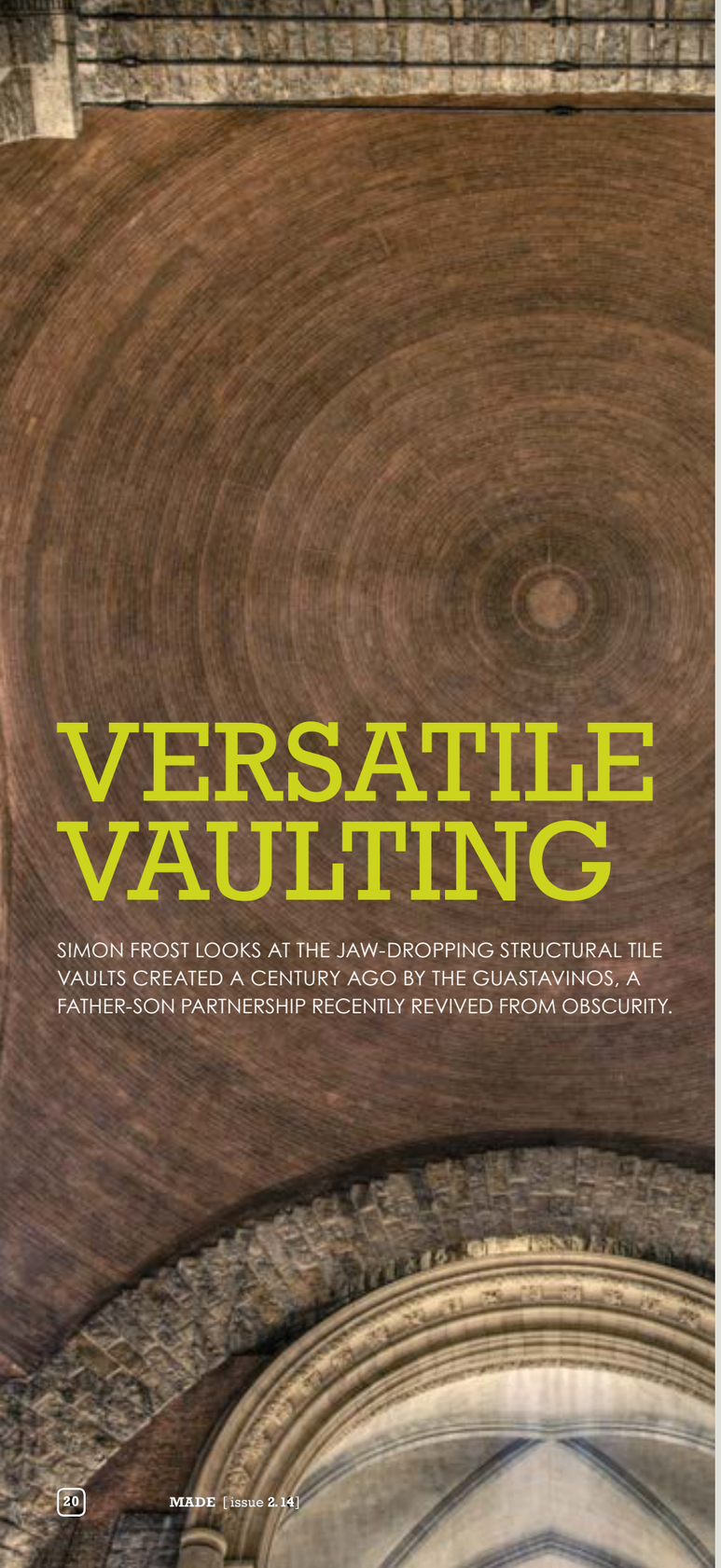


VERSATILE VAULTING

SIMON FROST LOOKS AT THE JAW-DROPPING STRUCTURAL TILE VAULTS CREATED A CENTURY AGO BY THE GUASTAVINOS, A FATHER-SON PARTNERSHIP RECENTLY REVIVED FROM OBSCURITY.

In the late 19th Century, the Statue of Liberty came to signify the golden door to the land of opportunity. Heaving ships were welcomed into port beneath its beacon, offering millions of European immigrants an escape from economic hardship and political oppression. New York City so became the world's iconic cultural melting pot – a term that originates from a 1908 play set in the city – shaping every aspect of the city's character, not least its architecture.

Among the new settlers was Spanish master craftsman, architect and builder Rafael Guastavino, who arrived in 1881 with his nine-year-old son, Rafael Jnr. They brought with them the centuries-old tile vaulting tradition of their hometown, Valencia, which they would develop with astounding success. Guastavino's distinctive structural tile system is an enduring feat of design and engineering that can be admired in hundreds of buildings across the USA – notably in the Beaux-Arts landmarks of New York and Boston, Massachusetts.

