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THE EVOLUTION OF MEDIA USE IN THE DESIGN STUDIO

Why are students not engaging in the Cutting Edge?

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Abstract. Although there has been a significant evolution in the development of representational media and tools over the last decade, it is apparent that students may not be engaging in the cutting edge. This research draws on a comprehensive study of media use in the design studio in 2002, and examines the evolution of representational media use in the design studio in terms issues of importance to student architects.

Keywords. Design studio; pedagogy; representational media; CAD; physical models; drawings

1. Introduction

This research refers to an extensive ethnographic case study of a cohort of second year architecture students at Deakin University in 2002 (Ham, 2010). Participant observation, quantitative and qualitative data from a series of questionnaires, analysis of assessment were used alongside Reflective Folios and illustrative examples of students' work were analysed to determine the multiple issues relating to how and why students use particular representational media in the design studio, factors influencing the selection and use of representational media within design projects and the perceived and actual implications of the representational media use in design projects.

Comparisons are made between the 2002 design studio and a more recent (2011) third year design studio programme, involving the design of a multi-storey building in Hong Kong. This design studio has been researched extensively, with a particular focus on Social Network Virtual Design Studio (SNVDS) pedagogy and issues of social interactions within the design studio

using FaceBook™, YouTube™ and Skype™ (refer Ham and Schnabel, 2012).

Although much has changed from 2002 in relation to the technologies of the design studio, representational media and tools, this paper proposes that the issue of representational media within the design studio remains as important as it was in 2002 and proposes the question ‘Why are students not engaging in the Cutting Edge?’

2. Representational Media in the Design Studio

The means through which architecture students work through design studio problems and communicate their outcomes is through design descriptions or ‘representations’. These act as surrogates for real architecture and enable students to test solutions to design problems without necessitating actual physical construction. Representations of design concepts are recorded through *media* using *tools* within certain *procedures* (Dave 2000). Representational media, constituting *analogue* or *physical* systems (tracing paper, graphite and ink) or *digital* or *virtual* systems (involving scanning, 3D CAD modelling, animations and rendering) (Bermudez and King 2000) are employed by students in the conception, development and presentation of designs.

Three principal representational media are widely used in the undergraduate architectural design studio either alone or in hybrid combinations:

Drawings have been a primary means of communication since the invention of paper in the 16th century (Kvan 2001). Drawings are a descriptive set of projections that operate in a geometrised, homogenous space that is construed as a real space of human action (Perez-Gomez and Pelletier 1997). Drawings are intrinsically two dimensional in nature and may consist of scaled orthogonal, isometric axonometric projections and perspectives. Drawings may be hand-drawn, consisting of loose freehand sketches, ruled line representations or may be generated from 2D CAD. Tools used in drawings include pens, pencils, paints, set squares, rulers and computers.

Physical models consist of scaled 3 dimensional representations that utilise a variety of materials to represent aspects of architectural design. ‘*Models of*’ are used in the representation of completed design proposals, whereas ‘*models for*’ are used within the design process as a means of problem solving (Kvan and Thilakaratne, 2003). Physical modelling has evolved from being hand-built to include CNC-routed, laser cut or 3D printed models derived directly from 2D or 3D computer models.

3D CAD involves the computerised construction of buildings using computer programs that generate virtual solids and surfaces, materials, objects,

elements and components. 3D CAD operates within a virtual three-dimensional environment, where all objects can be viewed from several simultaneous viewpoints, rotated, animated and edited iteratively during the design process. The preoccupation of 3D CAD is with geometry; however materials are applied as texture maps in a component based approach (Moloney and Issa 2003). 3D CAD operates through software (e.g. ArchiCAD™, AutoCAD™, MicroStation™, Rhinoceros™, FormZ™, 3D Studio Max™, Sketchup™). Parametric Modelling (PM) and Building Information Modelling (BIM) have evolved from the early iterations of 3D CAD as the 'profession moves beyond traditional practice and its drawing-centric model into a dynamic process/component oriented model for digital practice and the subsequent re-definition of professional services and contractual deliverables' (Ambrose, 2009).

Kvans' concept of 'models of' and 'models for' may be expanded into the discussion of representational media. 'Representations of' may refer to drawings, models and images of the final product, whereas 'representations for' comprise the many plan, section and perspective sketches, maquette models and multiple iterations of 3D CAD models used to form design ideas during the design process.

