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Implementation of Project Specific Web Sites in a Capstone Design Course

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Abstract

Project Specific Web Sites (PSWS) promise to revolutionize the way designers, constructors, and owners process and transmit information regarding a design/construction project. The PSWS can be thought of as a clearinghouse for project data, including text, graphical, and video data ranging from contracts and meeting minutes to final drawings and construction images. It can also be the center for real-time collaborative work, with participants in remote locations sharing and modifying images and other data. The capstone projects in the Architectural Engineering and Building Construction Department at Milwaukee School of Engineering are an ideal forum within which to experiment with this new mode of communication. During their entire senior year, our students work in multidisciplinary teams with a group of faculty specialists to develop a complete architectural, engineering, and construction management solution to a real client's building needs. The PSWS is the mode for faculty and students to communicate regarding course and assignment requirements, but more importantly it is the mode for students to organize, archive, and display their work. This paper describes some of the issues we have addressed during implementation of PSWS in the capstone projects. These include creation of hierarchies of data and hierarchies of rights to see or modify data in the PSWS, as well as strategies for presenting the concept of PSWS to students and faculty.

I. Introduction

Financial realities have encouraged the growth in popularity of the "design-build" concept, where planning, design and construction of a building take place simultaneously. The design-build team may consist of hundreds of people representing dozens of specialty design and construction firms. Successful implementation of this method requires quick and accurate transmission of information, responses to questions, and notifications of changes. Ninety-four percent of architectural firm principals responding to a recent study said that automating the collaboration process is a primary goal for the next five years.[6] Some of the key players in the building and civil structures construction field are beginning to recognize the power of the World Wide Web as a communication tool. The most progressive firms are beginning to use the web as a network for multimedia communication among the design/construction team members. "By erasing distances, small firms are becoming big firms; barriers between disciplines are falling; and work that used to mean getting on an airplane and flying to a meeting or endlessly shuttling drawings back and forth by FedEx is being done in, as they say, real time."[1] This idea has been implemented to various levels of sophistication as "project-specific web sites." Faculty and students of the Architectural Engineering and Building Construction Department at Milwaukee School of Engineering are implementing this technology into the students' capstone design projects. This paper describes the rationale for the project and reports initial progress.

As with all industries, the construction industry is feeling growing pains as it figures out how best to use the Web. The term "project-specific web site" (PSWS) was apparently first used in 1994 by Framework Technologies Corp. to describe Web networks to support project teams.[5] A June 5, 1995, *ENR* an article describes efforts to organize the homepages of individual companies and agencies, to facilitate efforts by constructors, designers, and owners to gather information,[9] but there is no mention of two-way communication, much less collaboration. Just two months later, the idea of a web site as a center for communication about a specific construction project is described.[8] The article implies that use of the site by project participants is strictly optional, and although the stated intent was to facilitate interaction between participants, information mostly flowed downward from the top. An example of this type of site was the one developed for the Central Artery/Tunnel Project in Boston (originally http://www.state.ma.us/bigdig/, now http://www.bigdig.com/index.htm). The site originally only contained information for the general public – this served a public relations purpose but did not directly serve the construction process. The current version of the site contains some information directed to contractors, and includes a means for them to request additional information. Through 1995 and 1996 the idea of an "intranet" for project-related communication within a single organization was developed.[7] Secure web sites were used by some of the largest design and construction companies to present organizational charts and holiday schedules to employees, and allow some in-house communication. The important step at this stage was that the industry began to recognize the value of a network that was open only within certain boundaries.

The industry's current model for a PSWS has evolved from a combination of the public web sites and the closed intranets. Access to the PSWS may not be a yes/no issue: A PSWS usually is entered from a public site, perhaps the home page of the project owner, prime designer, or constructor. This public site may contain a significant amount of information for the general public. Access to the PSWS itself requires a password, and access to information within the PSWS can be structured differently for the various participants. We will describe access issues in detail when we describe our implementation of PSWS in the capstone course.

