Exploring the Shift of Architectural Form 'Form Making to Form Finding'

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***Abstract*— Information technology has changed many dimensions of life. Its impact on architectural form is no exception. This paper discusses initially about, Post-modern era that was more about 'architectural expression and its meaning' where its expression and meaning was given more importance. Digital technology changed face of architecture and as a fascination for new form, it started producing new genre of forms which were impossible to imagine previously. This form making approach seems superficial when it started facing lot of architectural issues like construction, material and maintenance of such buildings. But now one can see there is shift from 'form making' to 'form finding'. The emphasis of the paper is on form-finding over form- making, on bottom-up over top-down processes, & on formation rather than form. 'Formation' must be recognized as being linked to the terms 'information' & 'performance'. This paper investigates, in contemporary architectural practices where form making is given more importance, has many architectural issues. Research aims to explore the shift of architectural form 'Form making to form finding'. Objectives are identification of parameters to study and analyze the buildings based on same. Case study method is used for analysis. Buildings were chosen based on the way form is conceived and manifested. While analyzing the buildings few parameters were considered e.g., logic of form, structure, material etc. While searching for matured approach natural evolutionary processes is taken as inspiration. Paper conclude on the new way of design & tries to demonstrate methodology which has holistic approach, one step towards sustainability.**

Keywords*— *Performative architecture; computational morphogenesis; tectonics; emergence, bottom-up process.

I. INTRODUCTION

In contemporary architecture, visual appearance has more importance as today's many areas of architectural production remain deeply rooted in Post-Modern concerns for appearance. That era was more about 'quest for interpretation & meaning' whereas because of globalization there are many issues that today's society is dealing with & architecture being integral part of it, architectural practice is more concern about optimal use of natural resources & energy. One can see awareness about energy conservation because the idea of entropy got introduced. Till now science & technology was ignored in architecture while history & theory was given more importance. But now scientific thinking is finding better space in architectural realm which gives new ways of production of architecture. During this, process of optimization & using scientific knowledge base one has to use digital technologies to a great extent.

Use of Digital technologies in architecture has increased because of creation of complex geometries and control on the same is possible. Even these virtual models are supported with manufacturing capabilities for actual fabrication process. Idea of production has changed from 'mold making' and now transferred to 'File to product'. This means if the virtual file of a product can produce actual product with the help of digital tools such as 3D printing. This is known as stylistic break because of new digital tools. From this 'form making' approach got emerged.

2. ISSUES OF 'FORM MAKING'

Digital fabrication gave confidence that whatever designer conceive as an idea can be constructed. Many times, it was without thinking of appropriate material & technology. In 'form making' approach, form is conceived first & then material system is selected as top-down engineering process. Instead, there should be simultaneous thinking of form, structure & supporting material. When such top-down approach is adopted, one could notice, many design & technical issues.

2.1 DISNEY CONCERT HALL (2003)

Actual form of concert hall is a resultant of iterative process of lot of acoustical analysis and it is highly performative. Shape of hall is adjusted according to technical analysis that gives efficient floor plan. It actually justified derived form. Internal structure is of lattice frame, it plays an important role in overall load transfer. One of F.O.Gehry's interview he mentioned that initially he was thinking of stone to be used for cladding but Bilbao got popularity, owner insist to use similar material. But to achieve sculptural expression designer has used thin metal sheets with doubly curved surfaces to hide internal lattice structure. Here outer external expression does not convey logic of internal form development. Envelop & structure is different and hence there is not synchronised thinking in terms of form & material used. It is not possible to experience flow of forces through building elements & joints [1].

Figure 1Internal Lattice Frame

Figure 2 Metal sheet of doubly curved surfaces

2.2 BMW BUBBLE PAVILION (2000)

It is basically designed for to covey social message of clean energy from water and the sun was symbolized in the form of an iconic structure: a drop of water. A drop simulation computer program was used to create this shape. Form is derived from a dynamic process to express the balance between internal pressure and surface tension of a drop of water, designer simulated physical forces of two drops merging under the influence of gravity, and so the Bubble was generated. It is one of the first examples of building fully designed and manufactured using digital tools. The material & construction are well chosen purpose, like high quality finish & elegance. Here again structure and skin are different. Construction is simple to show logic of forces. But structure worked for shape instead with it. So, in terms of performance, it fails.

Figure 4 Actual structural frames

Figure 3 BMW Pavilion

From above two case studies one can see that there are lot of issues in terms of construction, lack of integration of different systems. Actually F.O. Gehry is the first person who cracked this digital technology & design magnificent structures. But after sometime his structures got lot of criticism for 'form making' approach. This fascination for 'form making' is undergoing change. As Menges [3] has pointed out, Software used for form generation can only assign not integrate the properties and logics of material, structure and form to be constructed. This inconsistency between digital form definition and material reality of building has unfortunately led to qualitative problems and disappointments. Just 'form making' approach will not help [1].

3. SHIFT FROM 'FORM MAKING' TO 'FORM FINDING'

Hensel and Menges [2] discussed that Computer based design processes enable us to engage in a much more fundamental way with the principles of higher-level functionality and integration in nature and suggest new modes of designing through an expanded set of computational techniques and technologies. After analysing 'form making' approach & with the help of more matured, refined digital technology there is new thought process, it talks about 'Integration of material, structure, responses to context & responding form to all this; is more important'. Form finding approach is demonstrated in Aquatic centre at Beijing where concept of water foam is used in holistic manner. Referring study of physicist, geometry of soap bubble is well manifested & integrative thinking of material, climatic aspects evolve form.