Much of the time students spend on design processes is spent working with combinations of these three representational media doing 'representations for'. Media use has a powerful impact on the outcome of their design processes (Johnson (1997), acting to constrain or enhance design thinking, where 'the nature and power of available media facilitates what is conceived and accomplished' (Ataman (2000).

The object of representation is to 'achieve situational awareness that allows for meaningful criticism of design' (Kalisperis and Pehlivanidou-Liakata (1998). This situational awareness appears to be more of a critical issue to novitiate designers than mature practitioners. Architecture students in the early years of their studies are engaged in a complex process of knowledge acquisition wherein design learning is undertaken in parallel with learning about representational media. Whereas the 'architect's ability to comprehend and extrapolate information is acquired through years of education and working experience' (p 2), students have limited abilities to comprehend important aspects of their design processes. The process of reflection-in-action (Schon 1985) is informed by representational media and enables the iterative testing of design solutions through the visualisation of concepts (Lawson 1980).

A critical issue inherent in the use of two-dimensional representational media within design processes is the *perspectival hinge* (Perez-Gomez and Pelletier (1997). This 'invisible perspectival hinge is always at work between

these common forms of representation and the world to which they refer' (p. 3), thus acting to limit comprehension in design processes. *Ideas* of buildings are built up between a set of projections (plan, section, elevation, perspective). This idea of the building is then translated into a building, usually by a third party (builders). Thus, it follows that the ideas under development may be limited by the two dimensional nature of the medium of drawing. Working beyond the limitations of the perspectival hinge requires training and experience.

Beyond basic engagement in representational media lies digital mastery, the evolution of media use in a craftsman-like manner using 'technique, hard work on form, also a probing of their medium's capacity, (and) a passion for practice' (McCullough 1996). Digital mastery evolves from moving beyond the cognitive background, or 'the basic sense of how things work' (p. 248), and shifting beyond focusing on means to focusing on the ends.

3. Media Use in the Design Studio

The 2002 study identified several factors impacting on how and why students use various representational media in the design studio. These include Media Skills, Project Duration and Assessment and Availability, Cost and Resources. These are drawn upon for this research.

3.1. MEDIA SKILLS

Skill levels still have a critical impact on students' decisions relating to the use of representational media in the design process. Despite the advancement of media, tools and software over the last decade, the issue of basic engagement remains a primary one for students. Bermudez and King (2000) outline potential strategies adopted by designers and students in the use of media within the design process. Students, as emerging designers, are developing the knowledge, skills and abilities they, and their educators, perceive will be of value for them in practice. Because of this, they utilise representational media differently than mature designers (practitioners). They may adopt different (less mature) design and media strategies and may be more dynamic in their learning.

Bermudez and King (2000) found that designers develop (and conservatively keep updating) a *media/ representation repertoire* that they manage during the design process. They suggest that there is a breaking point in the media iteration process where the designer settles on either analogue or digital representations to complete the design. Media iterations are highest at the beginning of the design process and tend to slow down and eventually come to a stop at the end-phases of design development. There is a comfort zone

where the designer tends to flee when faced with high performance expectations under stressful conditions. The designer leans towards media where they feel most comfortable so that they can concentrate on addressing the content of the challenge without having to add the practical and theoretical problems of the media.

Choice of media and software are critical elements in achieving project aims. Inevitably there will come a time where a critical decision regarding media is made. For Bermudez and King (2000) when the designer 'settles' on a particular representation this is the 'breaking point'. A 'breaking point' implies that there is a stage at which students will make forced, rather than considered, decisions.

The 2002 study confirmed that more capable students, who were generally more mature designers, are likely to explore multiple possibilities and processes as well as weigh the risk factors, and base their decision on what is the best fit for the purpose. This appears to not have changed, and evidence provided in the review of current project work illustrates the continuation of the direct linkage between media skills and design skills.

High performing design students generally develop a broader, more dynamic and less 'conservative' media repertoire than low performing students. For high performing students, demonstrated ability in design is closely related to maturity of media use in the design, development and presentation of their projects. These students appear to develop carefully considered media strategies based on consideration of immediate appropriateness for their design processes and also their own longer-term learning.

