OPEN TOWER

Developing design research practice

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Abstract. This paper critically reflects on computational methods of design in relation to social and environmental sustainability design research within contemporary and future tall building typology. It develops the author’s experience in large-scale building design practice into academic design research. The analysis of tall building typology is presented initially in the context of practice, followed by its development in an architectural master’s studio. The authors discuss their design research within a practice context that determined the question: what opportunities do computational processes offer to the conception of the tall building typology? Its transference to an educational research context allowed for the deeper exploration and development of a position on algorithmic and parametric methods, their relevance to the typology of the contemporary tall building and complex architectural scenarios.

Keywords. Computational; tower; practice; research; typology; teaching.

1. AIM

Most, if not all, explorations into algorithmic process- and form-generation generally neglect the structural and material integrity of architecture (Rocker, 2006).

There is a particular opportunity at this moment in architectural thinking in linking the opportunities of computational generative processes and the complexity of the contemporary urban condition into which architecture is required to operate. The intent with the larger project as described by this
paper is to examine contemporary computational techniques through the register of a relevant architectural typology capable of dealing with the complexity of contemporary urban, cultural, social and environmental issues; namely tall buildings.

The skyscraper offers one of the best case studies for analysing whether architecture can still be practiced in a way that revives its reflective and critical dimension – a dimension vital to the very survival of the architect, and of architecture in its social and cultural roles (Abalos and Herreros, 2005).

The focus of the tall building typology to be discussed developed out of exploratory design work undertaken in a design research practice, of which both authors are directors. Speculative design proposals exploring social and environmental sustainability, urban conditions, structural types, infrastructure modes and organisational logics were prepared for multiple scenarios and audiences. Through critical reflection of this work we determined our interest in and obvious need for exploration of multiple systems and sets of logic. Concurrent research in computational processes indicated a clear opportunity for the use of relational logics and rule-based generative approaches and promoted an interest in developing a non-totalising or dis-integrated systems design environment.

Now that technology lets us treat abstract schemas as objects for manipulation, it makes no more sense to design by drawing each line and modeling every surface than it does to drive an aeroplane down a highway (McCullough, 2006).

2. Background

Initially work began that sought to explore large-scale issues of environmental sustainability strategies, primarily energy harvesting, as a register for experimental design of tall buildings. This work resulted in a project titled the Open Tower.

The premise for the tower is based on the notion that the past and current tall building typology as single program is unsustainable on multiple levels. Large amounts of energy are invested in the construction and infrastructure of tall buildings. Tall buildings use to be limited to single programmatic cycles results in needless energy inefficiencies and consumption.

As discussed in such texts as Delirious New York (Koolhaas, 1978) and Tower and office (Abalos and Herreros, 2005) multiple programs in tall buildings develop concepts that not only advance architectural form and space, but develop the high-rise as a sustainable typology for the contemporary city. The
opportunity for the future of the typology is to conceive of tall buildings as valid urban strategies via infrastructural logics, rather than limiting them to discrete objects servicing singular purposes.

In the new skyscraper three overlaid structures – public, private, and mechanical – define a self-sufficient vertical organizational system that tends to break down centrality into dispersed components and subsequently multiplies it (Abalos and Herreros, 2005).

Through the open tower project a variety of overlapping concepts relevant to super-tall buildings have been explored for their design potential. 24-hour use of building fabric and infrastructure offers a means of offsetting the large costs and energy use associated with tall buildings. Integrated public space enables multiple and connected programs throughout the height of tall towers. The base concept of optimum social group size and resultant interaction is examined for its generative potential within the programmatic organisation of the tower.

3. The open tower

The open tower project is a speculative un-built exploration of very tall building typology in an era of resource management, fluid programmatic and financial dynamics. It is also an important reconsideration of the future of public space within the realities of high-density urbanism. We set about to design an exploratory model for very tall buildings, explicitly to challenge several seemingly inviolate assumptions within this type. These are explained below.

3.1. PRIVATE OWNERSHIP IS NOT THE ONLY MODEL

Tall buildings considered as public infrastructure could work on novel models of public and private ownership considering the building part of the city fabric rather than an island in the grid. Our proposal is to treat primary circulation and super structure as public domain, and accumulate property deeds for vertical location and orientation to private interests, from shops to commercial scale floor plates. Continuous and accessible central public spaces, link the tower to larger urban concerns for public amenity.

3.2. A TOWER IS NOT A MONOLITH

Towers do not have to be mono-climatic, or monolithically programmed or serviced. We propose the open tower, an internally highly distributed or discontinuous tower, consisting of multiple micro-climates and highly atomised and fluid programmatic mixes, in overlapping vertical spatial parcels based
on a concept of scalable communities rather than horizontal floor plates. The volumetric clustering (hexagonal grid pods and gasket spaces, see figure 1) works bi-directionally across levels of communities and neighborhoods to commercial office workforces. The interconnections between these nodes allow for multiple means of entering and traversing the sections of the tower, either formally from the core or informally from the perimeter.

