

## DESIGNING WITH COMPUTERS IN A PAPERLESS DESIGN COMPUTING STUDIO

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**Abstract.** The advancements in digital design and communications are reshaping the economics of architecture and design practices. Designing with computers is based on establishing a fruitful dialogue between the designer and the tool. The "digital imperative" to switch from analogue to digital mode have already begun to manifest itself at the schools of design and architecture in the form of the paperless Design Computing Studio (DCS). This paper describes and reflects on the designing and teaching approach implemented in a paperless DCS within the domain of architectural design. The paper presents the implementation of this approach, on the first year students of the new degree of Design Computing at the University of Sydney and analyses the students' design learning experience in the DCS.

### 1. Introduction

The "digital imperative" to switch from analogue to digital mode have already begun to manifest itself at the schools of design and architecture in the form of the paperless Design Computing Studio (DCS). Design and architecture students will routinely use the best of new technologies within information-rich and fully networked, multimedia environment (Muir and O'Neill, 1994). The advances in design computing and digital media in the last decade have been phenomenal and what the next decade will bring can only be imagined.

However the advancements in digital design and communications are already reshaping the economics of architecture and design practices, many of the design and architecture schools are still using manual techniques similar to those of the beginning of the last century. Our approach for

designing and teaching in the paperless DCS at the Faculty of Architecture, University of Sydney as a new design medium is inspired by Schmitt's (1997) view of the computer as a design medium that is more than a tool and it is an interactive counterpart through its capabilities and what it offers. Our approach to a paperless DCS is also motivated by Resnick's (1996) view to new paradigms of computing as new paradigms for thinking and Madrazo's (1999) assumption that designing with computers is based on establishing a fruitful dialogue between the designer and the tool.

The comprehensiveness of a successful paperless DCS allows for design ideas to be created, sketched, developed, drafted, rendered, and animated in real-time. The digital design is then printed, presented on-screen or projected, sent around the world over the Internet, and even fabricated by a numerically controlled rapid-prototyping machine, without ever existing on paper.

The thrust of this paper is not about the software, hardware, and networking configurations and the potential of these configurations to accommodate emerging digital technologies in a paperless DCS. The focus here is on addressing designing and teaching strategies that are most suitable in a paperless Design Computing Studio (DCS) environment. Furthermore, reflecting on the effect of the application of these strategies within this new environment on the design ideas and artefacts created by students while designing with computers without the use of a drawing board. This paper presents the implementation of this approach, on the first year students of the new degree of Design Computing at the University of Sydney and analyses the students' design learning experience in the DCS.

## **2. Designing with Computers: Why Paperless?**

The infusion of digital media into the practice of design and architecture is changing how the design process is carried out as well as what is designed, i.e. artefacts, and the culture of design education. There is a transition from a completely analogue system of representation to one of complete computer immersion or the "paperless studio". Design and architecture schools have already begun to struggle with the physical issues of either integration of new media or going completely digital (infrastructure and economics). However, the pedagogical integration should be of a greater concern. New media and its forms of representation are challenging traditional skills of communication and representation. Changes in practice as well as design education should look to new media with the opportunity for further exploration of design ideas, creation of new forms and new design vocabularies. The creation of new forms comes with a responsibility of seeking new forms of representation (Norman, 2001).

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It may be asked why is it necessary to provide digital immersion environment in which traditional models for design exploration such as physical models and manual drawings would be excluded? An attempt to answer this question is with the question, why does it seem satisfactory to exclude digital media when exploring with traditional methods. The validity of a paperless design studio lies in the notion that digital media can change the process of design, the forms of design and how design ideas are communicated. A comparison could be made between a paperless DCS to a studio that has been instructed that the only medium for exploration will be casting. A casting studio would force changes in ones process, forms and experience (Norman, 2001). To draw a parallel to the paperless design studio, one needs to become aware of the unique abilities of what digital media offers and how it can be used to explore the design process. Digital models and web-based project sites are becoming normal practice within the real world of building construction. As the world becomes a more global society, the ability and means to transfer, communicate and collaborate design ideas in more efficient ways and timely manner is ever increasing.

### 2.1 DESIGN TOOLS IN A PAPERLESS DCS

Design tools in a paperless DCS should be primarily employed at the conceptual stage of designing and at an early level of design education to provide the opportunity for the students to comprehend the use of computers as design medium instead of a tool solely for drafting. As design tools are incorporated into the design process the student's ability to test and investigate design ideas becomes more thoroughly.

