Managing Digital Resources for Design Education

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This paper outlines the evolution of digital management systems used in the School of Architecture and building at Deakin University from 2001 to the present. These systems have been implemented to support a curriculum development programme in the design, construction and computing units. Two school-based information management systems are discussed in depth: low-tech network submission system and Bentley Systems Inc's ProjectWise. Early experiences in using a university-based system are also reported on. Lessons learnt from three years experience in managing digital resources for design education have informed the development of a growing digital culture in the architectural and construction management curricula. Whilst digital curriculum design and management systems supporting this curriculum have been developed effectively in this school, full optimization of IT to enhance design education is reliant on fundamental changes within traditional academic culture.

Keywords: *Digital management, digital curriculum, design education.*

A Digital Curriculum

Since 2001, the School of Architecture and Building at Deakin University has engaged heavily in the use of IT in the delivery, submission and assessment of student projects. This has been the result of a nationally-funded curriculum development project (see Woodbury, Wyeld et. al 2001, Ham 2001, Ham, Anson et al 2002) and a university-funded IT-enhanced resource creation project. Arising form these efforts, Games, Digital Projects and online resources have been integrated into units in construction technology, computing and design in the Architecture and Construction Management courses.

Games and Digital projects are delivered from unit websites hosted on a school server. Typical projects contain information on 'aims', 'tasks', 'checklist', 'submission' and 'resources', an adaptation of pedagogical templates established at the University of Adelaide by Woodbury, Wyeld et. al. (2001). They are supported by 'resources' which include working files (zipped web templates, 3D CAD files and images), hyperlinks to websites and digital case studies related to each project.

Once students access online project details and download the necessary resources, projects are undertaken using hybrid combinations of drawings, physical models, 2D CAD and 3D CAD, manipulated by graphical software (see Ham 2003). 3D CAD models, websites, PowerPoint files and digital im-

ages are submitted for assessment to school-based networks (2001), ProjectWise (2002-2004) or Deakin Studies Online (2004 - present) Examples of student works are provided in Figure 1, below. This paper will focus on critical issues encountered in the implementation and management of systems that support digitally-enhanced curricula.

Digital Network Submission

The 2001 development of Games in the design and construction curriculum necessitated the development of a reliable method for the uploading of digital files. A principal limitation of this endeavour was the inability of school servers to allow file transfers that penetrated the university firewall. Using limited school resources, a network-based system was developed to facilitate submission of large numbers of digital files for the 2001 academic year.

Submission of files for Games and digital projects was enabled through school-based computer laboratories inside the university firewall. Password-controlled directories and sub-directories were created relating to each digital project and 'game'. In submitting their projects, students were required to access school computers, map network drives and submit files to write-only directories. This presented a workable short-term solution for the digital submission of files. Five core units in the school utilized this system in 2001, comprising approximately 300 students and 1000 digital submissions.

Management of this system proved to be very time consuming from the point of view of network administrators and academic staff. Fundamental sources of problems included the inexperience of some staff and the recalcitrance of students in their management of digital information. With the absence of naming protocols and file size limitations for digital submissions, students submitted improperly named websites of up to 120Mb in size. A second major source of problems was the limited abilities of students in working with digital media. This was exacerbated by the limited digital training undertaken in construction units. A large number of submissions contained dead links, unlinked images, incomplete zip files or submitted to wrong submission directories. Contrary to the authors' perceptions of the students belonging to the 'Nintendo generation', basic file management appeared to be the failing for many students.

This issue was of particular relevance when a pilot semi-automated digital Online Gallery was developed by colleague, Sambit Datta. This system used PERL scripting to generate online galleries of images of student works, following their submission to the network. Although a successful pilot, semi-automation of this type requires absolute compliance to a pre-determined set of naming protocols. This is an issue that students find particularly difficult to conform to.

In summary, the authors' first foray into large-scale digital submission presented a valuable learning experience for all. Through this pilot year, realisations were obtained of the importance of naming protocols for submissions, limitations on file sizes, basic digital training and adequate infrastructure. Whilst digital network submission provided a low-tech, short-term solution to an immediate problem, practical lessons in ways of dealing with students' digital recalcitrance have been valuable in informing the further development of digital delivery, submission and assessment within the school.

