PROCESS-DRIVEN CONCEPTS

Digital agendas in studio teaching

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Abstract. This paper discusses studio design curricula using digital design as the medium to design process. The fundamental idea explored is that digital design thinking is fundamentally process driven as opposed to narrative driven and that digital design thinking leads to different way of conceptualising and solving design problems. The paper presents four studio case studies using different methodologies illustrating current digital design models. The types of studios chosen and the working methodologies adopted will be discussed in the light of understanding this shift of design conceptual thinking.

Keywords. Digital design pedagogy; digital conceptual thinking.

1. From form to process – a change in architectural conceptual thinking

The conventional educational model in the design studio has generally employed accepted a simulation of praxis as a didactic model. That is, most studios still employ stages that are usually driven by an interpretation of program, site, and conditions carried through stages of conceptualisation, schematic design and design development. Since the 90’s designers (Lynn 1999, Aranda and Lasch 2006, Liu 2005) started to define paradigmatic approaches in architecture design education, and as a result architecture as a design discipline changed methodologies, the notion of “processes” being more interesting than “ideas” (Zaero-Polo 2003) for example was a key change to design thinking.

Extensive research into digital pedagogical models and techniques and their relations to studio design has been developed by various researchers as a foundation for design education and pedagogy (Knight and Stiny 2001, Frazer 2002, Kvan et al. 2004, Oxman 2008). From these studies and frameworks
emerged the formulation of digital design models in studio teaching, the conceptual content and vocabulary of digital design. In their research the transition and transformation of concepts such as representation, precedent-base design and its replacement by concepts like generation, mutation, animation, and performance-based design and behaviour was solidly demonstrated (Lynn 2003, Kolarevic and Malkaawi 2005).

2. Four process driven studio methodologies

In this paper the four studios have been categorised in: “formation”, “generation” “performance” and “behaviour”. These themes arise from observation of current digital trends in education in the UK and are meant to facilitate a distinction between digital approaches and learning methodologies. This distinction is not to be taken rigorously as some of the studios overlap in tools and theoretical philosophy (for example both “generation” and “behaviour” share emergence, self-organisation principles). Ultimately, the themes represent the growing interaction between architecture and computer science, biology, robotics, artificial intelligence, electronics among other areas; they represent driving digital concepts and it is not intended that they suggest a classification for a digital pedagogical framework. The four design studios case studies presented in this paper were taught at different levels in architecture education using different conceptual digital design approaches. The first case study is at undergraduate level (year 2 and 3 in a vertical studio), at the Architectural Association by Claudia Pasquero and Marco Poletto. In this studio brief students have to develop and apply dynamic mapping and real time simulations as a design methodology. The second studio case study in 4th year studio in Canterbury Architecture School, UK by the author of this paper. This studio uses L-systems as an organisational generative design tool for designing a university campus master plan in a derelict industrial zone. The third case study is at a post-graduate level at the Bartlett School, UCL at the Adaptive Architecture and Computing MSc by Sean Hanna. The studio uses optimisation and machine learning techniques for structural design and digital manufacturing. And finally the fourth case study at an undergraduate level, 3rd year Interior Architecture students in Canterbury Architecture School, UK by the author of this paper. This studio uses Physical Computing techniques to explore adaptive and responsive space. In the next section of the paper each studio’s methodology and outcomes are described.

2.1. “FORMATION”

Studio #1: dynamic mapping and real time simulation

The design methodology puts a great emphasis on the material, spatial and
temporal articulation of outputs for social organisation and physical production. The design process is made through plans, sections and detailed drawings that form the basis to investigate the critical intersection of the design outcomes.

Figure 1. INTER10_ Re-charging city_solar desalination dune.
AA Unit 10 Intermediate 2010.

The digital drawings form the basis for all the studio design investigations; students acquire the necessary digital design skills to produce the digital drawings. A first set of drawings operates as frames to manufacture the productive landscape models; a second set, more detailed, will describe physical prototypes models. Outcomes: The Prototype models are not representational “maquettes” but are fabricated and deployed as tools of experimentation; they are treated as generative prototypes enabling the students to understand and “cultivate” new environmental, structural or material performances and behaviours. A third set of digital simulations is achieved by animating the digital diagrams and drawings in real time while time lapsing video techniques is used to capture spatial and behavioural effects of the prototype models as they unfold in time. Students invest efforts on developing different platforms to map dynamic information, being able to develop tools for visual integration of different data for simulation, articulation and evaluation of speculative ideas are key to the design process. In essence is about modelling self-organisation.
2.2. “GENERATION”

*Studio #2: L-systems as a generative organisational method*

The design methodology is based on using L-systems as a generative tool to conceive a design framework to promote the creation of stable, on-going relationships between organic and non-organic systems. This will allow the framework to operate in a sustainable way. The brief aim is to design a University campus in an abandoned industrial area. The main concept of the framework is that by using L-systems for re-writing conditions, the initial information or object is redefined by sets of rules as it grows.

