

DISPARALLEL SPACES: PARAMETRIC DESIGN EXPERIENCE

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Abstract. *Disparallel Spaces* was an architectural design exhibition showcasing creative digital design techniques. It explored how the coupling of architectural design with digital modelling and fabrication methods allows for a deeper comprehension and experience of space and form. The participating designers proposed architectural solutions that challenged and defied gravity, dimension, space and volume in unprecedented ways, resulting in novel designs created with freedom of innovation, interpretation, and definition without boundaries. The notion of non-conformity was the core of this collection of works, held together by the idea of spatial concepts in disparallel configurations and unconventional methods in the process of design.

Keywords. Parametric design; Fabrication; Design learning; Architecture and art.

1. Introduction

Between the months of May and July of 2007, Sydney's *Tin Sheds Gallery* hosted an architectural design exhibition. Aptly named *Disparallel Spaces*, the exhibition confronted problems in architectural design from a diversity of multi-faceted and eccentric approaches, setting the trend for novel viewpoints of innovation and spatial design, and offering a unique opportunity to experience the digitalized future in the field of architecture (Schnabel and Bowler, 2007). The art works were driven by creative use of computer-aided architectural design tools, scripting, parametric design techniques and fabrication, as well as crossover media. Fuelled by a design-studio theme *Cliff-hanger*, these artistic interpretations explored how the coupling of architectural design with digital modelling and fabrication methods allows for a deeper comprehension and experience of space and visual quality. Spatial concepts in disparallel configurations generated through knowledgeable employment of these tools in sophisticated and unorthodox ways formed the groundwork on which this imaginative collection was conceived.

Each individual piece in its developing phase explored design based on parameters. In order to construct a philosophy grounded in parametric dependencies and relationships, the designers used digital tools that enabled them to create and express their designs. Typically, architects employ such tools only for visualisation purposes after designs are completed in order to feed them into subsequent construction and manufacturing processes.

There are two inherent characteristics of parametric application. The first is that all entities start with a point in space and allow for the study of architectural conditions in a three-dimensional environment, rather than the commonly used two-dimensional context or layering techniques. The second elucidates the underlying concept of parametric modelling as an abstraction, which responds to manipulations in data, variables, and their relationship to other entities.

Participants of the exhibition employed their digital media skills early in their architectural studies to utilize and expand on their understanding and communication of various design issues in this challenge, following a tradition of design studios where participants explore design methods and tools beyond their original definitions and perceived limits (Schnabel et al., 2004).

The designs were translated using a variety of manufacturing processes, from digitally controlled milling machines and rapid prototyping to manual translation of the resulting creation. This crucial step between virtual to physical forms engages the designer in a tangible design process that bridges the gap between the initial idea and its realization. By presenting the work in a gallery environment, the works were again translated into another realm where interpretation of architectural design can transcend prevalent understanding.

2. Cliff-hanger and disparallel spaces

A building or structure can be expressed and specified in a variety of ways. Commonly, drawings are used to describe geometric properties that can depict, explain, and guide construction. Alternatively, performance specifications can describe observed behaviours. Another possibility of describing properties is via relationships between entities. Spreadsheets, for instance, specify the value of each cell as the result of calculations involving other cell entries.

These calculations or descriptions do not have to be explicit. Responsive materials change their properties in reaction to the conditions around them. Using this concept as a basis for design, artists have come to create reactive sculptures and architects have begotten sentient spaces that react to their occupants or other relevant factors.

Links to a variety of data can be established and serve to generate geometric forms using parametric design tools. When designing spaces, it is usual to collect data of the type of architectural qualities desired. However, little research exists examining or validating the framework of design using parametric methods and its enhancement of the overall process (Schnabel and Karakiewicz, 2007). The exhibition *Disparallel Spaces* ultimately reframes the question of parametric methodologies, and proposes new answers that will spark a revolution in design thinking.

Participating designers at the exhibition solved an architectural problem using applications focusing on the parametric dependencies of spatial perception, fabrication, and form finding. Their creation and exchange of ideas followed the cyclical design-exploration paradigm evident in design studios (Schnabel et al., 2004). This design-cycle frames the focal design question at its centre (Gao and Kvan, 2004), and full advantage is taken of the available building information modelling technologies to explore it. This approach challenges the limitations set by conventional, design-only methods. The cognitive aspects of the creative process and its relationship to parametric design methods operate as an influential factor for understanding the perception, framing, and creation of spatial knowledge within architectural design.

