Visual Graphics and Digital Fabrication: The linking strategy to teach design grammar

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Introduction

With current dynamic changes in the learning system, learning process, social values, and evolving digital means, the design studio pedagogy is now more susceptible to questions and reformation more than ever.

It is noticeable that the current trends of design education at various institutions are leaning towards the creation of forms that are dependent on ability of digital application rather than incorporation of principles of design, associated visual grammar, and aspects of other design forces such as program, site, environment, etc. In many instances students seem to gravitate to pattern-making and complex form-making that are generated through digital applications. Such methods lack both understanding of visual grammar, detailing of reality, and iteration of 3-d composition of spaces.

With the availability of digital software and hardware, in particular 3D applications in combination with laser cutters, 3D printers, and CNC routers, unlimited opportunities are available to explore design principles that encompass architecture, product design, and fine arts. In reality we do have more tools to teach visual design principles in architecture more than ever before.

The primary objective of this paper is to demonstrate the possibility of teaching design principles through a series of artifacts that have strong graphic application as well as use of digital technology for fabrication. With the primary objective of linking art and architecture and use of technology an elective course was introduced by the author. Assigned projects included, design of dinnerware, pair of sandals, 3D wall art, painting based on built environment motif, working clock, and working lamp. The paper intends to demonstrate that execution of a design task and its assembly-fabrication using manual and digital equipment through projects that are not necessarily architecture and do not have complex tangents of site, climate, program, etc. The central theme being visual grammar, each project dealt with specific tangents of visual design principles.

Architectural Education

For many decades, particularly until the early part of last century, the design studio pedagogy in architecture continued to be an unquestionable and untouchable area. It was primarily a by-product of professional practice.

Around the late 1970s, that scenario started to change gradually. Several architectural scholars started to discuss design education more along the line of an exploratory and theoretical thread. Since then,

studio teaching started to emerge into more systematic and research based learning with more emphasis on observation and analysis.

Formal architectural education was established at the turn of the seventeenth century by the "Beaux-Arts" in France. It emerged in response to the value system at that time and continued to be the only model for two hundred years.

Towards the end of the nineteenth century, the value system started to change. A new development of formal design education strongly appeared before World War-I in Germany. The Bauhaus model of design education emerged in response to the technological development and industrial revolution. The word "Bauhaus" itself means "house of construction" or "school of building". In spite of its name, and the fact that its founder, "Walter Gropius" was an architect, the Bauhaus during the first years of its existence did not have an architecture department. Nonetheless, it was founded with the idea of creating a "total" work of art in which all arts, including architecture, would eventually be brought together. The Bauhaus style later became one of the most influential currents in modern design and architectural education.

With current dynamic changes in the learning system, and evolving digital means, the design studio pedagogy is in the verge of reformation. In the late 1980s, 1990s, and early 2000s, a few attempts were made by individual scholars to investigate and critically questiond the trend of design pedagogy. Design juries on Trial: The Renaissance of the Design Studio (Kathryn Anthony, 1991), Voices in Architectural Education (Thomas A Dutton, ed., 1991), Architectural Education: Issues in Education Policies and Practices (Necdel Teymur, 1993), Building Community: A New future for Architectural Educational and Practice (Ernest L. Boyer and Lee D. Mitgang, 1996), Changing Architectural Education: Towards a New Professionalism (David Nicol and Simon Pilling) are important publications on architectural education which critically examine current trends and needs of changes.

Three: Changing Role of Design and Communication Process

Although significant changes had happened in all aspects of life in the last three decades including architecture and urbanization, the current trends and approaches of teaching design continue to follow principles and practices developed in the past influenced by the Bauhaus. From the academic perspective, Bauhaus principles still seem to be relevant because architecture is always seen as a fine art where principles of formal composition are considered being of greatest importance.

In institutional education, the design studio still is the primary focus where various other courses complement and enrich the needed learning for studio support. History/theory, Construction Technology, Environmental Technology, Structure, Graphic Communication and Professional Ethics are the main divisions of courses which typically support studios (refer to diagram).

