Profile

From earth bags to tensegrity pavilions, in his practice – StructureMode – engineer Geoff Morrow has created a place where creativity and innovation are paramount. By Jackie Whitelaw.

Geoff Morrow seems to have created a mews-based utopia. His seven-strong StructureMode practice makes its money doing clever commercial work and high-end residential projects across the UK (Figure 1), and finds the time to undertake humanitarian work – currently in several African countries and also Cambodia.

And in a garage just down the road from the Kennington base, the team can develop research that feeds into their commercial projects. This ranges from the development of fabric formwork systems to adventurous tensegrity structures, both in their own way at the cutting edge of structural engineering.

Morrow set up the firm in 2007. Prior to that he took a degree in civil engineering at Queen's University Belfast and, after a spell working in that city, moved to London in 1996. He worked first for Brian Clancy Partnership, with former Institution President Clancy his main supporter on his application for chartership, which he attained after four years.

"It was a super-friendly place and we did all sorts of interesting work, both civil and structural, but architectural/design-led projects were what I wanted to do," Morrow says. He switched to a firm that focused more on his passions, Alan Conisbee Associates; then two years on he moved to Fluid Structures.

"I was at Fluid Structures for six years, where I rose through the ranks and became a salaried director. But it came to the point where I had to think, do I want to buy in or set up on my own? I was 35. It was a now or never moment. My wife, Ranjita, really supported and encouraged me and is still by my side – and in my office doing her own health service research, including architecture of pharmacies!"

Innovative at heart

Now 44, he knows it was the right decision. "I set up StructureMode to be creative and offer excellent engineering design services; to be experts in structural design and practice-based research of unusual or new structural systems and materials.

"It came from my desire to drive change and innovation," he says. "I'm very passionate about doing new things and using new techniques. Personally, I am motivated by the research, sculptural and humanitarian projects. And I'm making the practice I always wanted.

"The commercial work we do is tricky and intellectually satisfying, not to mention the lifeblood of the practice. The humanitarian and sculptural work is a counterpoint that requires us to think differently and develop new skills – and helps attract great engineers to join us."

"The sculptural and research work also feeds into our commercial projects, where we introduce new ideas and collaborate with the architects or designers to achieve better outcomes."

Engineering is in his blood – Morrow's father was an electrical engineer who had worked on automatic landing systems for military aircraft in the 1960s at Short and Harland – and Morrow's understanding of buildings was nurtured when together they fixed everything around the family home. "We put a new roof on when I was 12, then later plumbing and rewiring. And I was fascinated by a four-stroke petrol lawnmower that didn't work. We stripped it down and repaired it, and forever after my dad had a willing volunteer to cut the grass."

Starting a practice at the beginning of a deep recession was always going to be a challenge, but it did help Morrow develop the business ethos of his company. "Throughout the recession it became clear to me that standing

Figure 1 The Mansio – a mobile ruin

BROTHERTON LOCK

Figure 2
Tension Pavilion

AGNESE SANVITO

out from the crowd was an essential component of future success in a very competitive market," he says. "But before that I have made sure that our basic services are reliable and of high quality – producing thorough, efficient, innovative and sustainable structural designs and robust drawings so all our projects run smoothly. We are also very responsive to queries, answering emails and phone messages; I'm very hot on that.

"This has meant we have a lot of faithful repeat clients who value our input."

Unusual structures

Projects Morrow is particularly proud of include one in Cambodia using fabric to cast reinforced-concrete beams and columns for a pair of two-storey school buildings, plus a steel-framed building, all completed in only eight weeks. In addition, he's happy with a demountable geodesic aluminium dome 30m in diameter that was conceived, designed and fabricated in four months for Glastonbury Festival in 2009. And more recently he's been delighted with the interest in a tensegrity pavilion (Figure 2) designed wholly by StructureMode for this year's Vision London event.

It's a system developed in the 1960s by Kenneth Snelson, a student of Buckminster Fuller. Fuller was the first to use the term tensegrity to describe the union of tension and integrity, where compression elements do not touch but are suspended in a sea of tension, Morrow explains. "Pioneering research into this structural system by Fuller and Snelson led to Snelson's 'Needle Tower' sculptures, but it has rarely been used in its pure form for building structures.