![Image of Mutant Urban Device Project](image)

*Figure 2. “Mutant Urban Device” Project, Year 4 Architecture (Dipl)
Canterbury Architecture School 2009, UK.*

The outcomes: a framework of spatial qualities (noise, light, thermal comfort, etc.) was mapped against functional requirements (studio spaces, library, dormitories, etc.) and an L-system framework was established to create a self-organisational system at an urban scale. Rather than layering discreet systems, the aspiration of the framework is to find points of flexibility and interaction in conditions, and determine how the dynamics of one set of spatial requirements can converge with other sets of spatial requirements flows to create not only improved combined fitness, but also unexpected qualita-
2.3. “PERFORMANCE”

*Studio #3: Parametric design in code*

In this design studio the methodology proposed is to parametric design as a learning methodology, promoting the use of procedural techniques to help forge a closer connection between the process of form generation and the real, constructed design in one of two ways: either in how it is built or in how it performs. The focus of the studio is on creating systems for performance-driven architectural solutions using basic design computation and 3D parametric modelling technology. It represents a working method based more on procedure than geometric form which is a very different from traditional design thinking where the focus is on the representation of final form described geometrically. This can be easily fine-tuned and changed by the designer whereas in parametric design force a prior procedural representation in which the form is only the result of this designed procedure. When revising the model it is generally impossible to make changes at the level of final representation – form; it must be modified at the procedural level.

![Parametric Design Stages](image.png)

*Figure 3. Parametric Design Stages, Workshop UCL, Bartlett ACC MSc 2008.*
The outcomes: the projects methodologies are procedural rather than geometric, what is being designed is not the final form, but the steps taken to generate that form, and if these steps are closely grounded in the reality of the project, then the generative process actually forces the designer to consider the logic of design on a deeper level than the simple geometry and the drawing (Hanna and Turner 2006).

In one project for example (Figure 3) solar and mineral paths and other environmental factors of a salt water site serve as parameters to form a surface ideally suited for salt crystallisation on the edge of the Dead Sea. The result is a sweeping curve plane that responds to changes in the site and environment with a million of unique elements. Such a form as the model produces is well beyond the capacity of a human designer to realise through conventional drawing.

2.4. “BEHAVIOUR”

Studio #4: “Game of boundary” adaptive and reactive space
The brief is designed to be experiential through its connection of physical space, materials, exploration and celebration of intense effects of immateriality, and speculation about “smart materials”. The aim of the brief is to open many directions for exploration where juxtapositions of material and immaterial and/or static and transient environments are investigated and co-exist. Additionally the students have to explore a theme via the construction of a full scale prototype.

The design methodology is based on cellular automata and the student’s project presented here is called “Game of Boundary” inspired by the “Game of Life” cellular automata by John Conway. A translation into the physical world of the game was used to set up rules as a generative framework to explore how architectural elements could enter into a dialog with its inhabitants and surrounding environment.

The outcomes: In the project a 3D matrix of 9 pivotal elements rotate according to the proximity of users walking around the space. The proximity sensors trigger a set of rules to constantly rotate the pivotal elements in the 3D grid at random. The user that enters the grid space is subjected to the laws of the system to get through the maze. The spatial artefact is responsive to people’s proximity, so it senses the environment. The project borrows its design logic from simple notions of ubiquitous electronic technology, artificial life, robotics, and human computer interaction (HCI) models as integral components of the design system.
3. Discussion: algorithmic (process driven) concept versus contextual (narrative driven) concept

To understand this process-driven conceptual shift is the position in this paper. The working methodologies shown in the four studios require a great deal of explicitness and effort up front to create schemas, there are no possibilities to thereafter switch explicit, procedural representation of a form. The comparison of outcomes in the studios and the impact of digital approaches of the four studios is not the objective and it would be difficult to achieve mainly due to:

1. different cohorts in background and levels of education;
2. the briefs have different scopes, and scales of design and address very different design disciplinary definitions, often perceived as oppositions, such as sustainable development, versus ecologic urbanisation for example;

But what we can examine is that all studios use algorithmic [process driven] versus contextual [narrative driven] architecture, bottom-up tactical versus top-down strategic design. In each of the case studies the projects were developed by manipulating digital models and techniques that suited the theoretical and conceptual content of each project brief. In each brief a conceptualisation of ‘digital material’ and a unique digital model or digital technique appropriate to the material concept was employed. The studios explore processes that can organise a set of ideas and rules that can then modify the process by selecting alternative methods and techniques of exploration. They explore design methodologies based on a bottom-up process approach with very basic knowledge of computational tools. In fact in second studio, “Generation” - the L-systems approach is used in a totally analogue way. In all studios a very introductory level of knowledge is taught, also in all studios the work was developed in a short period of time – 2–5 weeks.
What these case studies show is that instead of asking students to define essentially formal representation criteria it asks them to define a set of variables of a design framework, then a computational definition can be utilised to facilitate a variety of solutions. It is a way of thinking that structures and relates tangible and intangible systems into a design proposal removed from digital tool specificity and establishes an holistic relationship between properties within a system. It asks students to start with the design parameters and not preconceived or predetermined design solutions. It is therefore the hope of this research to suggest that process-based methodologies can give assistance to designers to structure their own thoughts. But as with any design method of working, the set of tools used influences the designer’s thinking. The fundamental difference is that all studios are fabricating and deploying tools of experimentation, by allowing students and tutors to understand and “cultivate” new environmental, structural or material performances and behaviours.

Acknowledgements

Many thanks to: all students from modules “Technology and Environment” and “High Technology” from Canterbury Architecture School, UK 2008/09; to Sean Hanna Bartlett School, UCL and to Ecologic Studio for kindly providing material for this paper and finally to my colleagues at XJTLU Department of Architecture for their valuable comments.

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