Multiverse of a Form

Snowflake to Shelder

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The almost seamless integration of computation, fabrication and immersion technologies in architecture not only constitutes potentials for exploring design instances through multiple media but also changes design paradigm from form-formation to form-formation-exploration. In this sense, multiverse of design as proposed in this study and integration of various design technologies from virtual to real aims to advance higher order thinking skills and a more exclusive design exploration in computational design process. Undoubtedly, the multiverse of design cannot be handled without emerging technologies temptingly easing fabrication in both physical and virtual realms. On the other hand, such technologies can easily be deceptive in regard with scale, choice of material, details and etc. Therefore, how and which modes of exploration (physical or virtual) should be integrated into the design process is critical. “Exploration of design” in the realm of new technologies does not only connote a formal exploration of design and its performance but it also becomes a way learning/thinking of design enhancing critical thinking and constructivist learning. Within the scope of this study, the multiverse of a form(ation) is explained thoroughly and exemplified through snowflake pavilion which is issued to 4th year and graduate students in the scope of an elective studio course. Snowflake pavillon comprises physical, virtual and mapped reality as a triskelion for immersive experience for visitors.

Keywords: Virtual Reality, Augmented Reality, Physical Reality, Fabrication Technologies, Multiverse of Design

INTRODUCTION

“Architects use concepts about space to solve problems and to form designs. A design concept is the manifestation of the basic instability of our mental performance: it is a makeshift that provides general direction for exploration. In synthesis architects explore concepts by inventing transitions that conclude to the description of artifacts” (Kotspoulos 2005)

The impact of computation, fabrication and immersion technologies (VR, AR) in architecture
been observed in many ways and at different scales. Almost seamless integration of these technologies offers great potentials in design and to designer (Sorguç et al. 2017). Today computational design cannot be thought without considering the proper fabrication technologies and the modes of exploration. Hence designers have more means to “form design” and many artifacts exhibit how the design paradigm has been changing from form-formation to form-formation-exploration. This possibility of exploration of any instance and any state of the design through multiple media offers a new understanding, perception and cognition of the space. In this vein, the whole design process which is manifested in a multiple way can be considered as the MULTIVERSE of the form(ation) itself. Hence today what is experienced through new digital design, fabrication and immersion technologies broaden our understanding of design process and the space itself.

THE ROLE OF DESIGN AND FABRICATION TECHNOLOGIES
Research on CAAD technologies with the advents of new design and representation means like AR and VR broadens its extend by focusing on physical, virtual and cognitive dialogues between human, computer and the design as well. Especially the use of VR technologies in architectural design is very promising enhancing learning and thinking the design process through media interaction. Learning/thinking through media (any soft or hard models) interaction is not a separated step which happens after thinking, but it denotes the notion of experimentalism, play and constructivism (Ataman and Lonnman 1996; Neiman and Bermudez 1997).

The concept multiverse of design as proposed in this study and integration of various design technologies from virtual to real aims to further develop higher order thinking skills in computational design process. Active engagement of designers into all phases of design process through continuous interaction of any instance of their design involves thinking and practice simultaneously. In the realm of computational design process, and its multiverse virtual reality implies more than the use of computer graphics and various human-computer interaction devices in a virtual environment, but it becomes a valuable mean to further explore multi-dimensional, dynamic and generative computational design process in an immersive way. The possibility of visualizing any information or a dynamic relation between multiple variables/parameters by visual, auditory or haptic representations, allow its users to explore and interact with the any instance of design(or formation process) in real-time. Hence the inclusion of immersive experiences brought by VR and AR technologies introduce a new way of spatial cognitive experience as a complementary design tool or a mean for any time exploration of the design/space itself extending the boundaries of the formation process.

Another important issue as acknowledged by all the computational design community is the dialogue between soft model and its fabrication/construction. The transformation from digital to physical in complex forms is not an easy process especially when different modes of production are employed. In most cases, an iterative process between the soft model and the physical one is unavoidable. Hence, developing various models in different scales and in different media with different fabrication technologies (additive, subtractive or hybrid) is a common practice as a part of the current design activities.

The possibility of transforming any instance of design from immaterial to material acknowledges any instance of design process as “the final design/artefact” in its own complexity which can be fabricated easily. However, the tempting ease of using several rapid fabrication technologies and their versatility can easily be deceptive in regard with scale, choice of material, details and etc. Similarly, VR and AR technologies provide an illusive medium for which the material and physical constraints do not exist. Yet, such forces are directly shaping the immersive experience. Therefore, how and which modes of exploration (physical or virtual) should be integrated into the design process is critical to avoid any mis-
leading experience. In that sense design process becomes more extensive by redefining representation, interaction and experience and thus design exploration.

