

Concept of Creativity and Innovation in Architectural Design Process

Danfulani Babangida Idi and Khairul Anwar Bin Mohamed Khaidzir

Abstract—Solution to a design problem can be achieved by understanding the holistic nature of the problem before adopting a problem solving process. As part of Architectural design problem solving Creativity and Innovation are among factors that incorporate new concepts and methods in designing. But, unfortunately these factors are affected by financial position and designer's level of experience. This study aimed at identifying factors that influence creativity and innovation in architectural design management through the process of observing design from inception to the concluding stage. The management process comprises of design brief, problem identification, search for solutions, design development, detail design, construction process together with pre and post occupancy evaluations. All these activities constitute architectural design management. This paper further identifies some of the functions of creativity and innovation in these managerial part of architectural design process. Among the functions identified are designer ideation processes, visual perception of aesthetics on physical elements use for façade design, together with the choice and applicability of building materials. These entire factors represent function of creativity and innovation in architectural design considered for this study. Designer ideation process was explained as part of designer behavior/actions in generating and manipulating the concept of the design. Visual perception of aesthetics on physical elements use for façade design represents the perception of aesthetics attached to the building elements use for the façade design. Finally the choice of building material represents frequent choice and application of newly innovated building material in the design. Designer privilege to introduce and manage new design concepts such as shapes, texture, appearance, materials and technological advance in a given design was among other function of creativity and innovation acknowledged in this paper. The paper finally concludes that creativity and innovation are among factors that influence designer ideation, building appearance and choice of building material in architectural design.

Index Terms—Architectural design, building appearance, construction materials, designer ideation.

I. INTRODUCTION

Architectural design process is the scientific study of existing ideas, thought and thinking in getting detail solution of an architectural design. It's explained that the difference between architectural design process and scientific methods is that, architectural design is concerned with how things ought to be done while natural sciences are concerned with how things are [1]. Generally it is considered that the difference between architectural, mechanical and industrial design

processes is the aspect of the problem considered, the primary source of knowledge, the degree of commitment made to output statement, the level of detail, and finally the method of transformation [2]. Design process is a method that reveals how things are created.

Fig. 1 illustrates the composition of four different activities in architectural design. Assimilation represents the process of gathering information related to the proposed design such as verbal communication with client and documentation of the design brief. The complete analysis of design problem and the identification of most suitable design solution constitute the components of general study. The growth and refinement of tentative solutions isolated during general study is what is referred to as development. Finally, communication is the act of representation design information to design teams, client, user and general public.

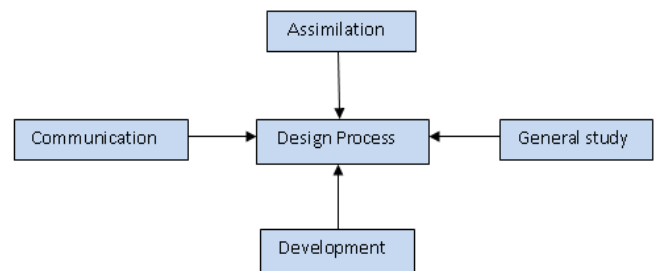


Fig. 1. Maps of design process by [3].

Architectural design is a combination of graphical and theoretical solution to a problem, such as residential design, industrial design, institutional design, religious design, and commercial design. The solution take the forms of plans, elevations, sections, details, perspective, graph, analysis of proposed and existing features. Table I, demonstrates stages involve in architectural design process. In solving these problems, designers' use thinking and drawing as a tool in achieving the required creative result [4]. Creativity and Innovation is important throughout the life span of the project. Some of its functions include generation and improvement of design idea together with improving perception of aesthetics on physical elements use for façade design. Other functions of creativity-innovation include choice and application of modern building materials [5], [6].

II. IDEATION

Designers/Architects generate analysis of their design ideas through drawings, written word and verbal expressions. Idea generation is an activity that transforms conceptual idea to concrete idea. Technique like brainstorming is commonly applied by designers for idea generation purposes. It is

obvious that such a critical part of human endeavor is an important part of the design process.