Each designer explored processes that use sets of variables and series of relations to question, create, and define the form and function of their resulting design. By doing so, they examined the interaction techniques at play between the design intent, framing of the design problem, and their subsequent creation.

Moreover, *Disparallel Spaces* was guided by the concept of three-dimensionality in the abstract design-studio theme *Cliff-hanger*. In this task, which acted as prelude to the exhibition and hence as independent project that can fulfil all requirements of an academic exercise, spatial issues were to be addressed differently than on typical planar sites and a variety of architectural languages were required to be used in the design exploration. There were three distinct stages that constituted the creative process in preparation for the exhibition: the defining of parameters, creating of rules, and fabricating of the design.

2.1 PARAMETRIC DESIGNING

Any object or form that constitutes our surroundings can be described in numerous ways, one of which is through the object's response to certain conditions. The design-studio *Cliff-hanger* looked into descriptions of behaviours by means of performance specifications.

The existence of condition-responsive relationships enables parametric design tools to formulate links between arrays of data that can then be used to generate an indefinite number of geometric forms. These descriptive parameters and rules can be applied directly to areas of manufacturing or design, such as in architecture, where spatial, experiential, financial, and environmental expectations and ideals can be met. The concept of *Cliff-hanger* explored these dependencies: designers illustrated their vision using parametric software and produced large-scale designs to express their unique parametric language.

2.2 SCRIPTING

Scripting uses computer programming languages that typically remain in their original form, are interpreted command by command, and are interchanged each time they run. 'Script' is derived from the term for written dialogue in the performing arts, where actors are given directions to perform or interpret.

Scripting languages are not technical. They define a set of rules, which are based on parameters. Scripts or rules also make applications programmable from within, so that repetitive tasks can be automated, potentially offering endless possibilities due to content and behaviours that can be set up.

Using digital techniques in spatial design, the theme of *Cliff-hanger* addressed parameters intrinsic to the built form of the physical gallery space: scale, gravity, materiality and site. However, instead of using compositional methods for designing, the artists utilise a script that takes over. The script forms its own generative properties - its own logic - like tree branching, motion of a flock of birds, or fluidities. Sourcing any form of algorithm, parameters or computation rules, the script is edited and controlled by the designer and applied to the constraints of the gallery space.

2.3 FABRICATION

Another stage in the creative process is the fabrication of the digitally created designs. Recent fabrication technologies have allowed architecture to take new directions. The combination of computer technology with computer-controlled machinery has made it possible for any shape, however complex or irregular, to be built. The artworks of *Disparallel Spaces* explored novel avenues of architecture that lie in the transformation of virtual design conceptions to physical objects via the use of computer-aided manufacturing.

2.4 EXHIBITION

After the design-studio *Cliff-hanger* was completed, the produced work could be curated to fit an exhibition showcasing the designers' engagement with parametric designing and fabrication. To mark the distinctive final stage of presentation in celebrative conclusion of design development, the exhibition was named 'Disparallel Spaces' (Figure 1). The event exemplified how digital architectural design can conceptually and artistically engage with any particular site, in this case, the Tin Sheds Gallery, where a variety of solutions to problems in architectural design were presented from a diversity of multi-faceted and eccentric approaches. The participating designers pushed creativity to new boundaries in definition of their artwork and cultural contexts, setting the direction for poetic viewpoints on innovation in architecture and spatial design.



Figure 1: Tin Sheds Gallery with Disparallel Spaces

3. Parametric artworks

As the participants were able to acquire a high level of skill in the use of specific tools, they employed them primarily as an amplifier to generate their designs. Based on their complex and interrelating parameters, scripts, and architectural interpretation of the theme *Cliff-hanger*, each design proposal emerged in its own unique exhibition setting. However, all the designs shared the common fact that each could not have been communicated using traditional architectural design methods or tools.

One of the many proposals was a translation of a music piece into architecture (Figure 2) . Parameters transcribed 48 virtual forms derived from the preludes and fugues of Book I of *The Well-Tempered Clavier* (bww 846-869) by J. S. Bach (1685-1750) . The physical form represented the relationship between music and architecture in the Western tradition, and its relevance to contemporary thought and practice. In illustrating the parametric forms produced, the exhibited artwork was a physical entity of "musical virtual space" .