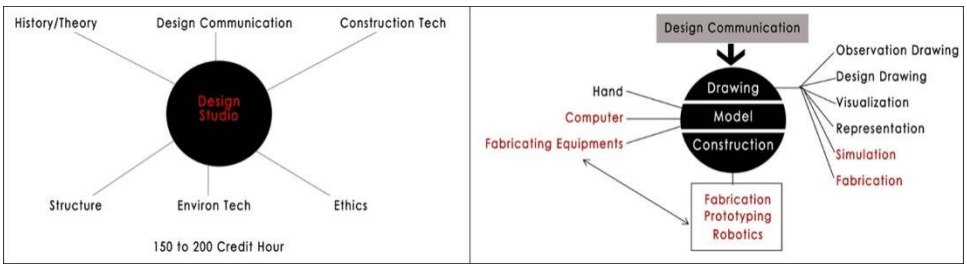

Figure 1: (a) Relationship between studio and support courses. (b) Various components of design communication

Apart from criticism of studio teaching, another change in the overall architectural education that already took place is in the area of design (graphic) communication teaching. After more than two decade's argument, it is now clear that the role of hand drawing and its implication in design visualization is progressively diminishing in the formal curriculum. On the other hand, a noticeable emergence of courses in areas of sustainable environment has become necessary in many curriculums.

Concurrently, the new generations of educators see courses in graphics as an opportunity to introduce various digital tools such as fabrication, analysis, simulation, etc. to replace manual graphics and tactile design thinking. It is not rare to see even the integration of robotics in beginning studios. Often the research conducted in doctoral works by many young educators seem to be reflected in their beginning studio teaching without much reference to overall learning goals.

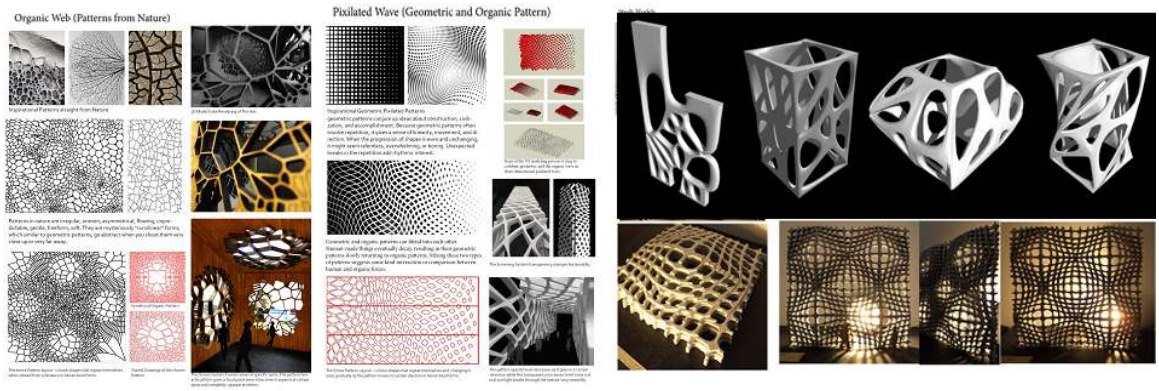

Figure 2: New trends of graphics teaching by author using laser cutter, CNC router, and 3D printer

In addition, from students' perspective there is a great interest in courses that offer integration of technology and exploration of new media which can minimize manual process and offer design options generated through software-hardware than creation by human mind. Students tend to gravitate to courses that are offered by new generation educators that often can be perceived as a self-standing course without much integration with the overall curriculum of the program.

The clarity of how to teach and what to teach is becoming blurrier in respect to design principles. In architecture, we cannot teach design, but can teach its principles. The recent trend seems to be parting from this notion and striving for tool-dependent learning. Design thinking in some instances is left to digital software parameters and processes of fabrication.

Four: Visual Design and Architectural Design

Design is a process of purposeful visual creation. Unlike painting and sculpture which are the realization of artists' personal visions and dreams, design fulfills practical needs. A good design, in short, is the best possible visual expression of the essence of a message or a product. This creation should not only be just aesthetic, but also functional, while reflecting the taste of the time. Design is practical. The designer is a practical human being. But before he/she is ready to tackle practical problems, he/she has to master a visual language.

Although a designer can work without conscious knowledge of any of these principles, rules, or concepts, because his personal taste and sensitivity to visual relationships are much more important, a thorough understanding of them would definitely enhance his/her capability in visual organization.