TABLE I: ARCHITECTURAL DESIGN PROCESS
Architectural Design Process

| Task | Stages | Description |
|---------------|--------|--|
| Assimilation | A | Meeting |
| | B | Design brief |
| | C | Investigation |
| General Study | D | Problem Identification |
| | E | Possible Solutions |
| | F | Growth of Solution |
| | G | Refinement of Solution |
| Development | H | Tentative Solution |
| | J | Representation of Solutions to design and Construction Teams |

Imagery is a mental picture in which a designer formulates in his/her mind a design and such representation comes in abstract form. The designer uses mental imagery and perception as a tool to represent his ideas at the mental stage. Mental imagery is an idea that was generated, evaluated, and transformed by the designer as a solution to a design problem. Meanwhile, perception is an idea which is triggered by a similar experiential idea either from a stored memory or perceived from the physical element of the immediate environment or the product of objects or events that exist.

Evidence of the importance of mental imagery in memory, reasoning and invention, and research reveal that awesome proportion of the brain is dedicated to vision. Evidence from cognitive science suggests that the mind uses imagery and verbal processes for complementary and interdependent purposes. This suggests that it may be an error to separate, as one tends to do visual or depicts from propositional mode of education. It has been scientifically indicated that visual thinking use different brain systems from verbal. When a person visualizes something blood runs faster in the visual cortex. Research carried out on patients' show that injury to the left half of the brain can stop the generation of visual images. Mental imagery is a vital tool for brainstorming activities. It is in these activities that "mental synthesis" is employed in the process of analysis and evaluation [7].

Fig. 2 illustrates the process of imagery using mental synthesis to integrate different objects and symbols together to form a single object. Designers use mental imagery to manipulate shapes and forms to recombine them in a meaningful and even more creative ways in designing. Mental imagery gives the designer the ability to visualize ideas in the form of diagrammatic depictions and illustrations. Humans used mental imagery in hunting, agriculture, and to make household tools throughout history. Today, mental abilities

have addressed most design problems [8].

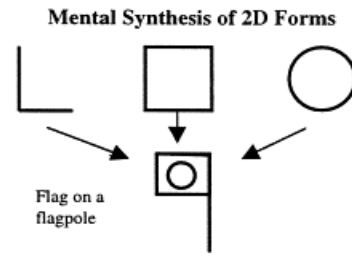


Fig. 2. Creative mental syntheses by [7].

Studies of mental abilities indicate that in an environment perceived to have high imaginative potentials; people get higher scores in design tests than environments with low imaginative potential. A study was conducted by [9] where participants in one group were asked to generate ideas in response to a specific task after being shown words stimuli while another group was shown picture and word stimuli. The use of picture stimuli elicited more creative ideas than word or combined stimuli.

The early stage of design process, identification of the design problem, design thinking, verbal communication, gathering of data and literature review, sketches are among the preliminary design activities Visual representation in design is viewed here as a transformation/transition of conceptual visual knowledge, which enables the designer to immediately control, promote or evaluate specific characteristics of the design in progress. Visual aspects of the design are explored and reflected through sketches. Moreover, visual representations, such as sketches, are seen as a graphical problem solving method, in which conceptual ideas of the design are concretized in visual form.

Sketching process is in the form of lateral and vertical transformation. Lateral transformation indicates the exploration of the slightly different design idea and widening the possibilities while vertical transformation entails producing sketches in deepening and more detailed versions of the same idea.

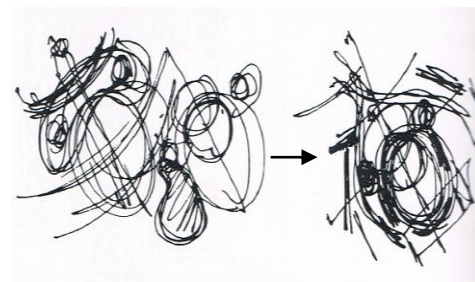


Fig. 3. Typical conceptual architectural design sketches by Goel.

The use of sketches is common to architects throughout history. It is almost impossible to understand the thinking of designers apart from their drawing because sketches unify thinking and image.