Figure 2: Peter Christensen: Spatial Polyphony, Fuge C major

Another design proposal explored the manipulation of attributes, such as surfaces, lines and vertices, parametric scripts of scattering, cracking, weaving and flocking (Figure 3). The installation captured the sweep and surge of a flock of birds in a physical realization of a digital process. Perspex, steel, wire, and mathematical computation amalgamated in translation into a visual cadence, breathing and existing, as it glided through the interior space of the gallery. The group of designers behind this art piece constructed an exact replication of the attributes and behaviours manifested by a flock of birds in flight, presenting integrated and layered complexities. The parameters and scripted design rules used in the development process provided the designers with complete control over the 'living organisms' they had created.



Figure 3: N. Barbov, D. Catalano, C. Doherty, M. Earl, K. Freney, E. Seeto, K. Shuttle & K. Zhuge: Stop Motion

One particular sculpture in the exhibition took the form of two distinctive interlocking skins. Utilising characteristics of typical coloured pencils, the piece explored the formal and structural properties of the hexagonal prism. It challenged the rigid, structurally efficient, and directional form by juxtaposing it with a pair of organic, playful skins. At a conceptual level, the piece investigated positive and negative spaces created by the skins and the interplay between them. The seemingly obsolete pencil as tool component adopted in digital designing received newfangled meaning that has subsequently made it indispensable (Figure 4).



Figure 4: James Garvan: Pencils

In another proposal named ‘para/site’, the designer developed a mycorrhizal relationship with its host, the gallery space (Figure 5). The urban para/site seeks opportunities in which to thrive, based on the needs of its architectural biology (appropriate structure, access, electricity, sunlight, water). Once a suitable site is discovered, the para/site employs a cellular growth pattern, creating a skeletal voronoi space frame structure. The para/site depends on its host for survival and through its establishment forms a new architectural engagement. These new parallel-sites are its symbiotic gift to its host. The para/site implements an intelligent cellular growth algorithm intended to mimic precedents of growth from the natural world. The resulting design is a function of the growth algorithm’s responsiveness to the environment in which it finds itself.

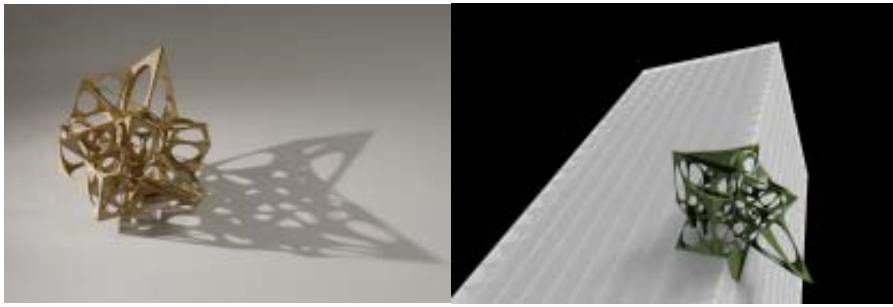


Figure 5: Paul Hohnen: *para/site*

Amongst the many other designs was one that explored the inherent parameters of graffiti art. In recent years, graffiti has undergone a rapid stylistic evolution - what began as a mere distortion of traditional planar letters has been gradually replaced by abstract, less conventional approaches. Today, graffiti is having its boundaries pushed to the limit as artists develop styles, which give their artwork the illusion of leaping from a two-dimensional space. Exploration has its constraints, however, such as the physical restriction of the wall, page or other planar surface upon which the artist's work is set. 'Graffiti's Third Dimension' (Figure 6) uses digital media to explore the representation of a two-dimensional culture in three-dimensional space. A simple tag is taken and extruded to generate a model built by a series of flat, stacked sections – a reminder of the tag's planar origins. This spatial graffiti is then placed into context with its own negative by subtracting the model's volume from a similarly sized rectangular prism.

