Digital Towers

Code, it would seem, is everywhere. We are beginning to understand that much of our natural environment is based on rule-based behaviours, from the emergent swarm intelligence of flocks of birds and schools of fish, to the complex patterns of snowflakes, ferns, seashells and zebra skins. And nothing escapes. Not even the human body. The human genome is being mapped out and sequenced by scientists to provide a genetic blueprint of human life itself. In this context, it is hardly surprising that architects are now beginning to explore similar principles in the design studio. The apparent primacy of these codes opens up the possibility of modelling systems through digital means, and with it the potential of using digital technologies to breed structures. An ever-growing group of young architects is using the technique of ‘scripting’ – the manipulation of digital code – to produce radically innovative architectural environments. A new generation of structures is being created that recognises the potential of the computer not just as a sophisticated drafting and rendering tool, but also as a potentially powerful tool in the generation of designs themselves. This selection of digital towers offers a glimpse of the forms that can be generated either by the use of code itself, or by the use of parametric modelling softwares. Five student projects have been selected, alongside five projects by architectural practitioners. None of the towers has been built. But it is not as if these towers are merely utopian follies. On the contrary, the techniques that they illustrate are precisely those that are informing advanced architectural production today. We are witnessing a shift in the status of digital operations from a marginalised domain of experimentation to a central role in the production of architectural information. Few significant architectural offices can afford not to engage with advanced digital modelling, which was once limited to the province of the avant-garde. Indeed many are developing their own in-house digital research units. So, too, we are witnessing the creation of a fresh and highly innovative vocabulary of architectural forms, generated by the algorithmic potential of the computer – from the proliferating logic of cellular aggregation, to the adaptive, parametric behaviour of distributive systems mutating across a field condition.  

Neil Leach

If there is one building that characterises the Modernist project of the 20th century and represents its aspirations it is the skyscraper. The Peristal Tower project attempts to reconsider and critically revisit this well-celebrated typology in the context of the ever-growing city of the 21st century. It aims to develop the notion of vertical mobility as an approach to the changing needs of both the individual and the collective. As the sole signifier of vertical rigidity, both programmatic and performative, elevator and core have been dematerialised through the invention of PeristalCity. Intended to dematerialise the organisational distribution of spaces that are influenced predominantly by the typology, PeristalCity seeks to rethink the structural and material logic of vertically distributed environments. It does so by introducing a new concept which breaks away from the dichotomy between space and circulation. This new concept of space is motivated by research into a new technology which seeks to overcome traditional typological spatial and structural constructs: an inhabitable pocket (living and working unit) contained within a flexible element. It is a module that flows in a vertical communicative field with its surrounding members. Its position is determined and managed by a responsive signalling system controlled by structural, environmental and spatial stimuli.

This project is conceived out of a desire to address the accelerated condition of design and construction in China. It works as a simulation tool for architects to test various structural and organisational patterns that can then be instantiated in the context of particular designs, and addresses the historically rigid high-rise typology. Through thickening and thinning, the Swells reinforce and expand the structural envelope of a tall building, and forces are transmitted across its poly-directional structural network by a system of horizontal connective hinges. Swells are generated through an ascending population of cellular agents whose collective transformation frequencies are indexed by the swelling intensities of the emergent global structure. Cellular layers come in and out of phase, thickening and thinning the skin tissue. The Swells form parametrically modulated symptoms of an affected skin, driven by the multiple vectors moving away from the core plane. Scalar modulation of spatial fabric can be retextured to allow for maximum openness or divisibility of space. Statistical propagation of programming molecules offers opportunities for populating high-rise territories more compatible with the flexible nature of current cultures of inhabitation. The recurrent organisation patterns that emerge form diverse neighbourhood relationships that allow for endless programmatic affinities.
The Rising Masses project addresses verticality and the madness of repetition. It features a residential high-rise building, floating within the regimented grid of Singapore’s office district. Writing form mathematically defines the basic concept, using the notation of functions and equations to confront both the abstract development of a syntax of form and the concept of ‘automatic writing’, where form is driven purely by industrial performance ratios such as floor-area ratios, maximum building heights, facade-to-area ratios and so on. The scheme proposes two 6-metre (19.7-foot) thick building slabs, each 180 metres (590.5 feet) high and 40 metres (131.2 feet) long. This building typology generates spaces within the slabs that constantly face each other, and thereby creates an awareness of the extremely thin proportions of the building that serve to emphasise a lifestyle characterised by constant confrontation with the extremely dense surrounding urban fabric. On their external facades the slabs reflect the monotony of the neighbouring buildings, while on their interior facades this monotony dissolves as they deform into vertical folds. The folds stabilise and connect each slab and provide external vertical circulation. The transformation from the rigid curtain-wall facade into an external structural grid blurs the spatial boundary of inside and outside, and interlocks the interstitial space between the two slabs with the dense urban environment.

