Forming, planning, imaging and connecting

Michael Mullins

This paper sets out to define aspects of the architectural design process, using historical precedent and architectural theory, and tests the relationship of those aspects to the application of computers in architectural design, particularly in an educational context.

The design process sub-sets are defined as: Forming, Planning, Imaging and Connecting. Historical precedents are uncovered in Classical, Modern, Postmodern and Contemporary architecture. The defined categories of the design process are related to current usages of computers in architectural education towards elucidating the strengths and weaknesses of digital media in those areas. Indications of their concurrent usage in digital design will be demonstrated in analysis of design studio programs presented at recent ACADIA conferences.

An example of a current design studio programme set at the School of Architecture University of Natal, South Africa in which the above described categories give an underlying structure to the introduction of 3D digital modelling to undergraduates through design process.

The definition of this set of design activities may offer a useful method for other educators in assessing existing and future design programs where digital tools are used.

Keywords*: Design-Process, Digital-Media, Design-Programmes*

Introduction

All South African architectural schools that responded to a questionnaire prepared by the author in 1998 confirm that there is a gathering momentum toward the integration of digital tools into their curricula. In 1995, in a much wider survey undertaken by ACADIA [A], 56% of the respondents had already provided facilities for computers in their studios, while only 6% had facilities in neither laboratory nor studio. That the traditional studio teaching environment has already been overtaken by developments in digital media is the assertion upon which this paper is based. Programme formulation, assessment and evaluation of students design outcomes and intentions relative to traditional studio-based methods will have to be redefined to accommodate the influence of digital tools on the design process.

The emphasis of this investigation is laid on the earlier stages of an architect's or student's activities, in which the initial steps toward expressing generative design ideas are made. This limitation therefore excludes the more widely familiar and practice-oriented areas which concentrate on the production of drawings for construction and scheduling purposes, in order to concentrate on themes useful to design facilitators and instructors.

There exist many previous attempts to define

activities in 'design process'. For example Sanoff describes design as transforming information through stages of Analysis, Synthesis and Evaluation (Sanoff 1977); Do uses the terms Organization, Ideation and Fabrication (Do 1996); Madrazo describes 'conceptual paradigms of the design process' in keywords which include Object, Type, System, Method and Representation (Madrazo 1998).

This paper begins from a _first-principles" study of historical and theoretical strands in design, in an attempt to uncover useful categories for application in architectural design education. The historical periods dealt with are grouped as: Classical, Modern, Post-modern and Contemporary. The design process sub-sets which have been related to each period are: Forming, Planning, Imaging and Connecting respectively.

Whilst particular attributes are linked to historical backgrounds, it is seldom that a building would be realized using only one of these types or 'sub-sets' of design process; these activities may all interact and dynamically influence the design of any particular building. Accordingly, while these sub-sets or methods are perhaps possible to find existing simultaneously in each historical period dealt with here, the predominance of any one gives an epistemological centre-of-gravity to that period's design activities. The purpose of this thesis is moreover to describe a method specific to a contemporary architectural studio, and is not intended to be definitive in the sense of an all-embracing unification of architectural theory. The definition of this set of design activities may prove a useful tool to other educators in implementing and assessing both existing and future design programs where digital tools are used.

Forming

Definition: 'Forming' is that aspect of the design process in which a mentally pre-conceived abstraction is represented in 3-dimensional space.

Vitruvius wrote:

> *"In all matters, but particularly in architecture, there are these two points: the thing signified and that which gives it its significance"* (1960 edition).

The Classical design episteme posits the metaphysical Idea as the determinant of Form. Architecture in this view may be interpreted as the physical manifestation of abstract concepts. The outcome of design will follow the conceptual abstractions grasped by the designer, where the order of knowledge is from the general to the more determinate (O'Doherty 1962).

An interaction between concept, design activity, and physical form can be described as 'Forming' insofar as: the intention of the architect is to create a form or volume of space/s which translates a pre-conceived 'Idea' or mentally held abstraction, directly into the three dimensions of buildings, physical or digital models. A concept realized in this way, can itself be modified by the geometrical or structural methods employed in its actualization.

