Ornament and craft

Digital design and the profession

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Ornament and craft: Digital design and the profession

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Cellular Tessellation, an architectural installation developed for Vivid Sydney 2014, is a softly glowing, geometric form that responds to movement to create an ever-shifting space of pattern and light. ***Chris Knapp*** and ***Jonathan Nelson*** from Bond University discuss their involvement in the project, and its implications for digital practice and research.

The separation of ornament from Modern architecture declared famously in Adolf Loos' essay "Ornament and Crime" placed space as the primary concern of architecture, with evidence of craftsmanship and symbolism removed from the canonical and conventional public buildings of the past century. Yet, Harvard Graduate School of Design's historian Professor Antoine Picon notes the widespread return of ornamental expression in architecture today is "inseparable from the massive diffusion of the computer" and furthered by a "weakening in the tectonic approach and the increased importance attached to surface."[1]

In *Cellular Tessellation* (CT)—a project developed for Vivid Sydney 2014, an 18-day festival of light, music and ideas – this contemporary problem of the separation of surface from structure was addressed as a core area of interest, as were ornament and the expressive potential of architecture through digitally enabled craftsmanship.

The research undertaken at Vivid served as a vehicle for examining architectural questions as a primary concern, with the technicalities of light pursued secondarily (we are not lighting designers). This work is a collaborative effort undertaken by a team with backgrounds in both professional architectural practice and academia, and carried out via the architectural fabrication lab at the Abedian School of Architecture at Bond University. Not only is the work of value to team leaders Jonathan Nelson, Michael Parsons, Nathan Freeman, structural engineer Phil Wallace, and myself, but to students in an educational context. Overall, the project involved 16 students from Bond in the fabrication and prototyping phases, and another 22 students aggregated from the University of Technology, Sydney, the University of Sydney, and the University of NSW who assisted with on-site assembly at Circular Quay, Sydney.

Cellular Tessellation

The project brief's very loose requirements – to achieve the spectacle of illumination for pedestrian interaction on a very tight budget – offered an opportunity to explore the aforementioned areas of interest through its geometric complexity, fabrication process, computational design, and structural integration with the building envelope.

The *CT* project employed innovative computational form-generation techniques to create and resolve the geometry and componentry of the pavilion. The project is fully parametric and digitally fabricated from flat sheet materials that are folded and interlocked to create a shell comprised of 380 unique cells. Aluminium composite panels form the fundamental pavilion structure, which is akin to a rigid but non-hierarchical net of self-jigging elements. Each cell is in-filled with 3 millimetre thick acrylic sheet and clad with 1.5 millimetre HDPE skin to house 200 lineal metres of light emitting diodes (LED's), which are wired in series and capable of displaying 16 colours.

Advancing practice

When the early stages of digital design and computation tools entered the architecture studio in the 1990s, the focus was on form with little regard for constructability. However, the tools we have access to today – namely McNeel Rhinoceros with the plug-in Grasshopper in the case of *CT* – are very inexpensive and robust, enabling one to have total control of fabrication as well as geometry in a way that is purposeful and intentional. With tighter integration and intelligent incorporation of the material and tool constraints into the design process as one of information management, questions of both technical and formal complexity can be addressed in a profound way that was not possible previously in the context of construction.[2] This positions architectural practice within a relatively new space where the opportunity to understand, simplify and control information related to construction practice – and to even engage in the act of construction itself – presents a novel opportunity to re-establish participation in building procurement for the architect.

The *CT* project exemplifies this proactive attitude toward construction and materiality. In this case, a smooth or curving geometry is utilised to address multiple contextual relationships; namely the direction of entry to the pavilion by visitors and their subsequent restriction to highlighted views, which are then punctuated by revealing both the Sydney Opera House and Sydney Harbour Bridge. Additionally, the curving form of the project provides a continuous and singular structural solution – a monocoque of integrated cells and skin that distribute loads in a multivalent manner. To achieve this, the primary surface geometry was panelised into relatively equal cells using a custom 'definition' (for example, code) that is similar to, but a more highly attuned version of, the Voronoi algorithm.

