ACSE Awards Submission
Unusual Projects Category

UTS Central Stairs

“The unusual staircase would be a real showpiece”
Julie Power, Sydney Morning Herald
Introduction
Bonacci was engaged on the UTS Central project to provide specialist structural design for the three feature spiral steel staircases. The unusual staircase would be a real showpiece and would be visible from the street through the glass facade of the new building on the corner of Jones Street and Broadway.

The project comprised of three distinct staircases:
1. The Helix Stair – a 4 storey double helix design with 176 steps
2. Reading Room Stair – a 3 storey spiral design with 60 steps
3. Wintergarden Stair – a 6 storey spiral design with 144 steps

To achieve the long helical spans, we designed circular hollow sections as primary torsional members, with additional stiffness provided by the structural steel stair treads and balustrades.

Project Brief
The architectural designs (by FJMT) were inspired by the repeating double helix structure of the DNA sequence, a tribute to major breakthroughs in science and technology. Being an important feature of the new UTS central building, the structural design needed to be sensitive to the architectural design intent, while maintaining the performance requirements. Bonacci was engaged by Active Metal, the steel fabricator and installer, to provide specialist design for the three staircases.

Design and Construction Process
The primary considerations for the structural design of the stairs were as follows.

Architectural Design Intent
The University (UTS) and architect (FJMT) wanted to avoid any visible vertical or hanging structure. As such, the whole structural system was designed to cantilever off the slab edges. This approach would generate large torsional forces in the structure.

Performance criteria
Due to the long spans and relatively low inherent damping in the staircases, the structure needed to be stiff enough to reduce the vibration response due to footfall within an acceptable limit.

Fabrication
Bonacci worked closely with the steel fabricator, Active Metal, to achieve an effective design which could be easily fabricated without compromising the architectural intent, adding unnecessary materials and within allowable structural zones. After a series of reviews of BIM models and discussions with the fabricator the primary CHS members were segmented rather than fabricated in a continuous curve to aid with fabrication.

Installation
As part of the design we had to consider the challenges of installation, cranage and temporary support. The structure was also designed to be fabricated in 180 degree segments that could be transported to site and craned into position.
The design of the structure was developed with extensive collaboration with the university, architect, steel fabricator and builder.

The challenging installation on site was a significant risk to the project. To ensure there were no issues, the team developed a prototype to determine the logistical difficulties of the final installation. The stairs were prefabricated in segments off-site from local steel and curved glass, and then delivered to site.

These segments were then craned in and fixed onto steel landing blocks that had been cast into the concrete slabs.

**Creativity and Innovation**

One of the key performance criteria governing the design due to the long spans and relatively low inherent damping in the system, was vibration due to footfall. Bonacci undertook calculations and finite elements analyses for several different structural systems including large curved steel members, structural steel balustrades, and hanging structures. Members with high torsional stiffness were found to be the most effective in reducing the footfall induced vibrations in the structure, as they had the largest effect on the overall rigidity within the structural system.

*Figure 1 – Photos of installation of the Double Helix Stair Segments*
The final concept was developed incorporating dual steel CHS sections as the primary structure, providing the maximum torsional stiffness per kg of material. Additional stiffness was provided by the deep central balustrade, folded steel stair treads and external steel balustrades, which were incorporated after various iterations of analysis and options studies.

**Sustainability**

By incorporating all the architectural elements, balustrades, treads and risers into the supporting structure, Bonacci was produced an extremely efficient structural design which significantly reduced the material requirements. The final design far exceeded expectations, resulting in a precise, economical and sustainable finished product.

**Built Environment and Heritage**

The staircases are the key design feature in UTS Central building. In all, there are 19 stairways, with a total of 1648 steps. Health is just one benefit, as stairs also encourage informal connections as staff and students come across each other on their way to work or study. Inviting movement and connection, the stairs are a focal point of the design, highly visible both internally and externally thanks to the open plan design of the space and the building’s glass façade that can be seen from the street.

**Further Design Challenges**

**Design and detailing** of members and connections with complex 3D geometry. Detailed 3D modelling and analysis of members and connections was required. Refer to Figure 3.

**Coordination and communication** of this 3D data between architect and steel fabricator. BIM was used for exchange of geometrical information. Refer to Figure 4.

**Temporary works** to maintain stability and safety, control deflection and tolerances during construction. Refer to Figure 5.
Design and installation of the large central balustrades. These extend like a ribbon through two floors above the highest landing of the double helix stair. The “Ribbon” plates were suspended from the concrete slab at the highest level and supported laterally of the mid height slab. Refer Figure 6.