COHESIVE CONSTRUCTION

Guastavino Snr cut his teeth in Barcelona as the city developed into a major manufacturing centre. Industrial growth required new mills, factories, railway stations and warehouses, all of which shared two essential criteria – they had to be big and they had to be fireproof.

An ardent student of masonry, Guastavino claimed that construction could be separated into two categories – mechanical-gravity and cohesive systems. A structure that relies on the resistance of a solid to gravity when opposed by another solid – post-and-beam, for example – qualifies as a mechanical system. The construction is relatively simple in that it relies mainly on the materials' physical strength. Cohesive construction, however, requires the amalgamation of materials through adhesion, so that a structure finds equilibrium by resisting pressure in all directions. This makes the chemical properties of materials as important as their physical strength, as cohesion requires chemical compatibility.

The historical continuity of cohesive construction was long broken with the loss of formulas for hydraulic mortars used by ancient civilisations, such as the Romans and Byzantines, and sporadic revivals since had failed to flourish. But Guastavino proved that cohesive construction could simultaneously achieve stability and fireproofing in large structures, as well as striking beauty.

His first experiments in cohesive construction were carried out with concrete alone, but he explained in an essay on the topic, 'I soon found that no arch work could be done with concrete – that is, cement combined with broken stone, gravel or sand, to satisfy the needs of the epoch – so well as it could be accomplished with tiles.' Guastavino's signature method used tiles like large aggregate, laid out in attractive patterns such as herringbone and left exposed. Unlike mechanical systems, the method did not require a substructure for support during construction. As Ann Katharine Milkovich explained in her study of Guastavino's methods, 'A light frame guide was used to assist in the placement of the first course of tiles. When the mortar had set, the construction could continue as a self-supporting system.' By adding a second layer with breaking joints and mortar, the weight of ▶

Courtesy of Boston Public Library, Print Department

OPPOSITE PAGE
The Cathedral of St John the Divine, New York City.

ABOVE
Guastavino Snr oversees construction of the Boston Public Library.

ABOVE, TOP TO BOTTOM
Central Congregational Church, Providence, Rhode Island.
Bridgemarket Food Emporium, New York City.
The Boston Public Library.

a vault was significantly decreased with greater load capacity compared to a mechanical vault, as it could be mere inches thick. Each vault required little or no steel or centring, with the first layer being cantilevered over the space and set with quick-drying plaster, which greatly reduced both cost and time.

START SPREADING THE NEWS

Guastavino identified that the use of high-quality Portland cement was vital to his method's success, but was frustrated by its unreliable supply in Spain, where he had earned a reputation as a skilled architect and builder. He was introduced to the USA in 1876, when he won a medal of merit for a submission to the Centennial International Exposition in Philadelphia. This exposure and the ready availability of Portland cement to be found there were key in his decision to emigrate.

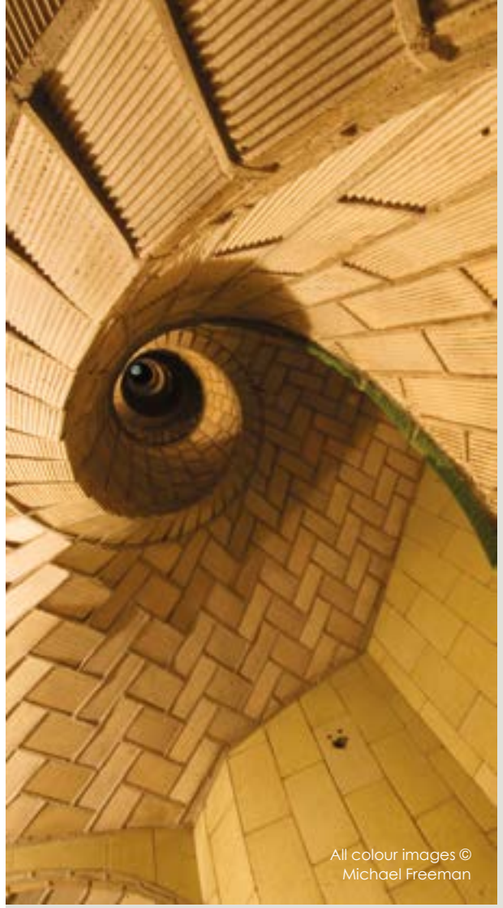
However, he was no overnight success in his new home. The concept of constructing large vaults and domes using only ceramic tiles and a cement mortar was alien to architects who had built the New World, using post-and-beam bearing systems. Armed with letters of introduction and an impressive portfolio, Guastavino's plans fell on deaf ears, in a country that seemed unprepared for his technology.

