

## FILLING IN MISSING LINKS:

### Using the Internet to Strengthen a Learning Community

From the *Proceedings of the Associated Collegiate Schools of Architecture (ACSA) West Regional Conference*, Portland Oregon, October 15-16, 1999, pp. 91-98

NANCY YEN-WEN CHENG  
University of Oregon  
nywc@darkwing.uoregon.edu

#### ABSTRACT

One of the challenges of education is connecting academic study to its professional, cultural, societal context. The Internet provides an opportunity to share the educational process with practicing professionals, allied specialists, remote teachers as well as families and friends. Students benefit not only from the expanded interchange but also from the publishing process.

Introducing design students to Internet communications requires finding appropriate situations for publishing and allocating the right amount of time and energy. This paper documents efforts to broaden Web-publishing from a specialized activity to a general baseline skill. At first, Internet activities were limited to small classes focused on digitally communicating design ideas to distant teams. With the evolution of Web technology, authoring tools and templates have made it possible for beginning students to acquire basic publishing skills. As teachers can rely on the ability to present information on the Internet, new ways of sharing emerge.

The paper tells the story about technology adoption by explaining how Web authoring has taken from specialized small classes to large-scale introductory classes. It documents the difficulties and rewards of adjusting a first year curriculum to incorporate Web portfolios. The major issues are aiming the teaching effort, improving the technical means and adapting to specific community dynamics.

#### INTRODUCTION

Design education has the complicated agenda of addressing both professional competency and academic rigor. The escalating complexity of the architectural profession and the specialization of academic research make it increasingly harder to create a comprehensive curriculum. Recent calls for increasing the relevance of the curriculum with more practical training and exposure to real social and political situations show that the problem has not been solved.<sup>1</sup> For example, In Boyer and Mitgang's Building Community, the authors felt that greater connection is needed

- between architectural knowledge and the changing needs of the profession and its context
- between faculty, administrators & students

and

- between the diverse perspectives within and outside our schools.

The report also cites the need for architects to be able to communicate more effectively so that they can be engaged in shaping the civic realm.

To begin address these deficiencies, we can look towards using the World Wide Web. Web

authoring is an essential skill for design communication. In order to compete in the design profession, students need to show their abilities to potential clients and partners. Whether or not they will eventually have a Web presence, skills gained in organizing information for Web publication will be useful in appropriately communicating design concepts to members of the design and construction team. Web technology is useful for centralizing information for the Architectural-Engineering-Construction building process. Familiarity with Internet communications allows environmental designers to understand remote environments by accessing remote resources, residents and specialists.

The World Wide Web is a good place for design students to show off their work as they can show it to multiple audiences who have an interest in their education. It is healthy for the professional, academic and personal communities to see how students are being taught and to see what students can do. Because local and remote members of these communities can then provide input, students benefit from an enlarged perspective on their work.

On university campuses, the Web has become a ubiquitous learning tool. Evidence of its current popularity is shown by a 1999 national poll of 1,200 undergraduates by Student Monitor which said that 57 per cent of the students used the Web at least once a day, and those surveyed averaged about six hours on line every week.<sup>2</sup> But despite student involvement with the Web, the educational community's full embrace of its potential has still to occur. Christopher Cole of the Benton Foundation explained that to make the most out of the Internet we still need to train teachers, develop content, define educational objectives, find ways to assess progress, increase equitable access and increase community involvement.<sup>3</sup> Evidence of poor teacher preparedness is reflected in an August 1999 poll<sup>4</sup> which said that only 39 percent of about 1,500 teachers felt well prepared for teaching with technology. The question remains how to get the most utility out of our connectivity with the least exasperation.

At the University of Oregon, I have been using the Internet to expand our learning community. In addition to making class resources accessible, the Web allows my advanced students to share design projects with foreign students and outside critics in what we call Virtual Design Studios. In this paper I will describe how recently my teaching partner and I scaled up the participation by training 200 beginning architecture students in Web authoring and by requiring them to maintain ongoing Web portfolios.

Hypothesis: Requiring entering students to maintain Web Portfolios is an appropriate way for architecture schools to connect the educational process to its community context.

## What is a Web Portfolio? Why is it useful?

A Web portfolio is summary of student work which is published on the Internet. While a designer's portfolio would mostly depict visual design projects, it could also include research papers, precedent studies, resume and personal information. Beginners convey their work only through text and graphics while more advanced students add multimedia elements such as animation, sound, video or JavaScript.