Where a building describes a concept, it may become a precedent or type containing knowledge and methods which the architect may extract and apply to a current design problem using the faculties of generalization, abstraction and analogy (Ozel 1998). An architect will recall generalized precedent design cases, and through a process of abstraction distill concepts and solutions which can be used in the new and analogous situation.

There is an important distinction, not least in design education, between analogical abstraction of a given design problem and analogical abstraction of a given *solution*. A solution matching of a previous design shortcuts the reasoning required for a similar problem by reducing the search for its solution, thereby undermining the learning process, since it does not lead to generalizations of the original design problem and does not develop the ability to transfer this knowledge to new design problems [B]. A distinction

is thus drawn between 'direct' and 'indirect' transfer of knowledge.

Building precedents and case-libraries (Akin et al), and the rule-base upon which they rely (Stiny 1980), can therefore be useful to the process of forming in architectural education, provided that their use may lead to a fuller understanding of the underlying _signified' concept, and subsequently an ability to work creatively with abstractions and conceptual problem solving.

In order to facilitate the creative expression of concept, design studios may encourage students to formulate their own abstractions through refraining from giving an over-specific brief. In experimenting with 'voxDesign', a software system which supports the early phase of design intentions, Donath and Regenbrecht (1996) provided students with a means to express design *ideas*, and observed that most of them abandoned simulation of real objects and 'played out' the opportunity to create in a gravity-free environment. John Marx's design studio at Berkeley (Marx 1998) specifies very few site and accommodation requirements, but requires that representations of buildings be the outcome. It may be observed that students revert to a building-type precedent (such as a high-rise hotel) as the basis upon which later modeling, design development and representation proceeds.

Planning

> Definition: 'Planning' is that aspect of design process in which sets of mutually exclusive functions and usages are defined in order to render them amenable to observation, measurement, statistical analysis, manipulation and disposition.

In the 19th century, the Industrial Revolution gave rise to formal techniques of rationalizing the functional performance of the production process of both materials and labour, that is to say predictability, repeatability and mathematical quantifiability (Cooley 1988), and the context within which rule-based methods for architecture proceeded.

This method in the context of architectural design is typified by an analysis and assembly of functional parts and volumes in a rational solution which meets the disparate needs of the design problem. 'Planning' typically advances in a linear progression of sequenced stages of predictable Cartesian causes and effects in the design and production process (Culverhouse 1995). It reflects a view of the architect as a separate discrete entity acting upon objects in the outside world.

'Function' need not be confined only to the realm of the 1D of data or 2D drawings, but may be developed into a 3D organization of spaces. Digital tools allow analytical methods to model the functional requirements of spatial components and materials, and to arrange them into different configurations for early comparison and visualization (Papamichael et al 1998), (Mahalingam 1998).

In a recent design program at the University of Idaho (Stannard 1998), it is expressly stated that "the programmatic functions of the assigned projects are secondary to the goal of designing with light". Analysis of building function and its subsequent spacial organization is thus intentionally de-prioritized, to allow concentration of effort in other areas. However, the analysis of light-effects by means of empirical observation, computer processing and charts is introduced. This data is used to recreate specific light effects, measure energy consumption relative to type, position and quantity of light, and precisely describe levels of intensity. It is also noted that this design program begins with this 'analytical' phase where the quantification of experimental results is the students focus. Thus while the approach changes the emphasis: to analysis of performance rather than analysis of need, the essential method remains as the basis of the exercise.

Gerzo (1998) however maintains that 'CAD systems will not help designers do a better job by means of intelligent human interaction software at least in the next 10 years' and that 'the improvement in the quality of architectural design in the near future

will not be the result of intelligent design systems' (Gero 1998). This being the case, the 'Planning' aspects of the design process will need emphasis outside of computer use in design programs, using more traditional means of representation.

Imaging

> Definition: 'Imaging' is that aspect of design process in which implied meaning arises through the manipulation of representational images.