3.1 THE NATIONAL SWIMMING CENTRE, BEIJING (2003)

A building that is not only expresses some of the abstract characteristics of water, but one that tightly integrates skin, structure, and the performance requirements. Being a swimming center designer wanted to use abstract concept of water. To capture the "spirit" of water, designer wanted the building to dematerialize, to change moods, to react to changes in the environment around it. Analogy of water foam is used to resolve geometry of soap bubble. This geometry also enhanced by using scientific principle 'how to divide space into an equal number of cells with the least surface area between them'. To materialize this, steel & ethylene tetra fluoro ethylene (ETFE) is used. Selection of material is appropriate for light weight, better acoustic and insulating properties, which eliminated the need for a secondary structure to support the skin. Other than conceptual from generation, actual form is refined introducing cavity wall and roof, it helps is passive heating. There are few typical ETFE pillow but none of the pillows have exactly the same orientation, the result is that no two cushions are alike. The way this structure is demonstrated where structural material, structural system and space carved out is so integrated which changed idea of stadium. Typical stadium had pylons and trusses whereas water cube has carved out space from structural foam.

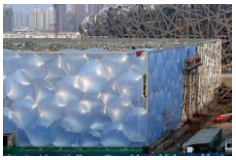

Figure 5 Metal structure and ETFE pillows

Figure 6 Experience of carved space

3.2 SERPENTINE PAVILION

In 'Deep Decoration' article author discussed about Serpentine pavilion. An article talks about, a structure based on a circling placement of twisted squares and their primary lines of force that then wrapped down and around the space, crossing and folding back to form angular forms which were, according to an algorithm, filled with solid or glazed surfaces for ceiling, floor, and walls. Out of box design emerged due to Toyo Ito's collaboration with Cecil Balmond which gives holistic approach to their design. The pavilion is a physical manifestation of an algorithm: pattern and structure are integrated. Ito and Balmond have created the building out of structure, as structure, which produces complex patterning. It is said that this box has given new expression where cohesiveness of material, technology, form is found at higher level [1].

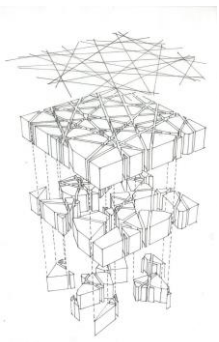

Figure 7 Pattern and structure are integrated

4. IMPORTANCE OF NATURAL EVOLUTIONARY PROCESSES

While using scientific analogies, every branch is playing its own important role. The reason for using biological analogies is as both attempts to model growth & adaptation. In today's architectural practice digital tools are used to create design schemes where similar tools can be used for morphological & performative capacities for a structure. Everyone knows that all natural processes are optimal & bottom-up processes. Out of many natural processes morphogenesis is a complex evolutionary process. It is associated with form, structure, immediate environment, material & emerging geometry. Logic of morphogenesis has not gone beyond as a metaphor. In nature, form is derived from material, structure & environmental stimuli. Due to evolutionary adaptive processes, self-organization takes place which gradually gives an emergence for a new form. As in complex systems small change in one of the constituents will affect on an overall configuration of the system. This entire process gives logic to new form i.e., morphogenesis. These evolutionary processes in nature will help to generate new logic for form finding which will support, a bottom –up approach. As in natural morphogenesis formation & materialization processes are always inherently & inseparably related, similarly in architecture same analogy should be used. Oxman R., [4] is explaining how designers can take help of natural processes. Some of those are stated below:

1. Use of emergence
2. Self – organization- physical form finding as pioneered by Frei Otto and others, is a design technique that utilises the self-organization of material system under the influence of extrinsic forces.
3. Adaptive evolutionary processes
4. Bottom-up processes

All these processes are generative and directly borrowed from nature. While the application of all these processes is changing as per perception of each designer. Depending upon individual's deep understanding application in architecture will be holistic or integrated solution.

New method for Performative structure

An alternative design technique is a morphogenetic approach that involves examining morphological complexity and performative capacities of materials without separating the formation and materialization processes.

BOTTOM UP PROCESSES & ITS IMPORTANCE

Salma A. [5] discussed in her thesis for this bottom –up processes, one needs to do lot of research for a broader spectrum where designers start with a particular biological solution in mind. Then define the biological solution. Based on potential solutions study has given one needs to extract principles. Most importantly one requires reframing the solution. This step forces designer to think in terms of how humans might view the usefulness of the biological function being achieved. In problem search step, search in the biological domain includes search through some finite space of documented biological solutions, problem search may include defining entirely new problems. This is much different than the solution search step in the problem-driven process. Problem definition will be based on study conducted and then principal application to solve problem in holistic way.

CONCLUSION

Digital technology and concepts derived from the same is getting manifested in more matured manner. Instead of visual form and expression, performance logic is playing vital role. The term tectonic is now getting refined due to awareness of performance of structure. Performance in terms of material, structural system, responsiveness to environment and form evolved from all this is becoming more important. This integrative approach is missing in two examples where that structure is facing lot of issues. While in water cube, one can see consistency in architectural expression, space and structural system. To achieve coherence in performance on all fronts, natural processes are used by N.Oxman and A.Menges gives deeper insight. Now rather than reiterating, recombining and simply varying existing concepts and design knowledge fused into the description of type, evolutionary computation provides for truly explorative processes with the capacity to discover and unfold novel design possibilities

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