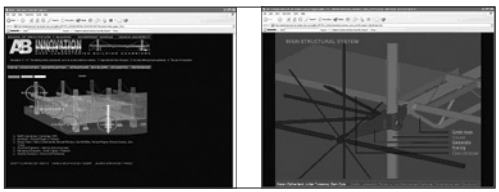


Figure 1
Examples of Student Digital Projects.

Implementing ProjectWise to Support Digital Design Education

In 2002, the School of Architecture and Building and Bentley Systems signed a Memorandum of Understanding (MOU) to support digital research

and curriculum development. As part of the MOU, the School piloted ProjectWise as the primary system for submission and management of digital project files. ProjectWise is used in the AEC industry as a central repository to 'manage information by controlling access within the work group, across a distributed organization, or among teams and firms collaborating globally' (http://www.bentley.com/en-US/Products/ProjectWise/:March 2004).

The installation and use of ProjectWise in an educational environment at Deakin University is unique to educational institutions in the Asia-Pacific region and used only by a limited number of educational institutions in Europe. School IT and academic staff were required to set up the database structure and management systems in-house, with minimal budget and during a limited time period.

There were two key aims of installing the electronic information management system. The first was to manage the delivery of copyright material to students. Architectural and engineering offices have been generous in providing documentation for the design and construction of the 'Woolstores' (Waterfront) campus that houses Deakin's School of Architecture and Building. This electronic material has been provided to the School on the understanding that it would be used for teaching purposes only under controlled access conditions.

The second aim was to manage student access to their files both for submission and return of assignment mark sheets. It was desirable that student have access to only those folders (directories) used for electronic submission for particular subjects. This was to be handled in two ways. The first was to provide a folder of each project of a subject and require the student to transfer the electronic submission to that folder. In this case all students transferred files to a single folder. Once a student had transferred a file they could not remove it nor could they access any files submitted by other students. The second situation was where each student had a separate folder for each project in a particular subject with only their folders being visible to them. A student could not see any other student's folders or have access to any other work than their own. The latter maintained the levels of confidentiality for students which have become increasingly important. A further supplementary aim was to give the students experience at using an industry based digital information management system.

Security vs Access - The Continuing Conflict

ProjectWise was installed on a dedicated school-based server by School IT staff with the assistance of Bentley staff. The server and ProjectWise was setup to handle up to 100 simultaneous logged on users. A critical issue which is unique in the in the configuration of the server is that it was required to be outside the security of the University firewall. This was essential for submission of student assignments. Under the configuration of the existing university network, students have been prevented from submitting work through the firewall. This had previously prevented electronic submission of work from outside the university network system which was (and still is) a significant aim of digital working within the School of Architecture and Building. ProjectWise has the required level of security necessary for maintenance of a student submission system placed outside the university firewall.

The ProjectWise front end interface to the SQL server provides a high level of access control to the data which the students would submit and access (Figure 2). While this is highly satisfactory and designed to be secure in a commercially sensitive environment, the operating system proved to be less so. Within three weeks of setting up the server a hacker in France had accessed the internet through the server at operating system level (Figure 3). This unauthorized access through the operating system forced additional measures to be put into place with the installation of a hardware based firewall (Figure 4).This has successfully secured the server against any further intrusions and enabled the School to continue its move into increased levels of digital content delivery and off campus submission.

Figure 2
Original Server Configuration.

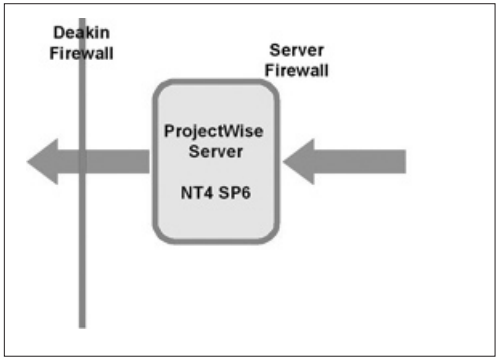


Figure 3
Hacking into Server (ProjectWise Secure).