The Web portfolios come from the tradition of artists, portfolios and the newer model of student writing portfolios. With the growth of project-oriented learning, portfolios have begun to take the place of exams as a method to document student progress. Educational portfolios are a way of engaging students to take an active role in their

education. The Dept. of Education states that they "involve students in their own education so that they take charge of their personal collection of work, reflect on what makes some work better, and use this information to make improvements in future work."<sup>5</sup> In addition, the report says they provide clear models of performance criteria for both students and the community of educators. In addition they provide a strong resource for assessing performance of both individual students and educational initiatives.

While the digital version of a portfolio shares these traits, it has the advantage of a much larger audience but the disadvantage of much more technical overhead. We found the challenge in ramping up the scale of the efforts is in finding a balance between benefits and resources required.

## Previous Work in Teaching Web Authoring

For the last several years, I have been working with colleagues on how to share design ideas over the Internet in the Virtual Design Studio project. By setting up joint student design projects with colleagues in other universities, we have tested out emerging communication tools and have studied social, technical and cultural factors that led to successful collaborations. At the same time, students have benefited by seeing different design approaches, honing their design presentation techniques and interacting with remote peers and tutors. Over 27 schools of architecture around the world have used this approach of sharing design projects with remote schools.<sup>6</sup>

I have organized 3 international and 1 local collaboration project at the University of Hong Kong (HKU) 1994-1996 and 4 projects based at the University of Oregon 1994-1999. While at HKU, the international project involved small groups of fourth year students (5 to 15); the local project was done with seventy 2nd year undergraduates. The scale of web authoring adoption was ramped up from the small class of 5 students in Spring 1994 Virtual Design Studio to the large class of 70 students for the 2nd year students, mandatory once-a-week Fall 1995 Computer Aided Architectural Design II. Web authoring was simply substituted for desktop publishing in this survey course. The majority of the HKU students quickly adopted a simple level of HTML authoring and now their skills have been used to document a range of student projects including history and construction.

In coming to Oregon, I have taught two intermediate studios (~ 13 students) which incorporated a small amount of web authoring and

four media classes (11-13 students) which had Web graphics as part of the learning content. I tested the viability of requiring online portfolios by running a pilot workshop in the summer of 1998. For that four-week class, I provided a very simple document with 10 missing images which corresponded to the images that each student would upload. In this way, students could be given a quick 20-minute instruction on uploading image files to the server, and they did not have to deal with HTML authoring.

Just prior to teaching our large introductory computer graphics class, I got a chance to teach a workshop on Web Portfolios for Dr. Boswell at Southern University in Baton Rouge. It was his conviction in the need to open up the educational process to inspection and input that gave the final impetus to instituting Web Portfolios.

## Local Educational Situation

University of Oregon's Architecture Department has approximately 580 professional degree students at any one time, 2/3 undergraduates in a 5-year program and 1/3 graduate students in a 3-1/3 year program. About 20% of the Master's students enter with a non-professional degree and perhaps 7% come with foreign professional degrees.

As the curriculum currently stands, the entering Oregon undergraduates take a three-term sequence in the first year. In the Fall, they begin with Arch 222, a digital media course presented for all entering Architecture students. In the Winter, they take their first design studio, team taught Arch 181 and its accompanying traditional and digital media course, Arch 202 Design Skills. In the Spring, they take their second design course, team-taught Arch 182. Two digital design specialists, A. Scott Howe and myself, attempted to shape the Fall-Winter-Spring sequence so that Web portfolios were compulsory. We wanted to get students comfortable with publishing their ideas on the web both for their own learning and for the school's visibility. We hoped that by training the students, we would get a trickle-up effect by providing an accessible corps of Web designers to the faculty.

## Web Authoring in the Course contexts

Our architectural curriculum is already so full that adding anything requires careful consideration. For each of the courses, we tried to balance the benefits of the new skill with the need to maintain a strong foundation in established basics.

In Fall, 98, Scott Howe and I introduced web-authoring in place of desktop publishing to 160

undergraduates and 40 graduate students in the Arch 222 Introduction to Architectural Computer Graphics class. After a two-week about creating a Web page with Netscape Composer and Adobe Photoshop, students were taught geometric modeling and rendering with Autodesk's FormZ for six weeks. They finished the term by collaging a computer rendering in Photoshop, getting a chance to revise the term's work in a final online portfolio which replaced the previous year's printed portfolio. In this last of 10 weekly assignments, students were allowed to revise their previous graphic work for re-evaluation.