The claim that form follows function seems to be most valid when looking at biological systems. In order to survive, biological structures evolve as highly complex systems whose aim is to provide an optimal solution for any given requirement. Every organism and life form emerges through a process of evolutionary self-organisation. While the principles of morphogenesis tend to become an increasingly attractive paradigm in the field of architectural design, and while the aesthetic appeal of natural forms has always been important to architects and designers, the inherent principles of these systems have gained significance ever since evolutionary and genetic computation have been used for design and optimisation purposes. The Evolutionary Computation project investigates the potential of evolutionary and genetic computation in a more holistic approach to architectural and structural design. It takes advantage of evolutionary form-finding strategies through the use of material self-organisation under load and gravity. Instead of post-optimising the structure in the final stage of the process, the project embraces these methods and deliberately deploys them as the very tools of the design at the outset. Evolutionary and genetic computation strategies are here used for finding an optimised form (based on given demands) to create differentiated and complex architecture.
This investigation develops an innovative technique to design and manufacture a composite material with algorithmically distributed gradients of transparency. Scale prototypes explore scripted material distributions and performative capabilities. The procedural allocation of fibres within the composite assigns degrees of performance to the built component. Optical fibres conduct light from one end to the other based on absolute internal reflection. This gives the composite another characteristic, different from that of glass or other transparent materials: freedom of depth. It also embeds in the component the possibility of spatial transparency, beyond surface depth into volumetric and spatial depth. The varying density of the fibre matrix contributes levels of sensitivity, translucency and conductivity. The propagation of components and their positioning as an architectural envelope determine field intensities and transparency gradients. An initial study, the Cloud, was developed as a responsive 3-D display, where more than 15,000 pixels were freeform sculpted in space. Further explorations have engaged with larger urban scale surfaces and building envelopes, and include the development of a parametric module system that could be applied to existing buildings as a design response to natural lighting demands, and a proposal to make buildings literally and phenomenologically transparent.

The Automorphic Strand Tower introduces an environmentally sensitive 21st-century construction system based on the self-organising properties of extreme fibre networks. It draws on many sources ranging from tissue engineering and textile technology to organic templating. The tower instantiates agency at the level of individual fibres and fibre groups that organise recursively to create extreme networks of unprecedented complexity. This emergent strand morphology was generated using software developed by Testa & Weiser, and coded through an iterative templating and scripting process. The underlying principle of fibre agency and affiliation demonstrates the potential of coding structures for an exact construction. The ultra-light nested fibre structure builds strength and resilience through a massive redundancy of elements that challenges conventional models of structural and environmental performance. The tower is built on-site using an innovative automorphic construction technique developed specifically for the project, whereby robotically spun basalt fibre groups form nested structural and spatial layers. In effect the project consists of fibre strands that are robotically spun into place like candy floss. In this way the tower manifests in real time the concurrent development of material properties, spatial patterns, design technology and fabrication techniques.
The N Towers concept is a speculative project based on mapping the programmatic distribution of commercial, residential, retail and open public spaces in an existing high-density urban fabric, specifically surrounded by sites that have no present built form or development. The resultant model for projected growth mapped gradients of activity that hybridised programmes into various tower typologies. A design composition of minimal surface geometries accommodating the basic requirements of floor, wall, facade and structure categorised into an apartment and a commercial floor-plate type became the programmatic seed. When influenced by the projected data of directional growth against programmatic distribution, mixed-use tower iterations emerged as new solutions of habitation for the area. Some tower iterations remain uninfluenced as the proposed model for new commercial and residential ‘hives’, while others hybridised, forming complex mixed-use relationships incorporating retail and public open space that connected the active boundaries of the site. These emergent typologies of public open space and retail created a new ground level from which the towers spawned while directly interacting with the existing river to create a porosity that maintains its experiential qualities, integrated with the new iterations of habitation.