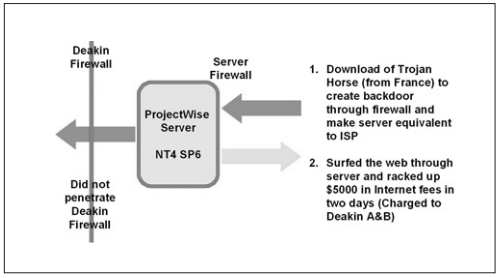
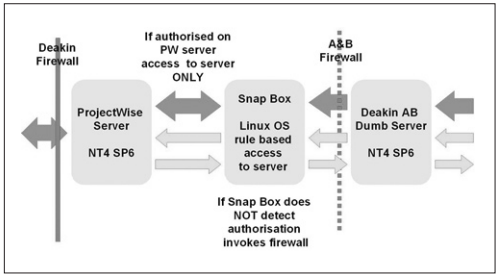


Figure 4
Solution to Security Issue.



Methods of use of ProjectWise in an Educational Environment

Three methods have evolved through the implementation of ProjectWise in architectural education at this institution. The first, most basic method uses the product for data storage for a digital repository of resources. This repository contains 2D CAD and 3D CAD files and a digital image archive related to building case studies. These digital resources are used to support digital projects, workshops and design studios. This method supported the development of the Woolstores (Waterfront) Multimedia Case Study outlined in Ham, Anson et al, (2002) and the AllomorphII international design workshop held at the school in September 2002. Access to these resources was available to students for Digital Projects in design, construction, and 3D CAD units.

The second method utilises the web-based document uploading capacities of ProjectWise as an online digital project submission system. Password secured 'vaults' (folders) are set up in read-write or write-only modes, depending on the requirements of individual units and projects (see figure 5). This enabled students to submit zipped websites or digital files up to 10Mb from university laboratories or (less successfully) from home. Submitted files are then extracted from the database by administrators to staff computers for assessment or digital design reviews, and then linked to online Virtual Galleries. This method supported the 'living' Woolstores Case Study digital project. This project involved students producing websites case studies of construction elements from the Deakin University Woolstores campus. Students accessed documents in the repository to complement their on-site measurement and observation of construction elements such as band beams and columns, stairs and retaining walls. Exemplar projects are then added to the multimedia case study, creating a cycle where student work is used to inform the learning of their colleagues.

An extension to this method resides in a completely paperless process of delivery, submission and review and feedback of digital projects. Once students' digital files are submitted to the database, reviews in front of a panel of staff and guests are conducted in the studio from digital projectors. Feedback is provided to students digitally from MS Word templates, which are then uploaded to individual students' project folders.

Figure 5
ProjectWise Folder Structure.

The third method of use of ProjectWise facilitates the sharing knowledge between architects and construction managers within a 'design-construct' scenario modelled on practice. Here, 'development teams' of architecture and construction management students work together to develop the construction technology and procure a student's design project in an integrated design unit. Permissions are configured to allow teams to set up their own folder structure for the management of digital information for the development of the project. To achieve this, teams must research file management structures and implement an appropriate system for the development of the project.

By allowing developer teams to manage their own information within a simulation of a design-construct practice, recognition is made of the importance of information management as an integral element of project management. Effective project management required digital files such as meeting minutes, images, CAD models and drawings to conform to naming protocols, and be filed in appropriate locations. The problems encountered when development teams poorly managed their information were similar to practice.

Lessons Learnt in using ProjectWise in Design Education

Our assessment is that ProjectWise adapted reasonably well from the AEC to the architectural educational environment. Throughout a two year period, the product effectively managed thousands of digital files (eg .dwg, .dgn, .html, .ppt, .exe) submitted by students. Major project submissions were managed most effectively through the school's computer laboratories, with submissions peaking at approximately 150 digital files in the space of a morning.

The ideal of home-base submission was only realised by limited numbers of students. Not all local Internet Service Providers enabled the uploading of files, meaning the many students were unable to access the full potential of the system. Attempts at uploading large digital files through 56K modem connections proved problematic. Recent advances in ready access to broadband connections have resolved this issue for many, subject to the cost of maintaining broadband connections. Further ISP issues arise with upload and download limits (up to 10Mb maximum).

Although this is a limitation of the system, it led to a positive outcome in terms of the way students were required to manage their information for digital projects. Limited by a file size 'budget', students were, by necessity, required to decrease image size and resolution to 72dpi and include the optimal digital information to communicate their design intent effectively. Thus, personal information management became an integral element of the representation of design solutions; a valuable attribute for architectural practice.