Ideation processes in Architectural design represents designer ability to think and generate new functional ideas that will become solutions to the architectural design problem. Designer ability is considered as designer fluency in sketching as a cognitive tool to the creation of design [10]. These sketches are normally significant in achieving a good design [11]. Fig. 4 illustrates ideation process in designer sketching

activity. Fig. 4a illustrates the initial idea of the design while Fig. 4b illustrates the final outcome of the ideation process.

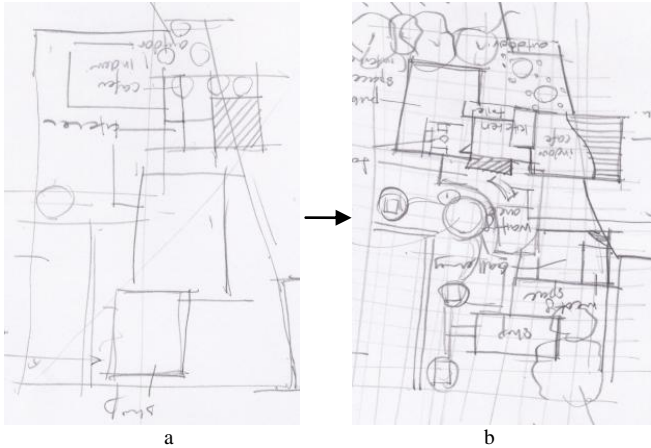


Fig. 4. Designer ideation process.

Ideation is among activities in the stages of preliminary design, design development and embodiment stages of Architectural design. Designers use their creative potential to contribute to the creation and maintenance of the world, they (designers') use ideation process as the basic concept of harmonizing and maintaining their design with the existing environmental features successfully [12]. These processes of transformation include the analysis of topography, vegetation, climate and infrastructure.

III. REPRESENTATION

All designers are concerned with the visual aspect of their design. Some designers use mental imagery to measure and ensure their design address the intended problem. Designers visualize designs being used in every possible situation through the process of grappling with the design problem until it is finally solved [13]. Visualization is a medium that generates design and technically presents it to the owner or client and the design team in facilitating the design process. This medium includes drawings, written word or verbal expression. Fig. 5 illustrates how visual representations are classified into categorical descriptions that represent abstract ideas or sign constraints and visual specific spatial depiction [14].

Designers in all disciplines exist in a very visual world of imagery which is the prime generator of visual thinking in designing. Drawings and modeling techniques in the form of two and three-dimensional representations are product of drawings, models, and pictures.

Methods of visualization in architectural design process include mental imagery, sketching, model making and computer technology. Fig. 6 illustrates different methods of visualization in architectural design process.

Drafting techniques in architectural design process are used for the miniaturization of the real and proposed environment in architectural design process on a greatly reduced scale. The information is manufactured into a graphic notation which is the media of architectural design where design ideas are represented as to be seen, talked about, and potentially, manipulated. Another important role of drafting is that designers engage in a conversation with drawings and thus

improve their design activity.

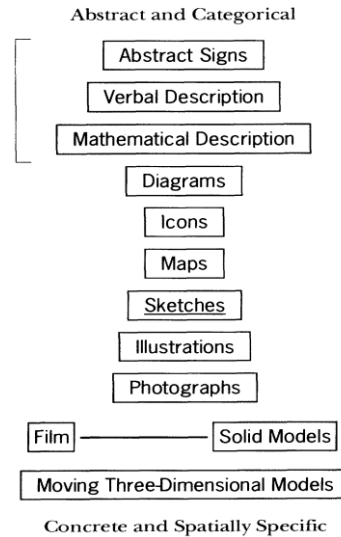


Fig. 5. Continuum of visual representation by [14].

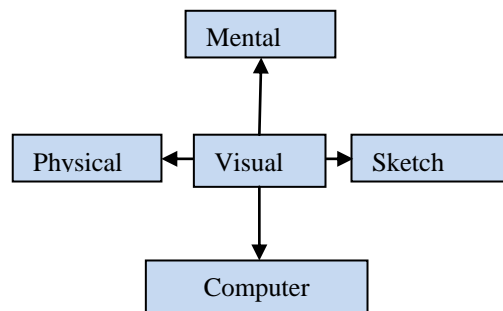


Fig. 6. Methods of visualization in architectural design process.