Examples of current PSWS applications:

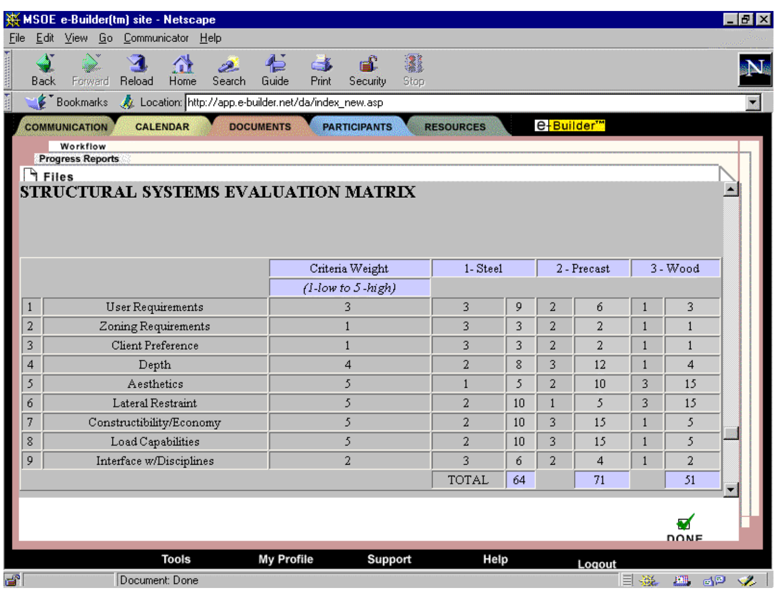
- The Washington Suburban Sanitary Commission, as the owner of a $14.3 million upgrade project, set up a PSWS (http://wssc.gcn.net/) so the designer, contractor, and subs could communicate electronically. They use the site to transmit schedules, submit and respond to RFIs, and view drawings and specifications.[4] The State of Wisconsin is using the same PSWS provider for a high-security prison project (http://supermax.gcn.net/). Each of these site's main page contains links to the owner's home page, the link to the secured PSWS, and some basic project information for the public. That the *owner* set up these sites is significant – this owner apparently expects a benefit from enabling improved communication among the construction project participants.
- The George B. H. Macomber Company, a constructor based in Boston, maintains PSWS for

its active projects, accessed from the company's home page (http://gbhmacomber.com/). The company's stated intent is to allow owners, architects, subcontractors, and its own people to share announcements, meeting minutes, floor plans, budgets, and photographs.[2] Presumably these participants are required to utilize the PSWS. This site maintained by the constructor may achieve the same result as one maintained by an owner, but now the constructor has the opportunity to use it as a marketing tool and as an example in its efforts to convince potential clients that it is a top-notch firm.

- The architectural firm JSA Inc., based in Portsmouth, New Hampshire, uses its home page (http://www.jsainc.com) as the portal to PSWS for active projects. This site is slightly different in emphasis from those presented above because it focuses on the design, rather than construction, phase of a building project.[2] The PSWS includes a repository of ideas and sketches from the early phases of the design, as well as the developing and final drawings, specifications, and schedules. Functionality of this designer's site overlaps the sites a constructor would maintain in the construction phase – a log of shop drawings and site reports including photos is maintained.

II. Capstone Projects in Architectural Engineering and Construction Management

MSOE's capstone projects in architectural engineering and construction management bring students with different areas of expertise into multidisciplinary design teams to work with a real client to develop plans, specifications, schedules, and estimates for a building. Our projects blur the line between "simulations" and "authentic" projects,[3] as we have a real client, real site, real soil and utility data; but the students know that they will not produce a 100% complete design and that it will not be built as they design it. The clients are usually local firms or governmental agencies, identified by our architecture faculty, which are in the early planning stages of a new building or expansion project. Clients typically use their experience with our students to refine their own ideas of what the building could or should be before they hire a professional designer.



STRUCTURAL SYSTEMS EVALUATION MATRIX

		Criteria Weight (1-low to 5-high)	1- Steel		2 - Precast		3 - Wood	
1	User Requirements	3	3	9	2	6	1	3
2	Zoning Requirements	1	3	3	2	2	1	1
3	Client Preference	1	3	3	2	2	1	1
4	Depth	4	2	8	3	12	1	4
5	Aesthetics	5	1	5	2	10	3	15
6	Lateral Restraint	5	2	10	1	5	3	15
7	Constructibility/Economy	5	2	10	3	15	1	5
8	Load Capabilities	5	2	10	3	15	1	5
9	Interface w/Disciplines	2	3	6	2	4	1	2
			TOTAL	64		71		51

Figure 1. Student posting of preliminary work.

