temporary architecture, to manufacture the 300sq m structure — one of the largest structures Inflate has ever made.

The result, says Seims, is "the biggest, the cheapest and the fastest [it had a three-month programme for its design, planning and erection] public building the AA has ever done,



## GROUND FLOOR PLAN



certainly in the last 10 or 20 years."

The site for the inflatable was the Theaterhaus Jena, designed by Walter Gropius and completed in 1922. The building was remodelled in the late 1940s, then partially demolished in the mid-1980s. These alterations have reduced its capacity from 700 to 200 and removed its original main entrance, so that now only locals know how to get inside.

To give the theatre's entrance some legibility, the inflatable structure was situated on an elevation of the building where there is an existing metal roller shutter door, and positioned below a permanent 95m-long membrane covering that stretches between two sides of the building.

Two main inflatable structures were designed for this site, their form generated by the axis of the theatre: an inner 9m x 9m x 8m-tall box provided tiered seating for 70 people and faced the main stage, also offering protection from the wind and rain; and a wider 20m x 20m x 9.5m-tall

## AIR AS ART

Over the course of the three weeks that the inflatable extension was in place, AAIS participants created and performed six scenography performances as part of the Crash! Boom! Bau! festival.

Each performance was in some way related to the building and one in particular, by Italian product designer Laura Boffi, was intended to link the inflatable lobby in Jena back to the UK using a "respiratory dress", in which an aquatic plant was kept in a translucent bag down

the front of the garment.

The same style and material used in the inflatable lobby was used in the design of the dress, immediately linking them to each other. Her performance involved wandering around the town of Jena asking residents to breathe down a tube attached to a pump hidden beneath her dress that kept the dress inflated and the plant alive.

Mollie Shomali

Breath-taking:  
Laura Boffi's dress project





Client Theaterhaus Jena, Architect Interprofessional Studio (AAIS) with Emerging Technologies (Emtech), Architectural Association, Structural engineer Webb Yates Engineers, Manufacturer Inflate



The inflated extension in place at the Jena theatre.

## 'STABILITY WAS KEY', SAYS ENGINEER STEVE WEBB

**Steve Webb, director of Webb Yates Engineers, explains the complexities of the inflatable structure's static design.**

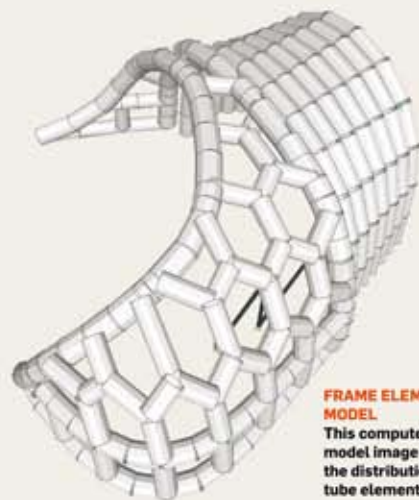


We design a lot of structures with Inflate that are very similar to the inflatable theatre extension in Jena. In general, the forms of the buildings we work with are simple domes or cubes and so quite easy to assess structurally.

Normally with temporary inflatable structures, our chief concerns are to ensure that the structure will not be lifted off the ground or blown along by the wind, as this would be extremely dangerous for any people in the vicinity.

The behaviour of complex inflatables in the wind is extremely difficult to assess accurately. They are subject to many unknowns, such as how the wind reacts with the form in its location and local turbulence. They respond to forces in a complex way — as the shape changes, the way the wind loads them changes and the strength of the structure changes. When one part of an inflatable is overloaded, another part may become stronger, or not. It is also difficult to be certain of what the internal pressure will be which is critical to the load carrying capacity of the tubes. In the end, we normally adopt an approach that combines an approximate analysis of the performance of the inflatable in combination with an assessment of the risks to people presented by the particular structure and its use.

We were responsible for the static design of the Jena structure. We were given the geometry and wind speed requirements by the AAIS design team and had to try to prove that the structure would stay standing. The outer shell was a complex shape, and within the shell a complex honeycombed grid structure



**FRAME ELEMENT MODEL**  
This computer model image shows the distribution of tube elements.



**AREA ELEMENT MODEL**  
The inflatable structure is made up of a combination of tube elements and skin elements. This computer model shows the distribution of the skin elements.



**STRESS ANALYSIS MODEL**  
The final image shows the stress distribution within the diaphragm shell. Purple and red denote areas of low stress and the blues and greens show the areas of high stress.

was used. The local authority in Jena required a very thorough set of calculations and demanded that the structure remained stable in high wind loads. There are no codes for inflatable design and so everything had to be derived from first principles. After having our deadline extended twice, we were able to put together a model and develop a spreadsheet to perform design checks for

each and every element simultaneously that satisfied the local engineers. In order to get the structure to work adequately we had to push Inflate to increase the internal pressures beyond what would normally be required.

The structure was eventually fabricated and erected and stood up as we said it would, although it is impossible to tell how accurate our analysis really is.

structure would act as a lobby.

Its unusual pattern, a first for Inflate, is derived from the shape of a dragonfly's wing and the Bauhaus lab logo — a series of variations based on an isometric cube. The pattern begins with a pentagon shape at the bottom and changes to a hexagon at the top of the extension.

The structure's "ribs" or tubes are made from PVC coated polyester weave, while the infill material is Ripstop nylon — a robust material used in most inflatable tent-like structures. Its key advantages are that it doesn't easily tear, it can be cut, and it is translucent, allowing light to shine through.

The inflatable was manufactured in China. Inflate sent computer patterns of the structure to the factory, which plotted the patterns on paper and cut them out. Within the seam allowance of the material, notches or markers were made so that when the panels were sewn together, the notches could be matched up. A team of 40 then

created the hundreds of different panels comprising 3,000sq m of fabric. Every seam in each piece of fabric had to be closed up, using sewing machines and a very tough polyester thread. The whole process was completed in just under two weeks.

Will Grindall, a designer at Inflate, says they used a Rhino programme to design the structure, a different software package from what they typically use, which can create more organic forms. Grindall says Inflate generally works with straight lines, but the theatre extension was more

complicated given its hexagonal pattern and the Rhino programme helped with this.

The extension was erected in three days, beginning on April 28 and was up for the duration of the festival until May 18. Lorenz says it would probably take only 20 minutes to erect the entire structure, but what held it up was inserting 40 tonnes of ballast — broken up concrete paving slabs — into the tubes and zipping it shut.

Lorenz and Seims say that in spite of their initial hiccup with the local authority, while the inflatable structure was up for the festival the locals loved it. Its whiteness provided a strong contrast to the black interior of the theatre and was a forceful signifier of the festival.

The inflatable extension is now packed up into a 1.5m cube and sits in a warehouse in Weimar. If Lorenz and Seims can find a space big enough to accommodate the fully erected structure, they would like to bring it over to London in time for this year's London Design Festival in September. Any takers?



Looking out from the structure.