The class combines 2 lectures and 1 tutorial per week (total 4 hours). We were assisted by five graduate assistants who led the 11 tutorial groups with the help of 5 undergraduate volunteers. Following the model of the previous summer's workshop, we put together a template set of linked pages which the students to transfer to their own server accounts. (We did not stick to the single page of images due to the long download time.) About 1 1/2 weeks of the 10-week course were spent on introducing the Internet and basic Photoshop for Web graphics.

In the following winter 1999 term, Scott coordinated graduate assistants teaching primarily traditional drawing and model-building skills. While students were required to submit a Web portfolio at the end of the term, enforcement of the requirement was not 100%. Some of the assistants did not flunk students for missing Web portfolios.

For the Spring 1999 term, I coordinated eight sections of the Arch 182 class, in which the students designed two short projects and one extended project. The students had two assignments with a Web component: a precedent case-study and a reflective summary of their three design projects. We provided a template for the case-study, but did not provide one for the personal portfolio.

For all three terms, the Web was used as an information source, with the class resources being incrementally developed throughout the term. The introductory computer graphics course had a much more extensive website due to the need to communicate to the large groups of people. By contrast, studio instructors met with their students for 12 hours a week, so there was less need to have information posted.

## DATA

In examining what affected the adoption of Web portfolios, I looked at 4 factors: 1) student performance in Web authoring, 2) student prior

exposure to digital media, 3) student attitudes and 4) faculty attitudes.

Student performance in Web authoring was measured by counting how many of the students completed web portfolios for each of the three terms, how many used 2D or 3D digital media plus a rough estimate of Web design finesse. The student's prior exposure to digital media was taken from a survey given to incoming students (69 of 120 collected) which asked them to assess their own computing skills. Student attitudes were measured by a short survey given at the end of the year with about half of the students responding (53 of 105) and by comments from midterm and year-end teaching evaluations. Faculty attitudes were measured by a short survey given at the end of the summer and through conversational interviews.

### Student Performance in Web Authoring

The students, completion of each term's Web Portfolio requirement is shown in the Chart 1, Student Compliance over Time. For the Fall Arch 222 Intro to Computer Graphics, we looked at the final grading sheet to see who had completed the portfolio requirement. For the Winter Arch 202 Design Skills and the Spring Arch 182 Intro Architectural Design II, we looked at how many of the students had work posted at the end of the school year. At the same time, the use of 2D and 3D computer graphics was recorded and a rough indication of proficiency with digital media was assigned. The architectural design quality of the represented projects was not compared to previous years due to curricular changes, the online record allows this to be examined in the future. Some caveats on the numbers: in the Fall term figures, some of the students did not have portfolios because they had taken the course the previous year when no web authoring was taught. The count for the Winter

202/181 class may be low because some students may have deleted their Winter portfolio work in order to make room for posting the Spring portfolio.

The graphs clearly show that the amount of Web authoring decreased over time with 79%, 61% and then 40% of the students creating complete records. In looking at performance according to Instructor for the Spring Arch 182 Intro to Architectural Design II, there was a wide variability in how the instructors enforced the requirement. (See Chart 2) While the team of instructors had agreed to that the two Web authoring assignments (precedent case study and post midterm portfolio) would be suitable, they ran out of time. Towards the end of the term, some teachers felt that the web authoring requirement was the most extraneous activity, given the agenda of the class to introduce architectural design fundamentals. A count of completed portfolios according to 182 instructors reveals that enforcement of the requirement varied widely. With the number of instructors interpreting the evaluation criteria, there was no single point of accountability. The one teacher who did not require Web authoring at all, spoke positively of the potential of the technology, but did not agree that the first year was the appropriate time.

In order to understand more about the factors which led to strong digital skills, we looked at the top 30 students in terms of their Fall Arch 222 mark, completion of the Winter and Spring portfolio, and use of 2D and 3D graphics. While more of the top students came from the instructors who emphasized Web authoring, the group was distributed over 7 of the 8 sections, showing that student interest overcame instructor direction.

In looking at the gender breakdown of top 30 students, the 12 women and 18 men roughly reflected the overall composition of the class. This is in contrast to the Fall term Arch 222 Intro to Architectural Computer Graphics class, in which we observed a gender split in Web authoring compared