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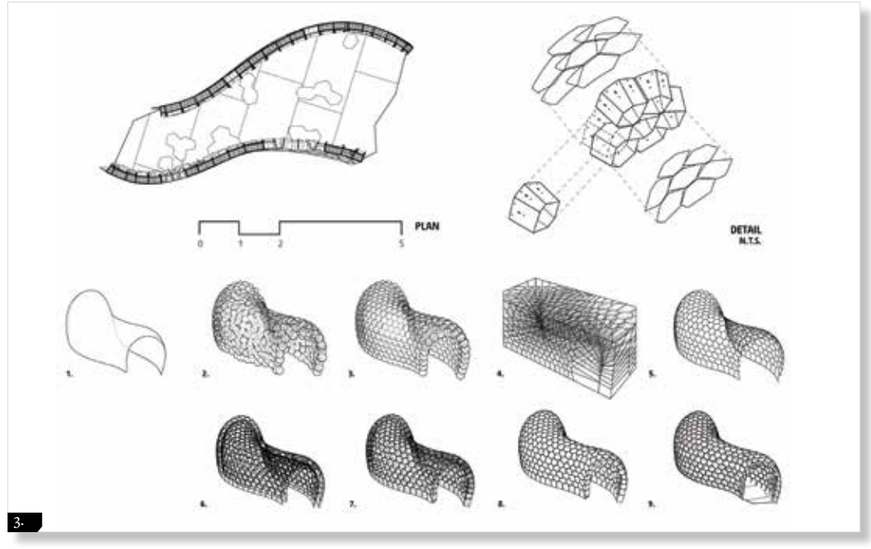

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1. *Exterior view of Cellular Tessellation on site at Vivid 2014.* **Image:** *Patrick Boland Photography.*

2. *Test assembly of Cellular Tessellation at the Abedian School of Architecture.* **Image:** *Jonathan Nelson.*

3. *Plan, assembly detail, and form-generation sequence.* **Image:** *Knapp/Nelson/Parsons.*

Successes and shortcomings

The Voronoi diagram has ostensibly been a very popular design motif in recent years, but it is not without its problems in respect to digital fabrication. Designers generally attempt to achieve a controlled randomness when using it, and while it tends to be acceptable in representational format, it often fails during fabrication. Common problems include highly irregular shapes that are difficult to fabricate with extremely short segments, severely acute internal angles, and cell sizes that vary greatly and are prone to becoming awkward.

The resolution of geometric, doubly curving surfaces using a Voronoi panelisation with very tight tolerances and zero errors is a highlight of *CT*, and such precision is the outcome of an approach concerned with craftsmanship. Not only did this lead to a structure with a compelling aesthetic resolution, it also resulted in a very strong, rigid structure that could accommodate six workers standing on it. The even panelisation allowed us to create cells with very tight and predictable tolerances for fabrication and assembly, resulting in variations of less than 5 millimetres over the 9 metre length of the pavilion.

An aspect of digital fabrication projects that is still to be resolved is that of assembly. Projects such as these are seldom achieved without copious volunteer labour. Fortunately, the process enables assembly by unskilled individuals, however, ironically, it also proves that the more digital fabrication, the more by-hand assembly. Three thousand bolts do not tighten themselves, and in this case the man-hours totalled into the thousands.

One shortcoming of *CT* was due to over-ambition. The project was conceived as incorporating a high degree of user interactivity through the use of motion sensors and programmable LEDs. At the end of the day though, we were simply happy to see the lights come on at all in time for the festival launch, despite lacking true actuated interactivity. While less than originally conceived, the subsuming and atmospheric effect of light within the tunnelled volume of the project still provided a satisfactory level of user experience. The three-week duration of Vivid pushed the wiring and lighting to the limit, but overall the project was robust enough to withstand crowds totalling 1.4 million over the length of the festival.

The value of Vivid

At the conclusion of the 2014 iteration of Vivid Sydney, *The Guardian* newspaper published a piece with the headline 'Vivid Sydney: Festival for the Instagram generation, stunning or superficial?'. It is easy to brand festivals like Vivid or Wellington LUX in New Zealand, as mere entertainment for the masses with little substance; for some reason, a parade of illuminated structures and projection-mapped displays is a simple but effective formula to entice participation by the masses. From a critical perspective, it can be seen as excess, populism and spectacle rather than 'proper' art. Yet for researchers and practitioners alike, these festivals offer an ideal opportunity to undertake meaningful and productive research activities; especially one that provides some funding and a very loose programmatic brief.

As is the case with Vivid Sydney, the *CT* project provided the opportunity for us to 'practice what we preach' in the classroom about advancing the state of architectural practice, and, more so, to test out strategies for computational design, fabrication and social engagement where most digital work never gets past the computer screen. This work provides an important means for the advancement of architectural technology, expression, and construction within an educational and professional context.

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Jonathan Nelson is an Assistant Professor and founder of the Architecture Fabrication and Research Laboratory at the Abedian School of Architecture, Bond University.

Footnotes

1. Picon, Antoine. *Ornament: The Politics of Architecture and Subjectivity*, London, Wiley, 2013.
2. Kolarevic, Branko. 'Information Master Builders', *Architecture in the Digital Age: Design and Manufacturing*, Spon Press, New York, p57.