Depictions of 2-dimensional Euclidian geometries evolved into the architect's scale-drawing as a means of expressing design intentions. The building form is reduced to essentials: an encrypted set of signs and rules, understandable to the trained as the means to power over Idea, the 'thing-in-itself', the blueprints for form creation.

Moreover, the industrial era forced a clear separation between the act of drawing-to-scale and the production process itself (Mitchell 1980), hence allowing the architectural drawing to be considered as an object of design in itself.

> *'There is more beauty in a fine ground plan than in almost any of its ultimate consequences. In itself it will have the rhythms, masses, and proportions of a good decoration if it is the organic plan for an organic building with individual style...'* Frank Lloyd Wright (Nute 1997).

The inherent graphic bias of architectural representation gives rise to an aesthetic formalism in image making; it stems from the visual thinking employed by architects in the cognitive manipulation of graphic elements in creating these representations.

In an age of media driven image-consumerism, representations become the objects of design in themselves, *simulacra* which are representations of representation, with iconographic references to the designer's and viewer's value systems.

Software aimed at architectural use generally simplifies image creation and animation. The interplay between problem-formulation and problem-solution can be represented at virtually any point in the process. Furthermore, these representations may themselves be the primary objects of design, conveying fragments of architectural meaning and becoming the currency of architectural discourse.

Marx reports highly satisfactory results from a design studio recently offered at the University of California-Berkeley. Students were asked to create digital models after briefly sketching a site analysis. The final presentation, and the general thrust of the studio, was to be in the form of posters, fully created in digital media, and were evaluated in terms of the content and meaning which the images conveyed; the compositional techniques employed; colour balance; and the use of text as a key compositional element (Marx 1998). The presented results indicate that the powerful images of buildings are where the emphasis and root of the reported success of the studio may lie, and not their three dimensional form, degree of fitness for purpose, nor their ability to function effectively in their context of environment. The posters produced by students are *simulcra* of buildings, imparting through selective graphical information what the viewer already knows of the precedent building type employed by the designer. They represent design through 'Imaging'.

In the field of architecture, computers are often seen as primarily another (albeit highly effective) medium of representation and documentation. However, digital media enable students of architecture to study and design with consideration of a number of issues in a relatively short time, such as colour, transparency, image, mood, meaning, time related phenomena, and focal point perceived from different positions (Goldman 1996). These representational and image-creating aspects, integrated into the early stages of problem solving, have profound influence on the development of the final design outcome.

Connecting

Definition: 'Connecting' is that aspect of design process in which physical and conceptual entities interact dynamically with each other and their context.

Computer technology has enabled the definition of new dynamic and interconnected models of the design process. In the preceding three sections I have outlined Euclidean. Cartesian, and 'Postmodern' notions of space and form. These three models of design can be generally described as linear or serial paradigms. Design has In recent years been viewed, studied and developed as parallel, distributive, and networked processes; or in other words, non-linear models of architectural design. This trend is reflected in an increasing momentum in the body of architectural theory which accepts that, like living organisms, both design and buildings are the product of complex communicational and informational processes. This standpoint holds that a building cannot be separated from its physical, climatic, cultural and political context: its meaning is integrally dependent on the context of its creation. It is at once physical, and a system or set of objects in dynamic relationships.

Furthermore, design process is seen in the wider perspective of the dynamic interaction of all groups who contribute to its creation, as a collaborative effort between people and machines in disparate locations and different time zones connected on a network: ' ... to assist human designers to communicate and evaluate the evolving product in an effective, and if possible, concurrent manner' (Kalay 1998).

In universities, there have been various experimental Virtual Design Studios (VDS) which place emphasis on collaborative design, and which can also be observed in larger projects carried out recently by architectural and engineering practices (Hong Kong Airport, NASA International Space Station). The distinguishing dimensions of virtual design studios identified by include: collaboration, digital media, networking tools, spatial separation of team members, and computing infrastructure (Dave and Danahy 1998).