Hence “exploration of design” with the advents of new technologies does not only connote a formal exploration of design and its performance but it becomes a way learning/thinking of design enhancing critical thinking and constructivist learning. The presence of designer from screen to immersion into the virtual reality has a strong influence not only in the design process but also on the modes of learning.

Although parametric design with all means is already a common practice, transformation of “form to formation” is still an intriguing issue in which the initial form, as we may call form at t=0, plays a crucial role in the diversity of the outcomes (i.e. all the t instances of the design process in digital or physical media). t=0 form in parametric design is not a mere beginning of the design process but also it constitutes a reference system in which all the parameters, their relations and thus the main concept of the design are embedded through this t=0 form. In a broader sense, t=0 form is the new reference for space exploration in the parametric design process. How designers can decide on the t=0 moment of the design process and the related initial state of the form from which the whole design process is to be built on still remains a major discussion and subject of many types of research.

As it is briefly explained above, today parametric design process should not be considered without including the fabrication processes and its exploration by different means. Hence “Form to formation” and “digital to material” transformations should be revisited regarding their different instances like form(ation) at the initial state, form(ation) at any instance of design processes and the form that is preferred as the final artifact together with possible means of conveying (Kolarevic 2003).

The idea of the multiverse of a form(ation) is explained in the following design, and construction of the snowflake pavilion which is issued to 4th year and graduate students in the scope of an elective studio course.

**SNOWFLAKE TO PAVILION**

Students are asked to design a pavilion which is capable of adapting itself to different locations and environmental conditions. They are also asked to develop the pavilion in a biomimetic perspective (Benyus 2002; Knippers et al. 2016; Speck et al. 2017). Examples from nature, (animate or inanimate) is a very valuable asset to define the t=0 form and the related computational design process. Accordingly, the snowflake is given as the initial reference for their studies. As the initial reference proposes a t=0 reference to the students, it also provides a wide range of formation references with various morphologies of different snowflakes. Therefore the morphologies are examined and major features like symmetries, branching and their variations in relation to environmental changes are used to define the initial state and design process.

Students used paneling method to cope with the issued pavilion task by dividing full size model into smaller units. Both units and overall form are gen-
erated based on the analysis and simulation based on snowflake unit and behavior. They approached to snowflake to comprehend its crystallization process by analyzing its changing morphology through time (Figure 1a). Decoded 2-dimensional morphological patterns are mapped into 3-dimensional unit variations (Figure 1b) which come into scene on the surface of the pavilion according to forces of the environment based on interpretations defined by the students (Figure 2).

The environmental forces have also an influence on the overall form of the pavilion which is defined at the t=0 moment as a basic shell with all possible instances in different locations in the university along with the radiation analysis (Figure 3).

Then, according to the environmental forces and changing morphology of the pavilion, units are determined and adapted. The resultant instance of the pavilion is generated in different media: digital, physical, virtual and mapped realities which can be seen in Figure 4.

Through the snowflake pavilion, students had chance to explore various modelling, simulation and manufacturing software along with different modes of production such as prototyping, VR, and video projection. In the course of implementation, Rhinoceros is used for modelling and detailing, Autodesk Maya and Unity are employed for VR and Autodesk 3ds Max and Adobe After Effects are utilized for video mapping. Moreover, adapting the model into different media along with various environments leads the students to revisit the design process especially the decisions made during the t=0 moment.

The snowflake experience was shared with the members of the faculty, with many visitors and invited guests to observe, compare and understand the impact of both physical and virtual immersive experiences on users.

CONCLUSION
It is seen that, the multiplicity of the design and exploration environments (from scale models to full size, from real to virtual) and possibility to explore them all at once i.e. the multiverse of the snowflake pavilion brings a broader spatial experience to both designers and visitors. While the built pavilion exhibits one of the possible instances of the formation
Figure 3
Instances of Snowflake Pavillon for different locations and radiation analysis.
process, in VR and AR many instances of the pavilion is experienced in an immersive way allowing to experience temporal and spatial changes. Video mapping process included in the design offers a new way of interaction/inquest of form of the pavilion rather than the contained space in it. It is seen that the culmination of different experiences of the snowflake pavilion result in a different spatial cognition and understanding of form(ation) process.

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