3.3. OPPORTUNITIES

The role of the tall building in the future will be to generate, not just consume. Conceiving of the tower beyond the iconic single program object can fulfill the necessity for responsible and sustainable urban density. As a profession we need to develop strategies to enable these opportunities, and to advance the tall building typology as a critical contribution to the future urban condition.
4. Research question

So it can be understood that the investigation of the tall building typology follows a contemporary ‘mixed-use’ approach that seeks a layering of functions as a way of obtaining the density and richness characteristic of urban life. However, in developing our proposal, programmatic mix and circulation systems are not compartmentalized or seen as absolutely efficient connections as might be found in the typical mixed-use tower. Multiple paths of travel and speeds of connection between a layering of program mixes have been designed in order to encourage movement closer to that within the urban condition of a city with its network of streets, public spaces and blurred distinctions.

It is this moment in the project that opportunities offered by algorithmic processes were recognised, and the research question posed for investigation within a teaching environment. Of prime interest to the authors was speculation regarding the implications of this research project on computational methods for the design of super-tall towers and specifically complex systems. We asked how might computational processes be created to further develop these re-imagined assumptions of the tall building typology?

The goal of promoting and combining multiple agent based and rule-based systems while accessing some form of rudimentary “real time” performance analysis became our fundamental interest.

5. Studio

Over the course of the process outlined above, it became clear that we were less interested in the design of the tower as an object through compositional methods (e.g., tower as icon, understanding form in relationship to city via silhouette, etc.) but rather how one might design the organisation of the systems that produce the infrastructure and logic for the object as an environment.

In doing so, the multi-program tower with infrastructural organisational logic and urban scale sustainability objectives became a worthy testing ground for novel computational methods. Our objective then was conceived as a parametric ‘rig,’ consisting of multiple overlapping or weakly connected parametric systems, with a focus on structure as one of the primary logics required in tall building morphology. The other important reading of structure is in terms of organisational logic enabling control of spatial and programmatic configurations that would enable unexpected or novel spatial relationships and qualities to emerge.

The studio specifically sought to develop a process to quickly sketch and test structural performance through a code environment that encompassed structural analysis, while promoting an environment of ‘fail fast’ generative...
methods for tall building design. This master’s level studio was broken into three phases. The first consisted of an introduction to procedural logics and “relational” architectures through the Java Based software Processing, an open software platform developed at MIT by Casey Reas and Ben Fry in 2002. The second phase explored tall building morphology around types related to structure and program to develop a parametric “structural rig.” The final stage brought these two parts together through a short group thesis project developed by student teams in collaboration with the instructors. The thesis focused on how non-uniform structural and organisational systems for tall buildings can be generated and developed. This master of architecture studio was run as a small research workshop of 10 students.

The first two parts have been explored in some detail in a paper ‘Contingent geometries,’ also co-written by the authors, presented at the AASA conference in 2008 and will only be briefly summarised as background to the computational techniques employed. The third part form the material discussed in this paper, as it involved the application of the relational logics and parametric rigs to an architectural brief for a complex mixed-use tall building on a site in Sydney’s CBD, where this enabled a specific architectural context to be tested against.

In the first part students were required to explore basic structural pheno-types relevant to tall building morphology using processing as a generative code based environment and multi-frame for preliminary structural feedback, with an ambition to demonstrate and develop the possibilities of a performatively based generative design environment. These structural tests included scripting stacking, network, lattice and branching structural logics using associative and contextual (environmentally contingent) design environments. Investigation was limited to structural performance and the potentials of the structural morphology selected.

In the second phase Bentley’s Generative Components (GC) was used to develop a parametric scaffold or rig of the structural system of a large tower based on the accumulated systems expertise of the first exercise. Moving beyond structural concerns only, a more complex set of ambitions was introduced, aimed specifically at avoiding the smoothly differentiated totalising geometry typical of parametric design to date. The focus was to develop multiple systems that produced and capitalised on localised structural effects rather than a globalised structural solution meeting minimum design standards. Students were challenged to investigate how GC might balance efficiency and effect within a non-standard structural praxis. Students were subsequently required to assess their parametric structural rig for its spatial consequences – that is, to consider structure and organisational logics relevant
to program. It was precisely those moments of apparent failure of a parametric system to smoothly encapsulate competing demands that were sought after and interrogated.

In the third part of the studio students teamed up in pairs and responded to the scenario of system(s) meeting the more defined architectural constraint outlined above. Students were required to respond to controls on height, envelope, floor area, solar access (to city parks), adjacent infrastructure and neighboring buildings. A novel programmatic mix was set as the brief – the combination of Museum of Contemporary Art and commercial hotel (replacing the existing site’s hotel accommodation requirements). In addition, an equivalent area of commercial program was required as a means of simulating a possible financial model to provide further complexity to the organisational and infrastructural requirements for the tower.

Programmatic (and resultant circulatory requirements) were required as specific areas to address, with the understanding from the initial work produced that this would not only allow engagement with relevant and important social and cultural values / parameters, but they would also serve to qualify emergent structural formal and spatial results. This requirement is a deliberate move away from the contemporary form-finding processes most computational processes create whereby use was fitted into a form already created from any number of positions.