Undeterred, he wrote illustrated articles for magazines as a means of introducing Spanish architectural styles to the American public, and studied American tastes, construction traditions and available building materials. During these testing early years, he developed his first patents, and in 1885 his first four were granted for floor and ceiling vaults, vertical partitions and Catalan stairs – all approved based on the novelty of his mortar.

His break came in 1886, when a private owner hired Guastavino to design his home – the first building in the USA to fully use cohesive construction. Bernard Levy, about whom little is known, was attracted to Guastavino's novel ideas and allowed him to incorporate shallow tile vaults in the roof and floors, as well as construct a staircase using only tile and cement. He encouraged Guastavino to continue developing and applying for patents. For the patents to be approved, structural tests were required to prove their stability. And so, gradually, confidence in his methods improved within the architectural community – capacity tests returned remarkable results, with thin vaults photographed loaded with pig iron, and thin tile stairways bearing tonnes-worth of sandbags. Fireproof testing also proved highly successful, which was essential following several disastrous conflagrations in the late 19th Century.

THE BOOM

Respected architectural firm McKim, Mead and White enlisted Guastavino's help with its Boston Public Library (BPL) contract in 1889, offering a US$85,000 deal to construct the library's vaulted ceilings. Given the perfect opportunity to showcase his skills, Guastavino did not hold back – MIT Professor and author of Guastavino Vaulting, John Ochsendorf counts seven different types of vaulting at BPL, noting that the decision to leave the tiles exposed 'opens up a new decorative possibility in American architecture'. The BPL was Guastavino's statement of intent to the American architectural community, and it was heeded. On the back of this success, he founded The Guastavino Fireproof Construction Company, and business was good. Guastavino's name was suddenly hugely respected – as Ochsendorf writes, 'The company was given complete freedom in design.



All colour images © Michael Freeman

Architects would write "Guastavino goes here" in the plan, and leave that space empty.' He was invited to make keynote speeches to the Congress of the American Institute of Architects, and secured contracts across the country – so many, in fact, that he couldn't procure enough tiles. The company built its own manufacturing plant, producing standardised terracotta tiles designed for Guastavino's method, measuring around 300 x 150mm and less than 25mm thick.

FROM FATHER TO SON

With Guastavino Snr's death in 1908, his son, aged 37, took the reins. One of his first projects was the dome of the Cathedral of St John the Divine, in New York City, which Ochsendorf describes as 'Guastavino, top to bottom'. The biggest church in the USA, it required one of the largest domes in the world. The company built it in just 15 weeks, with no support from below. The construction gathered crowds on the street and it was written up in *Scientific American* as a great achievement – 'They spanned about 130ft with a five-inch-thick dome, which, proportional to the radius, is far thinner than an eggshell', Ochsendorf notes.

The company's success continued under Guastavino Jnr's direction, with developments in acoustic tiles and plasters, perhaps most famously incorporated in New York's Grand Central Oyster Bar, nicknamed the whispering gallery. Guastavino Jnr also inventively experimented with coloured tiles and even collaborated with mural artist Hildreth Meière on the Nebraska State Capitol. By his death in 1950, the Guastavino Fireproof Construction Company had designed tile vaults in close to 1,000 buildings across the USA and beyond, with 24 patents to its name.

The company folded in 1962, due in part to the rise of International Style architecture, a shift towards steel and concrete construction, but its legacy lives on – and not only in the 600-plus surviving structures. The Guastavino Project at MIT, run by Ochsendorf, documents and preserves the Guastavinos' works and carries out tile vaulting projects of its own. Testament to the Guastavinos' brilliance in a time before computational mapping or calculation, Ochsendorf says of a spiral staircase built at Carnegie Mellon University, Philadelphia, 'I have students at MIT doing doctoral research, trying to understand how these structures stand up. We can't build this staircase today.' All but forgotten for many years, the Guastavinos were celebrated in 2014, with a six-month exhibition at the Museum of New York City. It's a revival of interest that's long overdue.

OPPOSITE PAGE
The La Massa Theatre In Vilassar de Dalt, Spain.

LEFT, TOP TO BOTTOM
Spiral staircase at the Cathedral of St John the Divine.
Tiled mural created in collaboration with Hildreth Meière for the Nebraska State Capitol.

FURTHER INFORMATION

www.gustavino.net