Chart 1: Student Compliance Over Time

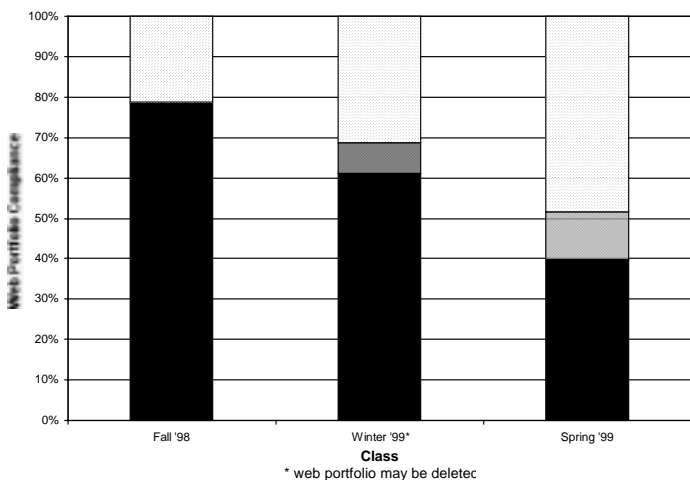


Chart 2: Student Compliance Spring '99 by Instructor

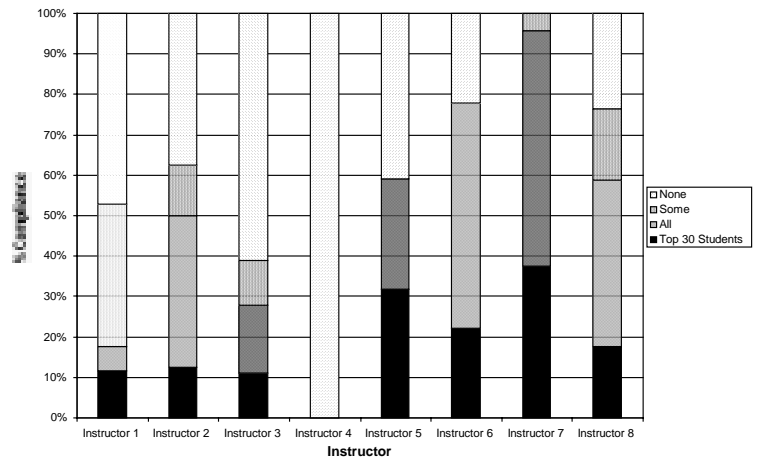


Chart 3: 98/99 Incoming Students' Self-rated Skills: all students

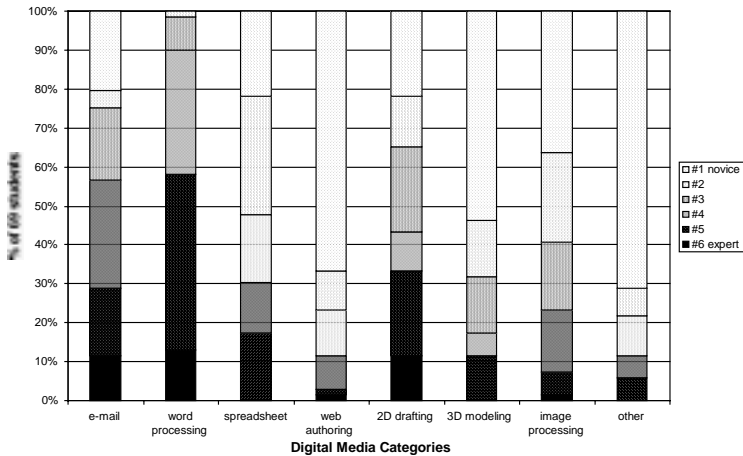
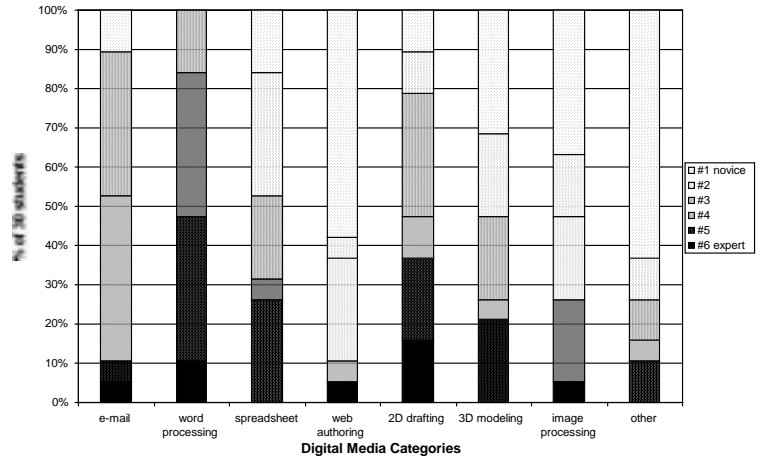


Chart 4: '99-'00 Incoming Students' Self-rated Skills: top 30 students



to the modeling and rendering exercises. Without an exact count, in creating the course gallery we found that more female students made vivid Web pages and many more male students created strong modeling and rendering projects. This may be correlated with the fact that women are more socially-oriented and aware of appearances and that men are more typically have the 2D CAD skills that boost their understanding of 3D modeling and rendering.