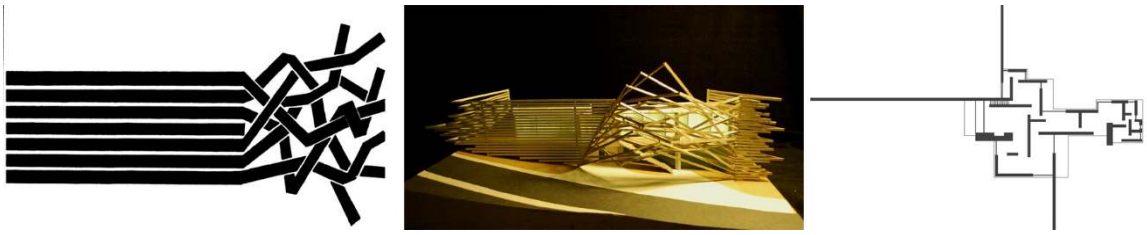

Figure 3: Composition of lines, a visual grammar in art architecture, and tectonics (facade design by student Jessica Pickelesimer from authors 2nd year studio)

In the first year's curriculum of every design school, regardless of the fields of specialization, there is always a course variously called Basic Design, Fundamental Design, Two- Dimensional Design, etc., which deals with the grammar of this visual language.

Five： Interpreting the Visual Language

There are numerous ways of interpreting the visual language. Unlike the spoken or written language where the grammatical laws are more or less established, the visual language has no obvious laws. Each design theorist may have a completely different set of discoveries. Primarily, this is more linked with systematic thinking and very little to do with emotion and intuition. This is to tackle the principles in precise and concrete terms with maximum objectivity and minimum ambiguity.

Elements of Design

The elements are, in fact, very much related to each other and cannot be easily separated in our general visual experience. Tackled individually, they may appear rather abstract, but together they determine the ultimate appearance and contents of a design.

Four groups of elements are distinguishable:

(a) conceptual elements

(b) visual elements

(c) relational elements

(d) practical elements

The ordering principles of design include: concepts of Axis, Symmetry, Hierarchy, Datum, Rhythm, Repetition, Transformation, Gradation, Radiation, Anomaly, Contrast, Concentration, Positive-Negative, Texture, etc.

The most important visual element after synthesis of various forces is 'form'. Three-dimensional forms can encounter one another in numerous ways, such as being Detached, Touched, Overlapped, Penetrated, Subtracted, Unified, Intersected, Coincided, etc. The various kinds of interrelationships should always be explored when forms are organized in an architectural design in order to achieve a meaningful space composition.

Form Generation Strategy

An act of design has various tangents, including site, climate, client, and program that culminate finally into a three-dimensional spatial built form composition. Assuming that after considering all factors a student has formulated the relationship of spaces and its volume and is ready to explore the final form. At that point the form may be generated from three distinct methods.

Through known geometric parameters

Through discovery of unknown form manipulation in physical models

Through computer application

Through known geometric parameters

The traditional form-making strategy is fully dependent on known geometry, be in 2D or in 3D. In this method, syntheses of all design considerations are spatially composed in a known geometry and their transformative forms. This is still a valid design method where use of visual composition and language of point-line-plane and solid-void in 3D form can create a spatial composition that is contextual and generated from the program, site, and environment. Examples provided are manipulation of a known geometry, a square in plan and a cubic form in three-dimension.

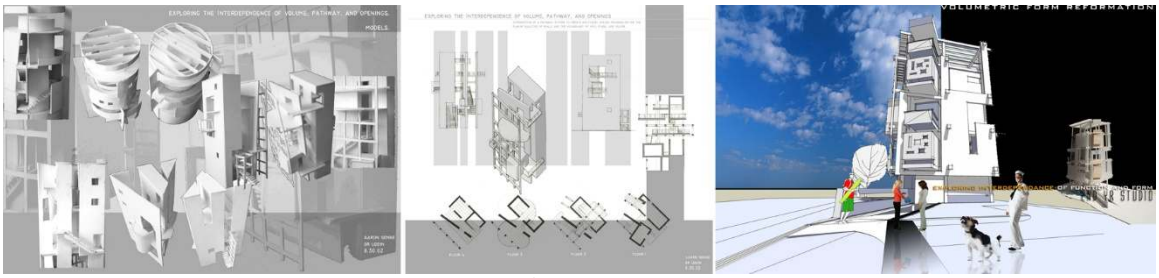

Figure 4: Architectural design process initiated through known geometric manipulation

Through discovery of unknown form manipulation in physical models

The second method has a strong component of discovery through making. An example shown below would be to focus on the strength of a single generative method in design; that is, rules and strategies in forming spaces and forms using the notion of 'Fold.' Such an exploration allows for the emphasis on the reiterative and cyclic character of a design process, in which a step is constantly revisited in order to

proceed to the next iteration. In this format, folding is articulated as a starting point in the exploration of the morphology. The process of the morphology include:

- Starting point not from known parameters

- Unexpectedness

- Discovery

- Mapping the process

- Establishing the grammar

- Extending to characterize space-qualities

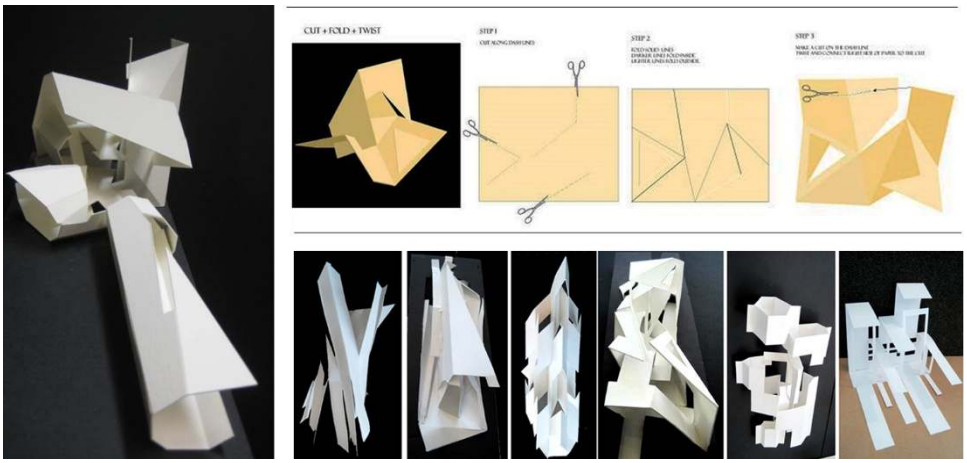

Figure 5: The act of folding and discovery of unexpected spatial enclosure

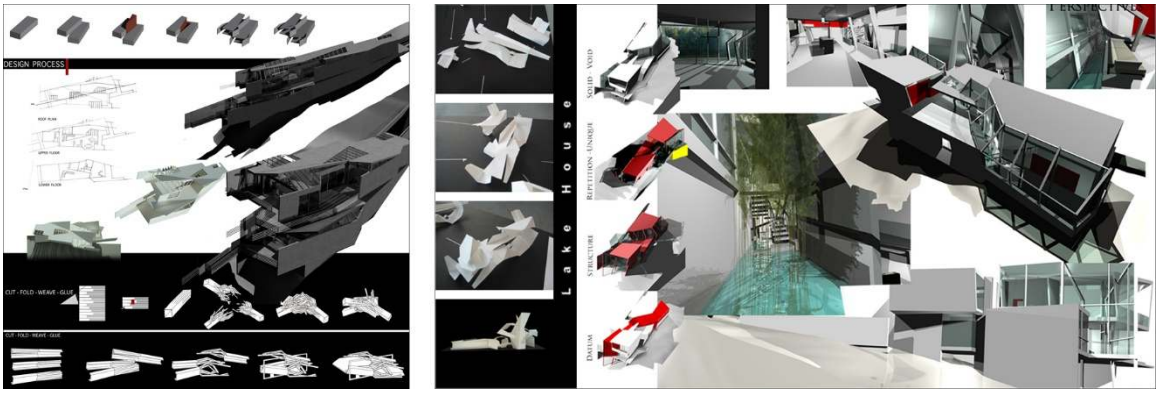

Figure 6: Iteration of folding transformed to functional design

Through computer application

The tendency to depend on 3D computer modeling application is an evident recent trend for the generation of spatial form. Often in this method students depend on manipulation of platonic geometry through software parameters. Use of various commands such as extrusion, loft, sweep, revolve, boolean, morph, path blend, skin, stitch, etc. are used to generate an overall form which

although a valid process most often becomes a surface enclosure without much consideration of structure, site, program, and climate.

Six: Visual Design Language, Product Design, and Fabrication in an Architecture Course

In the absence of a clear strategy of teaching 'principles of design', an elective course was introduced by the author to help students strengthen their understanding of visual grammar. The course had three specific goals: 1) use of visual design principles to design a series of everyday used products, 2) application of visual graphics for functional objects, and 3) use of digital software and hardware to fabricate designed products.

With the primary objective of linking art and architecture and use of technology, this course was an offshoot of traditional architecture studio. Assigned projects included design of dinnerware, a pair of sandals, 3D wall art, a painting based on built environment motif, a working clock, and a working lamp.

