Learning about architecture with the computer, and learning about the computer in architecture

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Most students commencing their university studies in architecture must confront and master two new modes of thought. The first, widely known as reflection-in-action, is a continuous cycle of self-criticism and creation that produces both learning and improved work. The second, which we call here design making, is a process which considers building construction as an integral part of architectural designing. Beginning students in Australia tend to do neither very well; their largely analytic secondary education leaves the majority ill-prepared for these new forms of learning and working.

Computers have both complicated and offered opportunities to improve this situation. An increasing number of entering students have significant computing skill, yet university architecture programs do little in developing such skill into sound and extensible knowledge.

Computing offers new ways to engage both reflection-in-action and design making. The collaboration between two Schools in Australia described in detail here pools computer-based learning resources to provide a wider scope for the education in each institution, which we capture in the phrase:

Learn to use computers in architecture (not use computers to learn architecture)

The two shared learning resources are Form Making Games (Adelaide University), aimed at reflection-in-action and The Construction Primer (Deakin University and Victoria University of Wellington), aimed at design making. Through contributing to and customising the resources themselves, students learn how designing and computing relate.

This paper outlines the collaborative project in detail and locates the initiative at a time when the computer seems to have become less self-consciously assimilated within the wider architectural program.

Keywords: reflection-in-action, design making, customising computers

Pedagogical basis for inter-institutional resource sharing

Good, mature designers engage a continuous cycle of self-criticism and creation that produces both learning and improved work—this is widely known in the field as reflection-in-action (Schön 1987). It is mostly a learned behaviour—beginning students tend to cut it short (Anthony 1991). If recent Australian national and international design awards, (Mainwaring
1997, Poole 1998 and Le Plastier 1999) are any indication, society places considerable value on architects who have profound knowledge of building construction and how it can be used to augment an architectural idea. Developed practitioners of design making can relate the distinct domains of architectural ideas and a constructed reality. Beginning students and other laypersons have particular difficulty with such discourse between a world of ideas and a world of physical form.

In the built environment professions, sound skill in, deep knowledge of, and an ability to continue to learn about computing in design are highly valued. Graduates who can use and extend their skill and knowledge in innovative ways are given opportunities for especially exciting and fulfilling work. Worldwide, undergraduate schools of architecture produce few such people.

**Sharing resources**

This collaborative project addresses each of these three concerns by immersing beginning students in an environment that models and encourages reflection-in-action, design making and innovative computing. Diagram explains how it will do so.

All resources are online. The Construction Primer addresses all aspects of building construction information and gives students access to and assistance with computer-based design making. The Form Making Games provide a series of ‘games’ that encourage directed exploration, reflection and ‘play’ in designing and a means to record how a large group of students engages with the games. Australian Lightweight Houses comprises a collection of articles, images, computer models, animations and videos of a distinctively Australian house type. The Online Treasury is a multimedia database with authoring rules for distributed contribution and quality control. These are outlined more fully as follows.

**Construction Primer**

The Construction Primer is an online resource that looks at all aspects of building construction information. The resource contains an array of information varying from generic interactive 3D descriptions of how buildings go together, the standards and building control laws that regulate the built environment, and access to the professional bodies and manufacturer’s databases that influence practice.

It recognises that making wise choices of construction systems requires knowledge of the
available choices; their various implications; and of how to make choices under uncertainty and in the face of conflicting demands.

Students use the Construction Primer to access and examine information about construction systems according to a broad range of criteria. They also use it as a journal to create their own construction case studies.

With the Primer, students with cursory CAD skills can become productive extremely quickly and to contribute to the Primer as much as they are able to take information from it. In doing so they scaffold not only their abilities to research and analyse construction systems, but also their ability to customise computer software for their own ends. It has a simple interface using protocols designed to avoid constant re-editing, ensuring consistency within the resource.

**Form Making Games**

Form Making Games is a student-centred learning resource that enriches the capacity for design in first year students in architecture, landscape architecture and urban design. Students are encouraged to learn interactively in an original milieu characterised by self-directed play with a game in a low-risk computer-modelling environment. As they gain confidence, peer critique and collaboration become an intrinsic part of their learning.