As a start to this work the students were required to integrate their relational logics developed as individuals in the previous task, together into an integrated proposal for the project, thereby immediately adding a significant level of complexity to their parametric rig. In doing so, this additional complexity would further enable their ability to deal with multiple local contingencies.

A clear focus to the studio was the specific requirement to avoid creation of a system in which singular global control as one might see in a parametric rig for the façade of a building or exhibition object. The position taken was that global control was insufficient to deal with contingent parameters and local requirements of complex architectural propositions. A ‘global control’ of form evidenced in some proposals was quickly encouraged to become one of the systems, not the prime control for the form of the tall building.

Interpretation and interrogation of iterative results, based on initial parameters selected was essential for the development of a feedback loop. That is, to allow for the examination of the structural, formal or spatial logic (depending on the particular students’ focus) to re-inform the parametric rig, and be folded back into the parameters for the rig, increasing its complexity and scope for contingent responses.

The design of multiple and concurrent complex systems for a future tall
building, as well as the more speculative potential suggested by the project, exceeded the capabilities for parametric design control via a single model (of building or system). As a result multiple parametric systems were employed in combination. Within this process the overlap and juncture of systems created a new opportunity for generating spatial condition, integration and organisation of building program, structure and systems.

6. Examples

Project one developed from consideration of a highly redundant structural logic akin to the fibrous make-up of felt. Initially an environment of structural form finding was created that used layers of proximity queries to connect fibres in upper and lower levels of an initial point field. Once fibres had been drawn, their thickness, geometry through their length (changing section), their profile and extension were developed as control parameters. From a fibre-based logic to a logic of adhesion, the elements were then formed around basic connecting volumes, mapping their minimal surface to connection, while distributing fibres within a range of randomised orientation and distribution algorithms.

The resulting test case developed a highly controlled yet free forming structural solution that queried typical boundary relationships through identifying a possibility for the role of highly controlled structure as boundary.

Project two developed a consideration of multiple circulation types into the proposal for a tower that challenged the elevator as the major structural and programmatic organizing element in tall buildings. Using a range of circulation types, in combination with a number of programmatic opportunities
they identify, this proposal completely broke with circulation to perimeter and program relationships creating a highly novel programmatic logic for the tower, intertwining the commercial, gallery and hotel components together through a series of circulation helix-like entanglements.

Figure 3. Project two: “Pervasive circulation” (Amanda Clarke and Alina McConnochie).

The result developed systems that promoted the dynamism and complexity possible in the inhabitation and interaction of mixed populations inhabiting a multi-programmed tower.

The ambitions for the tower typology the authors developed within the open tower project have been taken up methodologically in the studio through the testing of multiple software packages in combination with multiple systems of logic. The subversion of the typical tower logics via the dispersion and multiplication of program meeting regularised structural requirements promotes new spatial conditions, circulatory systems and modes of inhabitation.

7. Conclusion

I have always been committed to the proposition that the production of architecture is one of emergence. It is not about a pre-ordained image, icon or aesthetic that is imposed on the world, but rather an opportunity to devise and experiment with a conceptually rigorous methodological system offering a broad range of adaptations in relation to an ever-increasing body of interests. This approach is obviously tainted with risk and unpredictability for those who aspire to instant gratification, but most importantly its unique contribution for our current generation of architects is one of utilizing controlled chance as a means to managing complexity and taming the unfamiliar (Douglis, 2006).
Through the process of translating the parametric structural rig to the formal, spatial and infrastructural requirements of the tall building typology, two key issues emerged. The first is that we can conclude projects of significant architectural complexity require more than a single parametric system for their design control and relevance to larger social, environmental and political contexts. As such the design space lies in what Evan Douglis refers to as “complex of complex systems.” Our framework to meet the complexity of the contemporary and future architectural project is conceived as ‘ecology of systems’ (whereby ecology refers to relations between systems and to their context).

Secondly, that in the design of this ecology of systems and the relationships amongst them, unexpected spatial and organisational opportunities emerge in the overlap of systems, in the glitches that occur when computational processing power is insufficient or when errors arise in the application of otherwise sensible parametric constraints.

Currently parametric systems tend to homogenise structure and programmatic opportunities, opting for unity of expression over a robust complexity. However, the authors believe the typological reinvention of tall buildings will occur as a result of promoting ecologies of systems. As such, the tall building typology will continue to offer experimental and tangible visions for the complexities and requirements of future urban conditions.

Acknowledgements
Open Tower – Offshore Studio (Anthony Burke and Ben Hewett); Studio – Computational Media, School of Architecture, University of Technology, Sydney; Coordinators – Anthony Burke and Ben Hewett; Students - Alina McConnochie, Amanda Clarke, Luke Novotny, Peter Ung, Eric Escalante-Medoza, Albert Quizon, Robert Slavaich, Christian Moi, Daniel Jaramillo, Joshua Lynch.

References