"We turned the system on its side and bent it to create a sinuous ring of 24 tensegrity modules where all members in tension are slender cables and those in compression are solid timber sections; the ring supports a fabric canopy. This involved us developing a Grasshopper script to generate a parametric model to derive the curving geometry of all the elements, while maintaining the principles of a tensegrity system. Having done this, we can now design any size and shape of tensegrity system for any purpose – we're just waiting for a suitable commission!

"The tensegrity pavilion and fabric formwork projects are examples of how research at StructureMode has fed into our projects and has the potential to develop new structural opportunities and commercial business," Morrow explains.

Humanitarian work has also involved pushing the boundaries with software and novel construction techniques. One of the most successful was earth-bag construction for St Jerome's Centre in Nakuru, Kenya (Figure 3), working with architectural charity Orkidstudio. "The bags were reused grain sacks that are freely available, filled with local soil, compacted and sewn up and laid as blockwork to form load-bearing walls. It was not a new idea but we did a literature search and developed a pragmatic way to justify the structural system without further testing. This project was so successful because the local people who helped us build it have gone on to build more similar buildings in neighbouring villages on a commercial and sustainable basis."

"The same is happening currently in Zambia, again with Orkidstudio, where we are building

a) Under construction

ODYSSEAS MOURTZOUCHOS

Figure 3
St Jerome's Centre, Kenya

b) Completed building

ODYSSEAS MOURTZOUCHOS

Figure 4 Working with fabric formwork

a) Bomnong L'Or community centre, Cambodia

LINDSAY PERTH

b) Physical testing

STRUCTUREMODE

a new health centre using a compression-only arched roof structure of cement-stabilised earth bricks. Most structural analysis software cannot design compression-only arches, and so we wrote our own using the elastic-centre method, which has worked really well – it's under construction now."

Fabric formwork

Most striking though is the home-grown idea of fabric formwork which is shortlisted for the Institution's Structural Awards this year. The system was developed through physical testing in the practice's garage and backed up by computer analysis and modelling, then applied to the Bomnong L'Or community centre in Cambodia (Figure 4). "One of the attractions was that the fabric could be prefabricated (stitched) locally for the beams and columns, so it was fast to construct; also the building was in an area where most timber was from illegal deforestation, so it was great to avoid using it as formwork," says Morrow.

StructureMode is keen to use fabric to cast reinforced-concrete structures more in future, because of its many structural, aesthetic and commercial benefits. "Dr John Orr at the University of Bath has found that casting concrete in a permeable fabric mould can reduce the depth of carbonation and chloride ingress by 50% when compared to the same concrete cast in conventional impermeable formwork. The fabric mould allows air and water to escape during casting, creating a dense, high-quality, durable surface finish," Morrow explains.

"Through a process of research, physical testing in our garage and subsequent structural analysis, we determined the elastic modulus and Poisson's ratio of a particular fabric manufactured by Proserve. Using the results from our research and testing, along with Grasshopper to quickly generate the fabric meshes and Oasys GSA to form-find and analyse the fabric, we were able to replicate the test results in our computer models. Our analysis developed the same deflected fabric geometry as that when concrete was poured inside our actual test samples, which gave us confidence that we could design a fabric pattern for any desired shape of concrete section in advance, without further physical testing."

Morrow is excited at its potential for commercial projects in the UK. "With the skills we have developed we can design fabric patterns to optimise and vary the cross-section of beams along their length, so reducing the volume of concrete required and creating beautiful structural elements. Prof. Mark West has suggested that the volume of concrete can be reduced by 40% for equivalent strength prismatic-shaped beams by varying the fabric pattern along the length of a beam. We have ideas of how to apply these techniques to make ribbed or waffle slabs too – again, we're waiting for a suitable commission!"

Commercial scale-ups of StructureMode's research are important for the reputation and future growth of the company. "I have never had it in my head to grow a massive practice," Morrow says. "But I do want it to be one of the best."