This fibrous concrete shell tower for Hong Kong emerged from a series of earlier studies, undertaken with Rojkind Arquitectos, of exoskeleton tower typologies. The project compresses the structural and tectonic hierarchies of contemporary tower design into a single shell whose articulation self-organises in response to multiple design criteria, incorporating structural, spatial, environmental and ornamental imperatives. The initial topology of the shell’s articulation is algorithmically generated through a cell division procedure in response to the tower geometry. The shell is both performative and ornamental, and operates as a non-linear structure where load is distributed through a network of paths, relying on collectively organised intensities rather than on a hierarchy of discrete elements. The load-bearing shell and slender floor plates enable the building to remain column-free. Although the external articulation is geometrically complex, it operates within the thickness of comparatively simple shell geometry, enabling the use of conventional formwork techniques to construct a highly differentiated tower. The localised spatial complexity and intensifications in the shell geometry suggest a re-reading of the shell as epidermis – a performative outer skin that integrates a set of discrete concerns through the cellular structure of a continuous surface.
Compressed Complexity rethinks the typology of the classical skyscraper by combining a largely horizontal public shopping base and a mono-functional stacked private office or housing slab. This has implications for circulation, public accessibility, transition between programmes and the formal distinction between base and slab. Addressing this issue, the typical horizontal system of public programmes is superimposed onto a vertical organisational pattern and subsequently developed as a diagonal spatial prototype. Adaptations of this basic prototype are generated to produce various functional formulations. The diagonal allocation of the public programme enables a continuous vertical public space that enhances the mix of functions and facilitates navigation around the site. The residential landscape forms a dense horizontal urban fabric that responds to the scale of the site and allows it to blend into the existing context. As the surface folds up from the landscape into the tower, the geometric features are mutated and do not repeat. Different rhythms are achieved by two rates of change adjacent to one another, driven by internal organisational issues, and hybridised to produce a range of formal features in the tower.

Resonance: Between Repetition and Difference

THEVERYMANY (Marc Fornes, Vincent Nowak and Claudia Corcilius), 2006

‘Any tower is multiple’: such an assumption can easily be made by looking at towers as stacked objects. Once efficiency and other economic criteria have been introduced, such stacking usually becomes periodic – with the floor constituting the common period. Increasing the resolution through subdivision into smaller parts (such as rooms or desks) introduces modulation and higher frequencies. Resonance: Between Repetition and Difference is a design research exercise investigating such relations/rhythms through explicit and encoded protocols: ‘explicit’ because they are the result of precise and ordered sets of procedures, and ‘encoded’ because they are written within a scripted computational language (in this case Rhinoscript). The design constraints have been encapsulated within multiple logistical functions called ‘modulo’ operations in relation to floors, rooms or parts, each informed either through global parameters (such as overall twisting acceleration) or by the previous step. One step follows on from another in an unbroken chain of cause and effect which is completely predictable. In principle, the resultant morphology should therefore be completely orderly and deterministic. But in practice, due to the high number of periods in a tower, even small periodic increments can produce large amplitudinal vibrations that constantly repeat their instructional sequences and generate tiny variations.

Texts and images compiled by Neil Leach

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