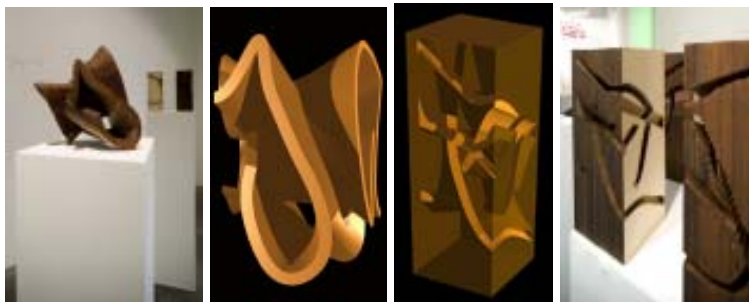


Figure 6: Caroline Granjean-Thomson: *Graffiti's Third Dimension*

The conventional interpretation of space is typically generated into two-dimensional architectural drawings that intend to convey a particular spatial dimension. In one of the designs, 'Sense Space Synthesis' (Figure 7) challenged this creation and perception of space, gravity, boundary and dimension through means of digital interpretations. The principle of this exploration aimed to tackle volume over surface, using forms with responsive characteristics that define the concept of ever-changing spatial dimensions. This responsive form demonstrated the relationship between senses and space in a digital representation. The idea of a sensorial space underwent extensive experimentation through different parametric translations, consequently expressed by an animation that sought to provide a macro and micro sense via projection on a sphere that distorted the image by merging what was real and virtual into a single sensorial experience.

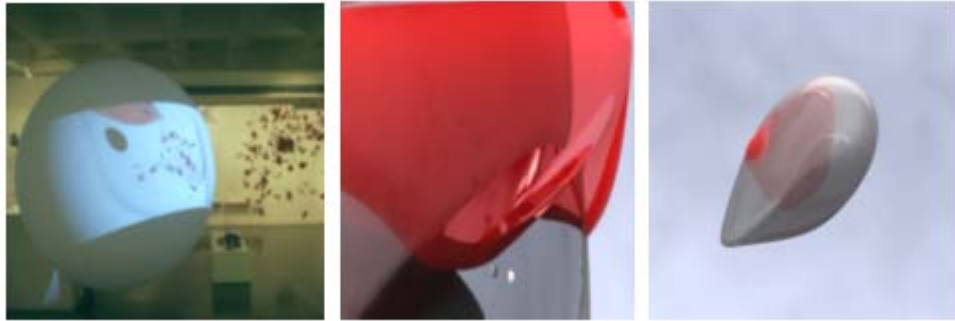


Figure 7: Andrew Kyon & Jennifer Lua: *Sense, Space & Synthesis*

In her work 'Line, Form & Volume', the designer explored the visual qualities and properties manifested in the draping of a material over a form (Figure 8). By employing processes of draping, folding and stretching, the parameters of a material's surface were changed. A draped material creates a series of folded ribs that become structural. 'Line, Form & Volume' utilised these contours to create a mould which ultimately became the positive form itself.

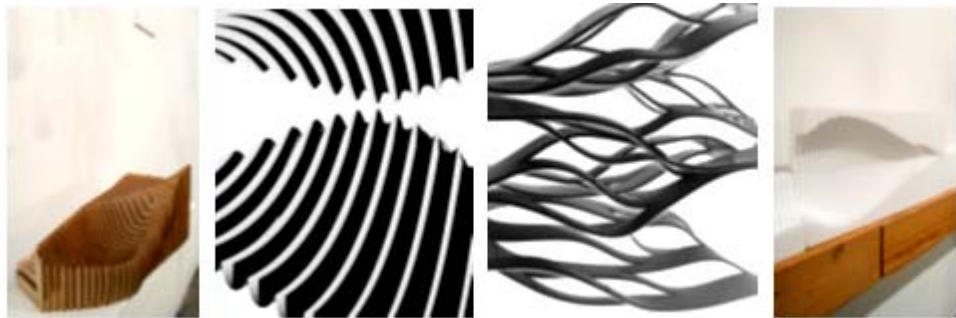


Figure 8: Miruna Sladescu: *Line, Form & Volume*

Other designers chose to explore a variety of other concepts, such as digital technologies and their application in architectural design. One of these is 'Erosive Fluidity' (Figure 9), which focused on evolutionary design - a creative process that uses the neo-Darwinian model of evolution to solve complex ill-defined problems. The artwork's group of designers began by generating complexity through simple rules, resulting in unique architectural spaces. In a subsequent stage, the underlying rules and process behind 'Erosive Fluidity' were used to investigate the technique of animation and digitally controlled manufacturing to create a responsive system within the gallery space. The resulting liquid form was endowed with an almost life-like behaviour, weaving through the interior space, setting off and responding to environmental events.