The course demonstrated that the execution of a design task and its assembly-fabrication using manual and digital equipment can be learned through projects that are not necessarily architecture based and do not have complex tangents of site, climate, program, etc. It concentrated on conceptualization, design, drawing, modeling, fabrication, and construction of three-dimensional every-day used objects using visual graphics and spatial and material compositional strategies.

The central theme being visual grammar, each project dealt with specific tangents of visual design principles.

Dinnerware project

Gathering, adapting, and transforming two-dimensional graphic motifs from various sources around us and then applying them to dinner plate design for unique visual expression was the objective of this exercise. The technique that followed was to create a composition using manipulated photographic image that express one or more of these design principles, such as: repetition, progression, movement, gradation, radiation, rotation, anomaly, contrast, concentration, hierarchy, and focus. Highlighting the features of overlap, size variation, and figure-ground are some techniques that were encouraged for graphic composition.

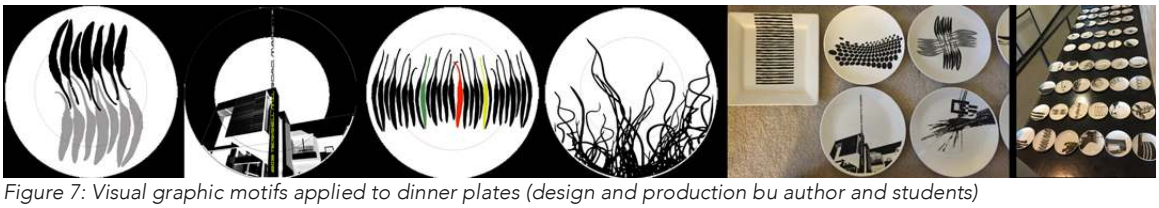

Figure 7: Visual graphic motifs applied to dinner plates (design and production bu author and students)

Architectural painting project

This project was introduced to students as a free expression of elements of architecture through fine art on a framed canvas. Color, composition, texture, superimposition, and figure-ground were the principles explored through the techniques of spatula, oil paint, and canvas.

Figure 8: Painting on canvas exploring information, composition, texture, color through elements of architecture and urban design

Footwear project

The highlight of this project was to exercise design principles and construction techniques through two pairs of sandal design: one emphasizing applied graphics and the other emphasizing unique design and construction. Functionally, both pairs had the same goal of travel transportability and interior use. Evaluation Criteria included:

- Design and functionality

- Material use (minimal) and comfort

- Construction technique

- Graphic strength

- Quality of finish

Figure 9: Footwear exploring new tools and fabrication through materials

Time device project

This project focused on non-physical (perceptual) nature of time that requires visual images to transform its perception. Re-visualizing the time scale, its units and proper visual graphics and movement were the objectives. The goal of this project was to initiate awareness in these areas:

- exploration of visual design/graphic vocabulary in a product design

- connection between art, product and architecture

- role of technology in creation of form, geometry, pattern, solid-void

Lamp project

This project looked for references from architecture, applied graphics, and elements and principles of visual design. Students were asked to formulate three design ideas based on 1. architectural precedents, 2. surface to volume (using techniques of fold), and 3. repetition of elements and modules to create geometry and form. The Applied graphic motifs reflecting abstract composition using point, line, etc. for light disseminating screen were encouraged. Highlights included:

- Form and geometry

- Light quality

- Construction technique & finish

- Graphic strength

Figure 10: Time Device and Lamp by students exploring function, form, craft, and tools.

Seven: Conclusion

In architecture, we cannot teach design, but can teach its principles. The recent trend seems to be parting from this notion and striving for tool-dependent learning. Design thinking in some instances is left to digital software parameters and processes of fabrication.

As new tools and techniques evolve, the education of architecture studios seems lately to be moving away from teaching 'principles of design' and leaning towards exploration of entities that are not directly related to architecture. At one end there is this abstract notion of "Phenomenology" in design thinking and on the other end there is this practical use of "Robotics" for construction. Both deal with specific aspects of theory and application. However, it does minimize the ability to design spaces with utmost efficiency for human civilization which still is the primary goal of an architect. The new generation of faculty seems to gravitate to prematurely introduce technology in early studios that are a direct reflection of their own research or recent doctoral topic, or trends borrowed from other renowned schools. One such example would be the latest trend of experimentation with an "Arduino microcontroller" that has a nearly limitless array of innovative applications for everything from robotics and lighting to games and gardening. The question remains, should we educate designers that are more proficient in designing spaces and architecture, or, explore other possibilities that traditionally belongs to other disciplines?

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