Why ‘play’? First, as a metaphor ‘play’ is widely used in the literature to describe ‘good’ designing. ‘Play’ seems to capture essences of designing—it is intrinsically engaging, both bounded and free, and open-ended. Second, ‘play’ can breed confidence and build new skill, which many beginning students sorely need. Lack of confidence and skill in form-making is a debilitating handicap, leading to frustration and disillusionment. It supports a division between those who apparently ‘have’ and ‘have not’ these skills, labelling students as ‘creative-imaginative-competent’ or otherwise very early in their course. Such labels all too easily follow through to subsequent careers. Third, our published work and pilot study suggest that form-making can be learnt and refined through self-directed, structured play with carefully conceived form-making games.

A typical game presents students with a ready-made computer model and some special devices for its manipulation and viewing, all in a standard computer-aided design system. Using a standard system means that students can progress smoothly from a form-making game to more comprehensive system use.

Students work as they do in any CAD systems. They make models, view models and produce output. The human-computer interface of the CAD system provides all necessary functionality, which we supplement and make more accessible through the operations and customised menu of each game.

**Australian Lightweight Houses**

The Australian Lightweight House resource is a collection of papers, images, videos and CAD models describing a set of Australian houses. Each house
has been designed by a well-known Australian architect - many have won design awards. The houses represent a distinctively Australian approach to creating houses for Australian cultures and climates.

The resource is used in early design education to provide examples of architecture that simultaneously embody rich forms and visual experience and reveal how construction can complement these. The houses are familiar to beginning students (they are recognisable as residences) which facilitates confidence and a relaxed approach to their study, yet seem strange in their composition, construction and siting, which creates opportunities for new insights into architecture.

Typical Australian Lightweight Houses are designed so that construction is a crucial part of the architecture; typically materials are simply put in place with all fastenings exposed and edges revealed.

Houses of this type demonstrate relatively complex spatial and formal structure. Designing a worthwhile building of this type demands an understanding of
construction and considerable craft in creating and envisioning exposed construction that is aesthetically compatible with a design. It also demands advanced reflection-in-action in perceiving, envisioning, assessing, judging and creating complex spaces that the constructed elements ultimately define.

**Online Treasury**

In almost all schools of architecture, the simulated project (usually referred to simply as ‘studio’) is the principal learning environment. The *Online Treasury*, under development at Deakin, is a digital repository and is used as a primary resource to support such project-based learning. The Online Treasury has three components:

- a database schema for organising information around a project and for relating different projects together [A];
- a set of tools for accessing and populating the schema;
- the database contents, including exemplar projects continuing to be developed within the *Online Treasury* by both staff and students.

The first educational challenge and one faced by all schools of architecture and building, is not so much compiling a digital repository, but rather the improvement of problem based learning through project work. Our strategy for improving project based learning is to capitalise on a currently under-utilised resource generated by project based learning - the students’ integration of exemplary resources produced as they address problems through project work. Students spend a significant proportion of time researching material to inform their own creative work. The integration of the student research is exactly what textbooks and other conventional resources are unable to do with a fluency to match the prolific and changing information required to assist decision making. Our means towards this end is the *Online Treasury* - a vehicle for capturing exemplary responses in a project based learning environment.

The second educational challenge is to assist students in developing robust working knowledge of and skill in information technology. A central premise is that we will do this within project-based learning and collective research effort.

**Application**

The central task of the project is a case study of specific Australian Lightweight Houses within Form Making Games and The Construction Primer. The existing material on the houses will be stored in the Online Treasury and thus made available to other resources and for general student use in other programs. While other cases could readily be supported in the Games and Primer, there are three reasons for focusing on the Australian Lightweight House. First, typical houses of the type are good models for learning reflection-in-action—they are
understandable yet complex artefacts from which many critical positions can be drawn. Second, the houses are exemplars of design making; they depend on direct construction for much of their effect. Third, a case on them thus supports linking learning about reflection-in-action and design making. Fourth, they are real buildings in the local context, an essential requirement for accommodating the concrete learning styles of most beginning university students.

The actual case constructed is designed to accommodate the redevelopment of the early part of the curriculum in both schools, each in their own way, but both using the Australian Lightweight House case study as a focus for learning.

Due to space we only discuss the Adelaide curriculum here. The following diagram (Figure 8) shows four of Adelaide’s first year core subjects (two in each term) using resources and focused around the case study. In each semester, the paired subjects will address one side of the dialogue between reflection-in-action and design making. For example, in second semester, the subject Design and Form 1B will develop reflection-in-action using the Form Making Games to create abstracted space and construction proposals. Simultaneously, the same students in the subject Construction I will focus on fundamental approaches to lightweight construction using the Construction Primer but will do so using the reflection-in-action support of the Form Making Games.