Using design tools that are object and time-based at the conceptual stage of designing is quite important. Utilising objects in a design tool is simple to conceive and in having the ability to simulate reality. And time-based animation allows one to approach, test and investigate a simulated reality. Greg Lynn (1999) describes animation as "evolution of a form and its shaping forces". The use of time-based media in the paperless DCS allows understanding objects in space and its relationships and influences over other objects. The indiscriminate application of computer design tools at the conceptual stage might allow the student (designer) to be removed from the design process and the software to be in control of the design outcome, however designers must be in control of the design tool (software) and design outcome. The ability to utilise the computer as a design tool comes with a responsibility of understanding its' limits and its' role as a tool for inquiry.

## 2.2 PEDAGOGICAL CONCERNS

Moving to a paperless DCS is more concerned with the pedagogical issues of integration and how to infuse the computers into the design process. This is a larger educational issue of concern compared to how to afford and place computers into a design studio that is financial or organisational dilemma on the part of institution or the student. The success of a paperless DCS relies on the ability of its students and faculty members to implement these new digital tools and to change the culture of the design studio environment. If students are not adequately taught the digital skills of concern in advance, the digital media will not become part of a process of design and will be degraded to instructional labs for software training. To avoid weakening the pedagogical endeavour in a paperless DCS, the students need to learn the related digital media tools and use the computers as a design tool for inquiry and exploration (Norman, 2001).

### **3. Design with Computers in The Paperless DCS**

Our first year design computing students have been given a brief to design a café on a vacant land next to the Faculty of Architecture's Tin Shed Gallery and were asked to design this café using ArchiCAD as a platform. ArchiCAD is very effective software that can be utilised as a design tool at the early stages of the design process and it satisfies the criteria outlined in section 2.2. Other digital media tools such as Adobe Photoshop, Microsoft Powerpoint, Macromedia Flash and Dreamweaver were used in the paperless DCS as image processing and presentation tools. The typography and surroundings of this land were modelled by the students in ArchiCAD. The climatic changes and effects on the site from surroundings were calculated and presented using ArchiCAD at specific hours of the four seasons as shown in Figure 1, e.g. 3pm. This had a primary effect on where the proposed building might be located on site to avoid the overshadowed areas. The students have produced a QTVR animation showing the analysis of shadow studies. This simulation of reality was of a great importance to the students and facilitated their understanding of the climatic effects on design.

A major teaching and designing strategy that has been elaborated in the paperless DCS is that the limitations of ArchiCAD as the platform should not be considered as constraints in creating design ideas but rather utilise its capabilities as primitives in developing various design ideas. Instead of viewing the platform as a shell to generate typical and routine designs, it is rather to facilitate the features of this platform as a starting point to explore design ideas. This approach had a great impact on how the students interpreted the brief depending on where and how they started to explore

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their designs and which features of the platform were selected as design primitives to create and compose their design ideas. Some examples of students' diverse design ideas are shown in Figure 2. Students have also found that the experience of designing with computers within this approach has opened up an enormous amount of new design ideas and imaginations for them that may have not crossed their minds if they were designing on paper or constructing physical models. Not only are their ideas become richer and innovative, but also were able to test the behaviour of their designs, such as climatic changes to achieve thermal comfort, colour and texture scheme to achieve aesthetics and harmony with the surrounding environment, etc.

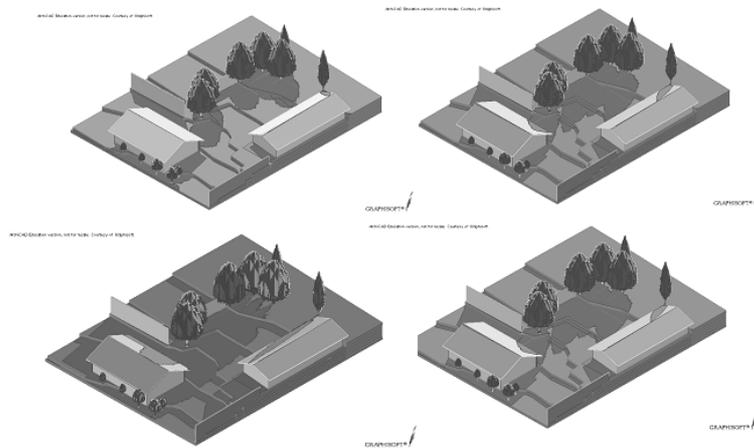


Figure 1. Land topography and shadow analysis of the proposed site to design a café.