Drawings generally involve making marks on a surface by applying pressure from a tool, or moving a tool across a surface. Common tools are graphite pencils, pen and ink, inked brushes, wax color pencils, crayons, charcoals, pastels, and markers. Digital tools which simulate these effects are also used. Sketch is a cognitive tool for idea development [14]. Ambiguity means at the initial point, a sketch may little or no meaning and only the author of the sketch has an insight of what is happening in the sketch.

Sometimes even the author may not fully understand the initial sketch. Clarity of the drawing is also important for presentation and for the removal of ambiguity in a sketch. Sketching could be a search of unidentified images of an object through a continuous generation of different kinds of display until a convincing image is found. Sketches could also be used as a medium to explain an idea in detail. A sketch supports the communication of ideas between the author and the audiences. Idea representation through sketches is more likely to have the advantage of generating new ones.

Sketch is also a tool in design process that enhances thinking, regrouping, and interpretation. The reorganization of functional, conceptual, and perceptual ideas to eliminate ambiguity is also a function of sketches [15].

Through interpretation and reinterpretation in sketching new design ideas are also discovered. Fig. 7 illustrates a conventional method of drafting in architectural design process.

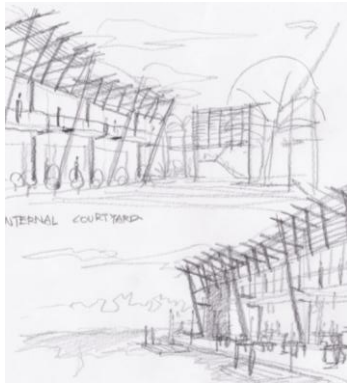


Fig. 7. Conventional drawing.

An artists' drawing is visual art that makes use of any number of drawing instruments to mark a two-dimensional medium. The most common support for drawing is paper, although other materials such as cardboard, plastic, leather, canvas and board, may be used. Temporary drawings may be made on a blackboard or whiteboard or indeed almost anything. The medium has also become popular as a means of public expression via graphic art, because of the easy availability of permanent markers.

It is obvious that the development of the CAAD system brought changes to contemporary architecture. The usage of CAAD system enhances the geometry of design forms, design speed, design accuracy, design development, flexibility of design, construction techniques and design presentation.

Through CAAD, marvelous forms and sophisticated construction techniques are introduced in modern design. Architects and designers have taken advantage of the CAAD system to produce landmark structures around the world. Some Architects confessed that CAAD system makes it possible for them to achieve all sorts of innovation [17].

When the CAAD system was first introduced people saw it as an oracle which would soon take control of all aspect of design. But after some decades ago it has only proves itself as a medium of drawing and arithmetic. Other design aspects such as structural analysis, climatic analysis, functional requirement, and even distribution of space are still not controlled by CAAD.

The computer actually helps to produce a generic 3D, whereby, aspects of construction technique, knowledge and applications of building materials are neglected [18]. Unlike design process which is relevant to structure, the users and the environment throughout the life span of a building, the computer only proves to serve as a draughtsman. Today most designers have a computer, and many use them for producing drawings [19].

Model brings a design project to life as vividly as a scale model display. Unlike an artist's rendering or computer animation projected on a monitor, a well-crafted scale model manifests dreams and ideas into physical and spatial reality generating enthusiasm and support far more effectively, no matter how well those other methods are carried out. Fig. 8 illustrates a visualization method of Haptic modeling in architectural design process.

Different classes of models in architectural design;

- Exterior model; buildings, landscaping, roads etc.
- Interior model; finishes, colors, furniture
- Landscape design model; walkways, bridge,

vegetation

- Urban model; town, cities, blocks etc
- Engineering and construction model; structural element.



Fig. 8. Physical model making.

Designer together with client, user, and the environment are all concern with the visual appearance of the design. As architecture is dynamic, new ideas and methods are always welcome in design education and practice. Experienced designer use inert abilities to generate and adopt a facade design that satisfies the aesthetic requirement of client, user and the environment at large.

Designers use imaginative thinking to perceive innovative ideas and applied them into their design to achieve good design view that satisfied the aesthetical requirement of the client, user and surrounding environment [20]. Due to the fact that designers know what can be done about a design it then becomes easier for them to innovate new design features and incorporate them into their design to satisfy the aesthetic needs of the design.