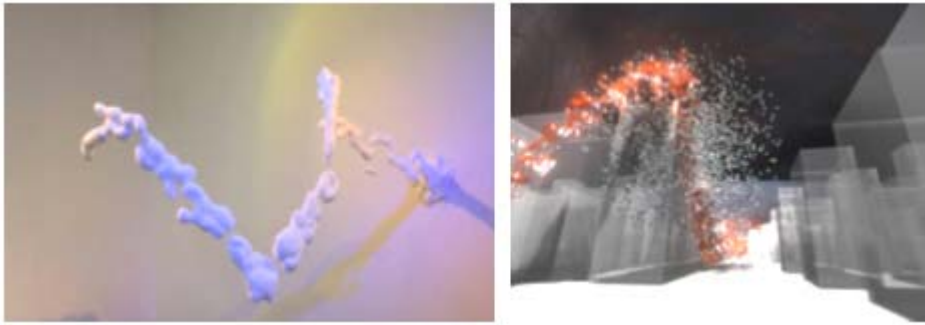


Figure 9: B. Coorey, N. Tan, H. Beresford, and J. Thompson: *Erosive Fluidity*

In its entirety, the participating designers of *Disparallel Spaces* demonstrated a competent level of design thinking through their individual artworks, resulting in the conception of compound rules and dependencies that ultimately produced the artistic schemes. The designers obtained a high level of skill and expertise in their employment of digital parametric tools and fabrication processes, using this knowledge to design from an unprecedented parametric approach. The art collection attested to the artists' style of thinking and depth of understanding required of parametric design, and determination in achieving their conceptual aim and anticipated outcome, breaking away from conventional design trends that deal with one problem at a time, regardless of its dependencies. The exemplified works of the *Disparallel Spaces* exhibition (Figure 10) illustrates how non-linear design processes and the re-representation of ideas can lead to architectural expressions that deviate from typical approaches in their differing natures of design creation. Exploration of these gestalts can enhance the understanding of spatial issues and lead to meaningful and responsive architectural descriptions in a much greater context. Despite the fact that three-dimensional representations of an architectural space serves only as a platform with which to aid understanding and communication of spatial arrangement, the parametric medium acts to further encourage, enable, and enhance designers' comprehension of complex spatial qualities via re-representations. *Disparallel Spaces* brings to light the myriad of possibilities made possible through engagement of the process of translation itself as a creative act.



Figure 10: Tin Sheds Gallery Space; L. Huan: *Rain* and K. Thomas: *Rigid Fluidity*

4. Conclusions

Tin Shed Gallery's *Disparallel Spaces* addressed computational concepts of designing and fabrication that influence recent development of architectural production. The event also explored innovative methods of architectural expression, form finding, and communication,

whilst developing unconventional solutions to a proposed design problem. The coupling of novel design creation with an art exhibition closes the gap between acquisition of skills and the reflection of knowledge, as well as discovering methods of framing and integrating compound design issues.

The use of digital parametric tools allowed all participants to design within an environment based on rules and generative descriptions, amplifying their understanding of the creative process and its learning outcomes. Each designer bridged the rift between their knowledge and ambition, creating inspiring concepts and never-seen-before proposals. The compiling of all projects into a single exhibition removed the artists from the context of individual ownership, providing them with the invaluable opportunity to reflect on both their own and their colleagues' proposals as a coherent collection of contributions towards one concept of design.

With knowledgeable employment of parametric software, the designers were able to experience the dependencies and rules of the various artworks in a spatial aspect. Each design could be communicated using both physical and digital models or representations. Design data generated can then be linked in numerous ways to extract or conceive new geometric forms and understandings. The resulting descriptions can be used directly in the manufacturing of objects controlled either by digital or manual assembly.

Every phase and development is an essential constituent of the design process, each addressing and expressing an important aspect of learning and the artistic experience. A holistic discussion about design, form, function, and development is consequently established - a significant venture not only within the architectural realm, but also in all other dialogues involving spatial representation.

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