For low performing students, there was little apparent sense of responsibility or challenge in the development of their media repertoire. These students utilised a more constrained media repertoire, and appeared to resist 'constructive dialogue' between media. They tended to use similar combinations of media for successive design projects.

As Bermudez and King (2000) recognise, expansion of designers' media repertoire is most pronounced in the earlier stages of the design process. In this context 'breaking point' may not be the most useful descriptor. Rather, it is a key decision as part of an ongoing process of informed decisions leading to the final output. In contrast, less able students and less mature designers will retreat to what was perceived to be known and manageable (i.e. their 'comfort zone') to complete the set task. For them, the stress of completing the task means that choices are not made based on careful consideration of multiple options to determine the best solution.

Skills in representational media use are developed primarily through what is taught in the curriculum in media and communications units. This curriculum is very constrained, with competition between design, technology, histo-

ry and theory and communications streams on what must be included in the architecture course. A significant further determinant of media use within the design studio is the actual skills that are taught within communications units. From 2002 to 2011, the School has changed the skills and software taught within basic communications units and this has significantly influenced the media that students utilize in their design projects. Hand drawing, sketching and ruled line orthogonal drawing classes have been retained in a similar form from 2002 to present, however the teaching of CAD software has changed.

This change has resulted in students' primary CAD skills being limited to Sketchup™ and AutoCAD™ 2D. These programmes are less suitable for use in complex, multi-storey building design than say ArchiCAD™ and Revit™. Students invariably use the programmes that they are taught, unless they have previously acquired skills through industry or previous courses (e.g. drafting).

The subject of media and tools formed the core of many discussions on the SNVDS FaceBook site. The collegiate atmosphere of the SNVDS allowed students to work together to crowd-source solutions to media use problems. This resulted in students organising their own ArchiCAD™ training as a means of crowd-sourcing a solution to the problem of media skills acquisition.

Much emphasis is placed on the quality of renders for final submission- 'representations of'. This seems to be at odds to the industry, where the emphasis is on developing 'representations for' through the use of a BIM-centred 'integrated practice' (Ambrose 2009) to produce time and cost efficiencies in the design and procurement of complex buildings. Thus, in this instance, it is apparent that the 'state of the art' at the Academy is trailing the 'state of the art' within practice and the students are being disadvantaged as a result.

3.2. PROJECT DURATION AND ASSESSMENT

The length and assessment weighting of design projects are significant influences on how students use different representational media. Longer projects worth more marks appear to result in a wider band of use of media within the cohort. Both the 2002 and 2011 design studios involved short (2-3 week) and long (4-7 week) design projects. In both studios, there was evidence that reduced project time forced students to select, and settle on representational media quickly and efficiently. The degree to which students settled quickly on an effective media use strategy also appeared to impact the outcome of their project work.

Some students strategically adopt shallow learning approaches for certain projects by setlines for a lower mark by working within their design and media use comfort zone. Some students, usually those in the Pass to Credit assessment category for projects worth 10-20% of unit marks, produced basic representations of their designs as a minimal measure to achieve a bare pass. For other design projects, these same students reverted to media that they knew would bring better understandings of their designs, and bring better results. This supports the observations of Marton and Saljo (1976), that students often strategically adopt shallow learning approaches for one project, then revert to deep learning for another, depending on how the demands of each learning task were perceived.

Longer projects may, for some, create similar conditions to short projects because they require a greater depth of enquiry and a broader range of architectural issues. Because students (particularly struggling ones) may not manage their time as effectively, they may adopt a shallow learning approach and not explore the full capabilities of representational media. For other students, longer projects may increase the authenticity of learning experiences, through a greater integration of content and skills, disciplined enquiry and academic rigour, increased levels of thinking and reflection (Martin-Kneip 2000). The simple factor of allowing more time for design projects may give reflective students more time to carry out valuable reflective activities. This reflective activity may have a follow-on impact on media selection and use in design projects.

3.3. EMBODIED EFFORT

A key concept in understanding media use in the design studio is the effort that is embodied within a representation of a design for a particular purpose. This ‘embodied effort’ is an important factor in media and tool selection, particularly when the project duration requires quick and effective development and representation of design ideas during the formative stages of design. Representational media and tools with a high ‘embodied effort’ are an often cause of frustration for students with low media skill sets.