Deakin Studies Online: Initial Experiences with a University-Based System

In July 2003, Deakin University introduced Deakin Studies Online (DSO) as a centralised learning management system using WebCT Vista. In 2004, all units in the university were required to have at least a basic DSO presence (level 1) Progressively over the next few years, staff are being encouraged to develop units to extended online (level 2) and wholly online (level 3). All Deakin graduates will be required

to participate in at least one wholly online unit prior to completion of their degrees. In Semester 1, 2004 (March – June) the school made the transition towards the University-based system, with 26 units operating at level 1, 15 units at level 2 and 3 units at level 3.

Between March and June 2004, the authors delivered two second year units to extended online level. These units, Computer-Aided-Modelling and Construction and Structures 2 had been previously developed as part of the Digital Projects initiative discussed previously, thus were already set up on the basis of online delivery, submission and assessment. DSO served as a 'one stop shop' for students to access unit details, upload projects and receive feedback and assessment. DSO enabled further enhancement of online teaching through discussion boards and quizzes to support exam-based units. As a university-based system, management is largely conducted outside of the school, with student access linked directly to a central Callista database. Externalisation of management of the system has both positive and negative consequences. Whilst DSO has resulted in a reduced workload for technical staff, technical difficulties are managed by the university IT services, sometimes with slow response rates.

Staff and students who have used ProjectWise previously in their curriculum are embracing the additional functionality and opportunities provided by WebCT Vista. ProjectWise is now being used as a primary repository of for the storage and control of extensive digital architectural information to support units in DSO. In addition, it is part of a suite of Bentley Systems tools being used in current research into digital information systems for the construction industry.

Initial expectations of DSO, for those actively engaged in online learning, are positive. Considerable efforts are being made to optimize use of DSO, particularly in relation to synchronous communications plug-ins being trialled for delivery in 2005. This will form the focus of future research into digital design education within the school.

Growing a Digital Culture

The development of successful digital education within architectural schools is based on synergistic interactions between at least three elements: digital curriculum, digital management and digital culture. A shortcoming in any one of these elements reduces the potential for positive learning outcomes for students.

Through the digital curriculum development undertaken at the school since 2001, we have designed, delivered and evaluated a wide range of projects optimized for the digital environment. It has taken three years for some units to find an appropriate balance that optimises the use of digital and physical media to enhance student learning.

This innovation needs to be supported by a reliable digital submission and management system in order to be effective. Our experience in digital design education using the electronic network, ProjectWise and WebCT has resulted in the development of standardized procedures and protocols to enable the efficient management of digital projects. After three years of development and research, a core of staff in the school are equipped with expertise in this area.

Whilst the digital curriculum and management systems have been adopted by this core of staff in the areas of design, computing, construction and quantity surveying, the majority of staff adhere to traditional methods of teaching. The role of the 'change agent' (Davies and Csete 1998) in architectural education is made difficult by a majority of staff who are unwilling to engage in enhancing their curriculum with digital media. This is seen as a principal limitation of growing a digital culture within schools of architecture and construction management.

The limitations of staff engagement in digitally enhanced education are overcome by a strong digital culture amongst the student cohort. Students currently enrolled in the final (fifth) year of the archi-

tecture course are the same cohort that engaged in Games and Digital Projects in 2001. This initial experience in digital design has contributed towards the saturation of digital media in their project work. Following a non-digital first year, some second year students demonstrate capabilities in digital media that challenges the fifth year students. They clearly belong to a culture that recognizes the importance and potential of digital media, even though some of their educators do not.

Further to the growing digital culture of students, an enforced digital culture is emerging. University policies now actively embrace online learning and require at least a basic level of engagement in the digital culture. Innovation in digital education has been rewarded, with staff in the school receiving 5 university teaching awards and nominations for two national teaching awards. In contrast, staff who are reluctant to engage are facing increasing challenges by both the growing digital culture of students and the University.

Whilst the future of digital education in this school is secured by a well-developed core of innovative digital curriculum supported by a university-based digital management system, it is limited by the academic culture. If a comprehensive curriculum is to evolve that is relevant to the industry of the future, it is this academic culture that must be addressed.

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