The student teams consist of one or more construction managers, one or two building environmental engineers (HVAC, plumbing, fire protection, electric power), and two or three structural engineers. The engineering students are pressed into dual roles, at times acting as architects and at times as engineers. The project series consists of a total of 14 credit-hours spread over the three- term academic year at MSOE. During the first term, our engineering students work primarily as architects to develop a program with the client, and the CM students begin project planning. During the second and third terms these students develop a complete budget and schedule, and a representative sample of architectural and engineering construction drawings and specifications, supported by calculations (see Figure 1). The students present their work to the client and faculty at several stages, beginning with sketches and models of the architectural design at the schematic stage. The project culminates in a team presentation of the completed architectural design to the client and a panel of professional architects, and technical presentations for construction management and each engineering discipline to a panel of practitioners in each field. The students are advised by a team of full-time and part-time faculty specializing in each discipline. The faculty act as consultants, steering the students when necessary but, ideally, helping them to solve the problems they discover for themselves during the design and planning process. The faculty use a series of assignments to guide the students through the preliminary and final stages of design and planning.

III. Goals for Project-Specific Web Sites for the Capstone Projects

Our goal in implementing PSWS is threefold. First, we want our graduates to be in the position of leading the firms that hire them into successful implementation of this new tool. Some of our recent graduates have been thrust into the field of PSWS by their employers – not because the graduates have direct experience but rather because it is expected that fresh graduates have more internet savvy than the old-timers. We see incorporating PSWS into our curriculum as a step in line with incorporating CAD or current engineering analysis tools. Second, we think that this tool can help us to improve the organization of a terrifically complicated course. For example, value-engineering discussions with more than one faculty advisor and the students can be very difficult to schedule, so we will organize the agendas for these meetings on the PSWS. Students and faculty can edit or add items to the agenda on-line. Third, this will give our students better means to present their work to us, and to the non-faculty critics they will face. The students have traditionally focused on large format drawings, models, and charts to present their work to the clients and the panels of professionals; these presentations will now be partially on-line with the aid of the PSWS. At a minimum, the students will be more likely to produce presentation documents with consistent format and re-use them in a variety of presentation types. Depending on the students' own motivation, they may also gain experience with multimedia presentations.

IV. Implementation Issues

A contractor, owner, or designer (or academic program!) considering its first use of PSWS has several options.[6] There are service bureau products, such as e-Builder from MPInteractive (http://www.mpinteractive.com/), ProjectCenter from Evolve (http://projectcenter.evolv.com/), Advantage PCS from Emerging Solutions, Inc. (http://www.emergingsolutions.com/) and others.

Figure 2. Main level hierarchy for a team's work.

Figure 3. Second level hierarchy for work by disciplines during a project phase.

The advantage of a service bureau product is that the user only needs internet access and rudimentary internet skills to create a full-service PSWS. There are software packages, such as ActiveProject from Framework Technologies Corp. (http://www.frametech.com/), which allow the user to set up the PSWS on any server. This option may allow the user more say in the appearance of the site and complete control over security, etc. The final option, probably only appropriate for the user with a capable and available computing staff in-house, is for a user to build a PSWS from off-the-shelf components such as Lotus Notes (http://www.lotus.com/). Our approach was to look only at the service bureaus, as that leaves us faculty with the least amount of responsibility for the direct operation of the PSWS, allowing us to focus on the implementation. Through a series of contacts, we developed a working relationship with MPInteractive and chose to work with their e-Builder product.

The basic structure of e-Builder is a set of tabs used to organize information and communication (visible near the top of Figure 1); the majority of our work is under the "documents" tab. Here in the "file library" we have established the hierarchy that is used to store files that faculty create to describe assignments and students create in response. Under the "participants" tab we define the individual users and the multiple groups to which each belongs. Each file added to the PSWS can be restricted so it can only be seen and/or modified by users in specific groups. Thus a student could, for example, protect his or her response to an assignment so only teammates could see it.

Perhaps the most important step in establishing the PSWS is developing a hierarchy which will be used to organize the library of files posted to the site. A robust searching function could potentially allow users to post all files into a single folder, but this is obviously not the ideal situation. Before establishing the hierarchy, one should anticipate the kinds of files, by subject and content rather than by application type, which will be placed in the main file library. The simplest way for an unsophisticated user to do this is to evaluate the kinds of documents that will *not* be placed in it. For example, e-Builder has pre-established areas to organize:

- Mail to individuals or groups on the project
- Discussion groups on the project
- Events listed on a calendar

- Progress reports posted by managers
- RFIs
- Participant information

Notable categories of documents not present in this list are the sketches, drawings, and text information (programming, etc.) produced by the designers during the pre-design phase; the construction documents (specifications and drawings), the construction manager's schedule and budget information, and shop drawings. The program's structure could be customized for a client that wants to include these or other items as tabs on the main screen, but the more common option is to set up a hierarchy in the file library to organize these documents.