A design has to be visually pleasant and artistically comfortable before it can satisfy the requirement of aesthetic as a function of creativity and innovation in architectural design. Fig. 9 illustrates a comparison between two different images one is considered as aesthetically good while the other is considered as aesthetically poor

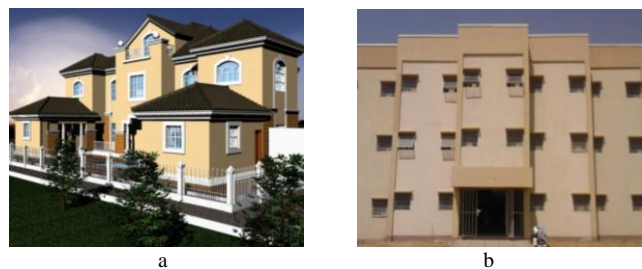


Fig. 9. The appearance of two designs.

Fig. 9a illustrate a design in which the designer introduce some aesthetical elements such as concrete eaves, hip roof, arch top windows, and some brick walling. These elements improve the visual perception of aesthetics on physical elements use for the façade design.

Hence, the design is considered as aesthetically good design. Fig. 9b illustrates a design in which the designer has not been able to use elements that could enhance the visual perception of aesthetics on physical elements use for the façade design. The design looks structurally stable but it lacks some elements that could improve the aesthetical qualities of the design such as roof exposure, wall cladding, window

styling, and painting. The introduction of these element could have influence the aesthetic qualities of the design. Hence the first design is consider been more creative and innovative.

IV. MATERIALS

Innovations in building materials are by no means a simple process. Initially, the material is invented or introduced, followed by testing the material, improving performance and finally expanding the development of the material. Newly innovated building materials such as carbon fibre, glass fibre, Teflon glass fabric, translucent glazing, carbon nana tubes, spider silk, Kevlar, Styrofoam are used by architects and engineers in innovating complex designs. These newly innovated building materials offered designers and engineers the opportunity to innovate all sort of complex designs [21], [22].

Conventional building materials have to give way to improved and newly innovated building materials due to rapid increases in population, urban requirements and climatic influence. Steel construction dominates the structural part of the modern construction industry due to its strength in workability. On the other hand glass, timber, plastic and aluminum dominate modern lightweight construction. The nature of space and settlement determine how designer deals with external features of the design. For example, the environment, influence the functional and conceptual requirements of the users.

Designer investigates and analyzes the proposed construction site and identifies possible links between proposed and existing natural features on site. The choice of materials is subject to the creative ability of the designer.

Architectural knowledge can be used to provide a more general insight as to how ideas are generated. One applies imagination to perceive form, order and balance in a given architectural design. But, one can apply creativity to imagine how to upgrade nature for human needs and leisure or to integrate nature with a proposed need.

V. CONCLUSION

This study contained information on previous literature that is related to this research which was indicated through rigorous study and in-depth analysis of the existing literature related to the topic. The literature includes study on design process as a body of knowledge that encompasses architectural design, representation and building materials.

Visualization was also part of the literature considered such that it is among method used for design representation. Some of visualization methods discussed includes; mental imagery, sketching, computer and manual drafting together with physical model making. The study introduces Architectural design process where creativity and innovation are specifically mentioned as aspect of the process. The study further categorized creativity and innovation into three (3) different aspects of the design process.

The categorization includes designer ideation process, visual perception of aesthetics on physical elements use for façade design and choice and applicability of building materials. Each aspect was explained according to its function

in creativity and innovation in the design process. The explanation includes the transformation of ideas from diagramming to schematic drawings in design process as it was illustrated in Fig. 4a and Fig. 4b. The visual perception of aesthetics on physical elements use for façade design was also used to explain how creativity and innovation was used to differentiate between two different designs.

The choice and applicability of newly innovated building materials was the final issue explained in the paper. According to [1] creativity and innovation enhance quality, appearance, and demand therefore, this paper is aiding in exploring its function in architectural domains. Future study can further categorized creativity and innovation in design process through other methods of empirical studies.

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