Faucher and Nivet (1998) maintain that CAD systems are presently generally unable to cope with 'design intentions'. Architects are presently required to first generate a model of their intended design before it can be analyzed and tested for performance against chosen criteria. Their aim is to develop a 'declarative' approach in which a design object is created from its required properties: that is the 'design intention'. By excluding the volumes disallowed by urban planning regulations, and including volumes which allow desired sight-lines and solar orientation, a constrained massing volume can be achieved. Their project can be viewed as an attempt to generate form through the direct influence of contextual constraints, and thus holds potential for 'Connecting'.

Application of Methods

In order to apply this research, a short design program was introduced for the first time in the first quarter of the 3rd year curriculum, 1999, at the University of Natal, South Africa. Its duration was 5 weeks. It's objectives were:

1. an integration of digital 3D modeling with the design process
2. a means to learn Form-Z software (recently acquired by the school)
3. to apply and test research and methodology of this thesis to architectural education.

The group comprised 9 students; only students who had a basic computer literacy were accepted for the elective studio, and most had some previous experience with 2D CAD; only 1 student had previous experience with 3D CAD.

The program brief required students to present design ideas for a given site in the Point area of the Durban harbour. No specific functional requirements were given by the brief and students were encouraged through multiple site visits to respond directly to the physical context with proposals for buildings or

architectural objects.

Initial use of mixed media, including sketch drawings, physical models and digital models was encouraged. Final presentation was however required to be in digital format.

Pedagogical aims of the programme were structured around the following:

'Forming'

Attention was to be given to the formulation and expression of *concept*.

Students were asked to clarify and formulate abstractions of their response and intentions, and to attempt to express these ideas into sketches, rough physical models and digital models.

By offering no ready-made accommodation brief, students are encouraged to create starting points for themselves. Some students chose to create buildings of an undefined nature (architectural 'follies') which attempt to reflect personal feelings evoked by the site. Others felt compelled to designate a particular function for their building (use of precedent) before they were able to proceed. Yet others assigned a function during or late in their forming process, adapting to suit the particular requirements of use.

Students were also encouraged to approach their design 'from the general to the specific' using rough physical models to articulate their early thoughts and abstractions. This worked to the benefit of some students in that they were able to direct their learning of Form-Z toward the modeling of these existing physical forms. However it was also detrimental to the degree that some students were unwilling to experiment with the software, and to allow the software to suggest new forms into their field of design creativity.

'Imaging'

Presentation of student work was to be made digitally. Both external and internal rendered views of their buildings were required. No hard copy was required. Students were required to continually document their design process through photographs and rendered images at various stages of their work, and to use these to present their proposals at the conclusion of the studio. As conventional plans, sections and elevations were not required, students were evaluated on their ability to convey convincing meaning through the control of visual imagery.

'Connecting'

Starting with observation of the site's physical environment, students were encouraged to consider climatic, regional, and cultural factors, and to respond intuitively, or in a manner they considered appropriate.

It was made clear to students that finished or developed buildings schemes were not the primary objective of the exercise. This was partly due to the limited 5 week time period available, the requirement to learn and present results with Form-Z software 'from scratch', as well as an intention to concentrate and document the individuals progress and design methods.

'Planning'

Issues regarding building function and plan organisation were given low priority, both in students' work and in faculty evaluations.

Analytical approaches to the design problem were actively discouraged, and students' work reflects this attitude. This approach is in keeping with the facilitator's observation that the weighting of performance criteria will need attention outside of computer use in conceptual design programs.

Moreover it is held that this area can be sacrificed where time is limited and pedagogical aims include the acquiring of new computer modeling skills. It was to be attempted to approach the design problem from a conceptual, representational and/or contextual base, rather than a functional or analytical one. Given a longer duration of the studio, an integration of this aspect of the design process could be attempted, f ex through site analysis, solar and lighting studies, spatial organisation exercises etc., with a corresponding increase of emphasis on evaluation of these criteria.

References

Akin, Omer, Michael Cumming, Michael Shealey and Bige Tuncer. 1996. An Electronic Design Assistance Tool for Case Based Representation of Designs. Design Computation. Proceedings of ACADIA 1996. McIntosh, P. & Ozel, F. (Eds.)