A staff development program is required to assist academics to use and adapt the existing online resources, to create new ones, and to teach students to do so. The refinement of learning outcomes amongst both students and staff is required but our evidence shows that a number of factors are making it relatively easy for staff to migrate to a more hands-on use of computers for computer assisted learning. Factors include better interfaces, faster computers doing what the doubters thought computers ought to do when they first tried and were put off from using IT.

Figure 7 (right). Examples of different media types. These are not stored within the database but managed by the database.
Literature and/or current practice relating to the project.

We focus here on efforts aimed at helping students learn reflection-in-action, design making and innovative computing, both individually and in combination. In architectural education, the chief educational model and pervasive ethos is active participation in simulated design situations under the guidance of a mentor (Schön 87). Subjects taught in this model are usually called studios. Not surprisingly, most of the relevant innovations occur within the simulated design project structure.

Since the early 1990’s, Flemming (CMU)(1990) has used an explicit process model to teach a 2nd year studio in which students learn both design making and self-awareness of process. Knight (MIT) (1992) uses spatial grammars as the rules in what we view as form-making games. Seebohm (Waterloo)(1991) has students undertake a serious grammatical study of a design corpus (for example, Palladian Villas) through the reflective making of computer-aided design models. Coyne (Edinburgh)(1998) has students engage computing in design both actively and against a deep critical position provided by an interpretation of recent philosophy. His approach appears to work well for advanced students who have already acquired strength in reflection-in-action. All of the above work is valuable and we continue to have close contact with its proponents. Adelaide’s Form Making Games (nationally funded through a teaching development grant in 1999) differs in its greater emphasis on a free-ranging exploration of design possibilities, in its promotion of confidence as a chief prerequisite for learning reflection-in-action, and in the degree to which it addresses our early curriculum.

The teaching of construction typically takes place though a combination of principles (weather protection, structural integrity, etc.) and exemplars (examining case studies of construction in buildings)(Brand 1990). The former involves describing relations between building elements and their behaviour, occasionally assisted by computer simulations (Latta 1973). The latter involves visits to construction sites that supplements the notion of ‘principals’ by providing access to a simulated site at any time with marked advantages in clarity of description and analysis of construction processes.

Brand’s work (1990) recognised the need to link principles with exemplars. To this, the multimedia Construction Primer (Burry et al. 1995, Burry 1997, Burry et al. 1997) adds access to related information and an ability to use exemplars directly in design using computers.

Most schools seem content to teach their students to be users, perhaps sophisticated ones, of software, with little higher-level reasoning and problem solving with and about computers. MIT’s Design Studio of the Future seems to be the zenith of this approach. Recent developments in virtual design studios (Dave 1998) may exacerbate this situation in their use of the Internet as a neutral medium of information exchange. Coyne (1994, 1996) points out that students engage computers in designing in diverse ways and that through such engagement student understanding of both design and of computing is changed. Burry (1997) fosters the existing computing skills of many students to build towards more complex and comprehensive computer use in learning. Dave and Woodbury (1990) use explicit models and model theory in an attempt to promote early higher-order learning in architectural computing. Though few schools today teach computer graphics programming, the issues raised by Mitchell et al. (1987) in their book on the topic remain current (Burry 1997).
Concluding Notes

Recent Australian developments, both nationally funded and otherwise, have focused on specific bodies of architectural knowledge taken in isolation and have used computers primarily as a delivery vehicle for this knowledge. Three prominent Australian examples are Gunaratnum and Maher’s (1997) multimedia case-based design tool, Newton’s *Simulated Site Visits* (Newton 1997, 1999), and Finkelstein’s *Digital Slide Archive* (1995). These developments stand as valuable isolated contributions, but are quite opposite to the approach described here. They do not address learning reflection-in-action, design making or innovative computing by students. Pooling resources in a manner that does not prescribe a common curriculum points to an assimilation of the computer within the business of learning about architecture that is becoming relatively painless, and especially valuable.

References


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Notes

[A] The database records the location of components (‘atoms’) across many servers, and is used to manage their relevance and quality through metadata identifiers.

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