### 4. Reflection on Designing and Teaching in the Paperless DCS

#### 4.1 DESIGN PROCESS IN THE PAPERLESS DCS

In the conventional design studio the design process have been stressed through the use of sketching, physical modelling and orthographic drawings. A unique characteristic of the conventional design studio is that sketching, tracing and recording ideas are left visible. This provides richness to the exploration through revisiting and revising previous ideas. The ability to see where a design idea is at present and where it came from seems to be a benefit of working in a physical or tangible medium. All of this and more can be offered using digital media in the paperless DCS (Norman, 2001).

The history of a project and process of design must be evident in the educational techniques employed in the paperless DCS. Editing a digital file might cause the history or part of the design process to be lost. This was simply resolved by using the design tool to benefit the design process in the paperless DCS. Whenever a design idea was revised a new file was saved providing a record of the past. This strategy was not applied by our students at every change in the design process but rather at times of conceptual changes. Another alternative to document the design process is with taking frequent captures and snapshots of the computer's screen state, well prior to final presentation. This allowed the students to see the evolution of their designs from various concepts to design developments. The documentation of the design process in the form of a digital sketchbook "digital portfolio" has broaden the students' design universe to utilise the design tool to digitally merge design ideas created at different time intervals of the design process.



*Figure 2.* Some examples of first year design computing students' ideas in designing a café produced at the paperless design computing studio.

#### 4.2 COMMUNICATION AND REPRESENTATIONS IN A PAPERLESS DCS

The newcomer to a paperless design studio might expect instant efficiency as a result of the move to digital design studio. Yet, even after developing a basic fluency with a given program, this efficiency is not likely to be immediate. Initially, a significant amount of time must be devoted to mastering computing in the design context. It is important to anticipate the “time sink” at the early stages of the digital engagement and to allow for it (Lewis and Wojtowicz, 2001).

The forms of representation in the traditional design studio have been the use of physical models, manual drawings, and even to some extent two and three-dimensional CAD drawings. In a paperless DCS using design tools as tools for inquiry there were various types of representation forms produced by our students at the paperless DCS including, real-time modelling, web-based presentation, dynamic presentation incorporated with sound, QTVR animations and walk-throughs. A promising aspect of the digital model lays in its inherent ability to be used as data for the production of design and to serve as data in CAD-CAM, or the quick prototyping process. This can potentially create a new relationship between designer, project and object of design, perhaps turning the designer into the digital artisan-craftsman. The nature of the digital design medium permits the designer to think more naturally in three dimensions and to a greater degree than previously imagined.

#### 4.3 PAPERLESS DCS AND ITS IMPLICATIONS FOR STUDIO PEDAGOGY

The nature of design with its uncertainty and irregularities are congruent with the epistemology and ontology of the constructivist pedagogy. The inclusion of constructivist ideology within the paperless DCS helps to increase learning and advance constructions of knowledge (Powers, 2001). Similar to a traditional design studio the responsibility in the learning process is shared and negotiated amongst teachers and learners. Utilising digital media in a paperless DCS enriches the design studio environment with a multiplicity of informational sources and representations that help students and teachers reflect upon design ideas at different time intervals at the early conceptual stage of the design process. The paperless DCS is an excellent place for the outgrowth of exploring, investigating and constructing design ideas and is congruent with the epistemology and ontology of the constructivist pedagogy.

## 5. Discussion

In the paperless DCS there were different types of interactions that took place between the students and the design tools, between the students themselves and between the students and their design instructors and teachers. The focus on the interaction between the student and design tools in the paperless DCS distinguishes the approach presented in this paper rather than using computers as generative systems. The generation of shapes using generative systems is very different with the creation of design ideas within a form of fruitful dialogue between the student and the design tool where designing as an activity occurs with the active participation. Designing with computers is not a systematic process by which a set of rules would generate design solutions (Madrazo, 1999). Designing with computers is rather a situated process wherein the result of design artefacts is based on the design situation that each student encountered, the state of interaction with the design tool and which objects primitives of the design tool the student were utilised. A designer, through analysis, investigation, research and interaction begins to synthesise an idea for a possible solution to the challenge of the situation at hand. The process is then to chase this idea down to see if it works, to test it, to modify it, to branch out in a different direction or to reject it back all together.

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