Cooley, M. 1988. From Brunelleschi to CAD-CAM. Design After Modernism. Thackara, J. (Ed.). Thames & Hudson.

Culverhouse, P. F. 1995. Constraining Designers and Their Cad Tools. Design Studies 16 p. 81-101. Elsevier Science Ltd.

Dave, Bharat and John Danahy. 1998. Virtual Study Abroad and Exchange Studio. Digital Design Studios. Proceedings of ACADIA 1998. Seebohm, T. and Skip van Wyk (eds.)

Do, Ellen Yi-Luen. 1996. The Right Tool at The Right Time - Drawing As An Interface to Knowledge Based Design Aids. Design Computation. Proceedings of ACADIA 1996. McIntosh, P. & Ozel, F. (Eds.)

Donath, D. & Holger Regenbrecht. 1996. Using Virtual Reality Aided Design Techniques for Three-Dimensional Architectural Sketching. Design Computation. Proceedings of the ACADIA 1996. McIntosh, P. & Ozel, F. (Eds.)

Faucher D. & Marie-Laure Nivet. 1998. Playing with Design Intents : Integrating Physical and Urban Constraints in CAD. Digital Design Studios. Proceedings of ACADIA 1998. Seebohm, T. and Skip van Wyk (eds.)

Gero, John. 1998. Speculations on a Machine-Understandable CAD Language for Architecture. Digital Design Studios. Proceedings of ACADIA 1998. Seebohm, T. and Skip van Wyk (eds.)

Goldman, Glenn. 1996. Reconstructions, Remakes, Sequels: Architecture and Motion Pictures. Design Computation. Proceedings of the ACADIA 1996. McIntosh, P. & Ozel, F. (Eds.)

Kalay Y.E. 1998. P3: Computational Environment to Support Design Collaboration. Automation in Construction 8 (1) 1998

Madrazo, Leandro. 1998. Computers and Architectural Design: Going Beyond the Tool. Digital Design Studios. Proceedings of ACADIA 1998. Seebohm, T. and Skip van Wyk (eds.)

Mahalingam, Ganapathy 1998. Representing Architectural Design Using Virtual Computers. Automation in Construction 8 (1).

Marx, J. 1998. A Proposal for Alternative Methods for Teaching Digital Design. Digital Design Studios. Proceedings of ACADIA 1998. Seebohm, T. and Skip van Wyk (eds.)

Mitchell, Tom. 1988. The Product as Illusion. Design After Modernism. Thackara, J. (Ed.). Thames & Hudson.

Nute, Kevin. 1997. Frank Lloyd Wright and Composition. Journal of Architectural and Planning Research 14:4 (Winter 1997) p. 273.

O'Doherty, E. F. 1963. Psychological Aspects of the Creative Act. Conference on Design Methods, London 1962. Jones, Christopher J. and D. G. Thornley (eds.). Pergamon Press, Oxford.

Ozel, F. 1998. Object oriented representation of design decisions. Automation in Construction 8 (1) 1998. p. 88.

Papamichael, K., J. LaPorta, H. Chauvert. 1998. Building Design Advisor: Automated Integration of of Multiple Simulation Tools. Automation in Construction 6 (4).

Sanoff, H. 1977. Methods of Architectural Programming. Dowden Hutchington & Ross Inc.

Stannard, Sandy. 1998. Computers in Design: Exploring Light and Time. Digital Design Studios. Proceedings of ACADIA 1998. Seebohm, T. and Skip van Wyk (eds.)

Vitruvius, The Ten Books of Architecture. Dover, New York 1960. Book 3, chapter III.

Notes

[A] ACADIA : The Association for Computer-Aided Design in Architecture.

[B] Ozel, F. 1998. Object oriented representation of design decisions. Automation in Construction 8 (1) 1998. p. 89. Examples of direct transfer of precedent solutions in architectural design given by Ozel include : using building typologies, transferring the architectural vocabulary of an existing building to the new, and transferring a technological solution directly from a precedent building.

Michael Mullins.
School of Architecture,
University of Natal,
South Africa
madura@iafrica.com