3D CAD, PM and BIM-oriented programmes such as ArchiCADTM and RevitTM may require a higher ‘embodied effort’ than less sophisticated but easier to use programmes such as Sketchup. This is because ArchiCADTM and RevitTM, as building modelling programmes require more base information to get started, whereas SketchupTM allows quicker formation of base ideas.

An example is when a student is performing a simple operation like placing a door in a wall during the early design stages. Placement of a door in an

ArchiCAD™ model requires confirmation of location, height, width, door handle type, threshold type, architraves, frame type, panel type and colours and materials of all elements. Consideration of all these decisions serves as a distraction to designers who just want to place a door in a wall. Effort is required to deal with too much information relative to the intention of the representation during the early stages of design.

This issue of ‘embodied effort’ is amplified by projects of shorter duration undertaken by students of lesser skills and may result in students returning to a ‘comfort zone’ of media use (Bermudez and King, 2000). Thus, even though students may be aware of the cutting edge of BIM and PM, they adopt a strategic media use strategy that sits within their comfort zone.

3.4. AVAILABILITY, COST AND RESOURCES

Architecture students are required to outlay hundreds of dollars on basic equipment, including pens, pencils, basic drafting board and T-square, rulers, cutting knives and other essential equipment to support their studies. We have observed the evolution of computing technology from 2002 to present where almost all students possess laptops, tablets and smart phones for use both privately and at University. We have also witnessed the transition from students relying on University-based computers to working in a mobile, laptop-based work environment connecting to each other through a series of social networks (Schnabel and Ham 2013). Engagement in digital media is no longer optional.

Fundamental changes have occurred in the method of physical drawing production, Drawings and sketches that were once presented directly ‘off the sheet’ or photocopied are now inevitably brought into Photoshop for final formatting. At this School in 2002, all physical models were invariably cut directly from card, paper and plastic and 2D CAD was only used to provide floor plans or elevations or to derive dimensions from. Nowadays, the hand-made physical modeling culture has largely disappeared from the School with the use of laser-cut MDF models and 3D printing. Students generally do not hand build models for larger projects any more.

This has produced a change in the economic equation for producing design representations where the substantial cost of 3D printing or laser cutting model elements is offset by the reduced time taken to produce models. This factor has resulted in the evolution of student skill sets away from traditional physical modelling towards a hybrid CAD-cut-assemble mode of production.

In 2002, 730 students in the School of Architecture and Building had access to 44 computers with a range of software (Microstation™, ArchiCAD™, Rhino™, Photoshop™, Macromedia™, MS-Office™ etc.).

These laboratories were often overcrowded, with students competing for machines in peak times, and resorting to overnight rendering sessions.

Nowadays, although lab facilities have been retained, student reliance has diminished, with students bearing the cost of purchasing and maintaining laptops, printers and software. This has been assisted in the period between 2002 to present by the ubiquity of computers for general use, the rapid increase in computing power and reduction in price of hardware.

The issue of software copyright (discussed in depth by (Goehner 1997)) has remained from 2002 to present. Although many software companies allow students to use free licences for their studies, these programmes often 'stamp' prints and present inconveniences for student use. Thus, illegal software use has remained high amongst the cohort. With the expansion of peer-to-peer torrent-based sharing, illegal copied software is openly accessible to students, making illegal software a driver of media use within the design studio. A crackdown on illegal software use in the design studio would undoubtedly produce in a significant change in media use and could result in the reversion to analogue media.

It is apparent that resource issues are more influential in students' decision making than Bermudez and King (2000) suggest. The availability of media, workspaces, facilities and infrastructure, perhaps more than the other factors discussed, profoundly impact the media repertoires and design processes adopted by students.

4. Conclusions

The use of representational media and tools within the design studio remains a critical issue that profoundly impacts the way in which students of architecture engage in learning about architectural design. Although there have been many advancements in the use of digital representational technologies (principally in the form of 3D CAD) within practice and the academy, the design studio may not have kept up with these. The focus on 'representations of' and not 'representations for', the content of communications courses that determine skills, project duration and assessment and availability, cost and resources impact students' selection and use of representational media within the design studio. Although many architecture students may not be engaging in 'the cutting edge' of media and tools, their decisions are strategic ones made within the limitations imposed by the curriculum as well as internal and external constraints.

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