The hierarchy is analogous to the folder structure any personal computer user sets up. For a design/construction project, there are several rational bases for the first level in the hierarchy: one could list the work categories as organized by CSI, parts of the building, types of file, etc. The first level of the hierarchy we established separates documents produced by faculty for students (assignments), documents produced by students for use by the entire group, and documents produced by individual multidisciplinary teams in response to assignments. Within each team's folder, documents are organized around the project phases as defined by the construction manager; these are listed in Figure 2. Within each project phase, the documents are placed into folders for each discipline (see Figure 3).

If a PSWS is to be useful, all project participants must use it for all communication. In the academic setting we have different requirements. This academic year is the first in which we

Phase[*]	Discipline			
	Construction Management	Architecture	Structural Engineering	Building Environmental Engineering
1	Owner-CM contract Designer-Owner contract Design milestone schedule	Programming Preliminary design	Code review and statement of design criteria	Code review Site utilities plan Basis of Design statement
2a	Value engineering report Preliminary budget Constructability report	Design development Plans, sections and Photos of models	Structural systems options LFRS[**] explanation Constructability report	Preliminary plans for water supply, waste, and sprinkler pipes
2b	Detail estimate	Working drawings	Structural plans Sample details Sample calculations	Mech room floor plan All piping plans Final Basis of Design
3	Construction contract Construction schedule			
4	Project manual Cost control system			
5				

Table 1. Student work posted to the PSWS during project phases.
*****1 = Pre-design, 2a = Design Development, 2b = Construction Documents, 3 = Bid and Award, 4 = Construction, 5 = Post Construction.
**Lateral force resisting system

have the multidisciplinary teams using the PSWS. Faculty members are utilizing the same series of assignments used in the past, and declaring that certain student work is to be handed in via posting to the PSWS and the rest is to be handed in via traditional means. Our criteria for what is posted to the PSWS is the sites should be complete enough to demonstrate the minimum possibilities to next year's seniors, who can build on their predecessors' experience. Also, the work posted by students this year will become the focus of a presentation we are planning for professional constructors. Posted work will include client reports such as the structural systems evaluation, all CAD drawings, a sampling of scanned-in sketches and calculations, and schedule and budget information. Brief descriptions of the type of information to be posted are given in Table 1.

A significant concern in implementing a program such as this is the impact it has on course content. Some minor shifts in course priorities are a given, but for the most part the course content has not changed. A similar paradigm shift took place in the industry when CAD replaced manual drafting. Many in industry protested the added expense of computer hardware and the added training (learning curve) required to bring their technical staff up to speed. In the end most would agree that CAD has improved the quality of drawing, estimating and the delivery of projects on time. Our trade-off will be the time that used to be spent plotting drawings, running off blue prints and making large renderings, is now spent learning how to submit files electronically, setting up a team home page, and learning how to make a multimedia presentation to a client.

A faculty development workshop is the missing link in this ambitious project. The critical logjam in implementing the project is expanding it beyond the realm of a few faculty members. In order to have the entire senior class involved, we have to first teach the rest of the teachers. We have obtained funding to allow a few of our faculty to create a curriculum which will teach the rest of the faculty what the PSWS is all about and how it is incorporated into the coursework. We will develop this curriculum during the spring and summer months of 1999, and present it to our faculty during late summer in a formal seminar.

V. Conclusions

Project Specific Web Sites are already having a significant impact on the construction industry. It is too early to know the impact they will have in our capstone design projects. One preliminary observation is that posted CAD files and HTML versions of student assignments and presentations have become a reliable method of reviewing student work. Also, in their evaluations of student work our clients have been very impressed with the quality of the designs and presentations. On the down side, one of our greatest strengths, small class size and faculty offices in close proximity to student workspaces, do sometimes work against implementation. It is may be easier for students to walk down the hallway and get an answer to a question directly, or just wait and ask during class meetings.

In preparation for next year's projects we intend to evaluate our progress through surveys of students, clients and faculty. We plan to report the results of this assessment in a later paper.

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