And the students who came in with computer experience did not necessarily jump on Web authoring.

## Students, Previous Exposure to Digital Media

Prior to starting the year, students were asked to rate their own knowledge of both general office software and graphics applications (e-mail, word processing, spreadsheets, web authoring, 2D drafting, 3D modeling, image manipulation). While the survey was taken to inform the level of instruction in the Arch 222 Introduction to Computer Graphics, it allows us to see that Web Authoring was the least familiar type of program. Other than a small number of computer graphics enthusiasts, most students had minimal exposure to graphics software other than 2D drafting programs (primarily AutoCad). (Charts 3 & 4)

Because the survey was not anonymous (allowing the possibility of setting up tracked tutorial sections), the self-rating of particular students could be traced. To see if the top 30 Web authoring students had strong prior preparation, we looked at how the top 30 students had rated their own digital skills on entering the program. While these students had rated themselves slightly more familiar with 2D drafting programs (48% vs. 43% for all students), generally these students did NOT come in with more computer preparation. Despite that their backgrounds were as diverse as the whole class, these students became very involved with Web authoring.

## Student attitudes

When queried about the use of Computer methods in the 3 term sequence, 53% of the students felt that too much time was spent on Web authoring, compared to 14% or less for other digital skills. In comparing digital media, they wished that they had more instruction and practice on 3D modeling (47%), Rendering (29%), and Image Processing (25%), with few opting for more Web authoring (14%). While the fall course emphasized 3D skills over 2D drawing, few students thought that they needed instruction in that area (6%). (Chart 5)

Familiarity and comfort may play a role in student preferences. When comparing traditional and digital media, the students wished that they could have concentrated on traditional freehand drawing (43%), model building (22%) and hard-line drafting (22%) much even more than digital modeling (16%) or drafting (6%). (Chart 6) They were inclined to spend more time on the skill which is most familiar, not with the unfamiliar territory of web authoring. The response also reflects that we did have to return to instructing web authoring basics since many students created chaotic pages.

In order to improve the situation, we will try to reduce the amount of Web authoring taught to beginners and simplify its presentation. We'll also try to provide contextual information so they can understand the value of various digital skills.

Chart 5: Student Feedback on 1st Year Media Train

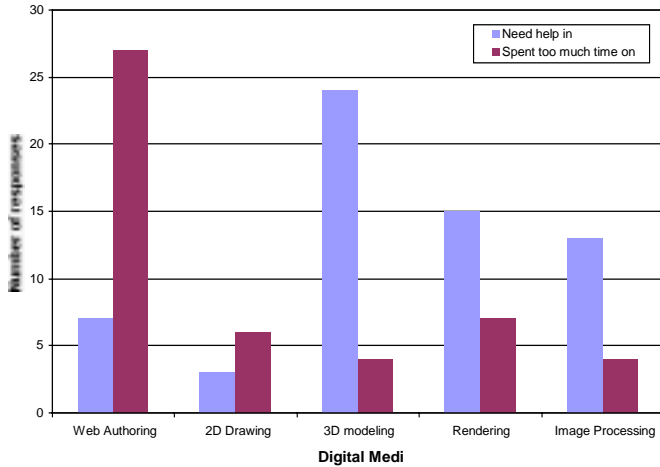
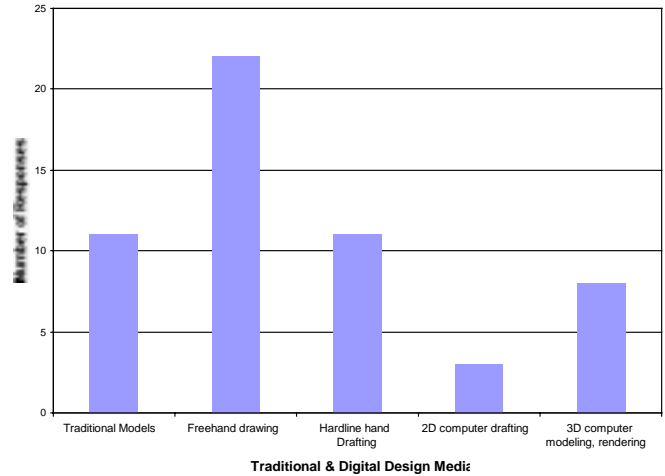


Chart 6: Areas students wish they could have concentrated on more



## Estimated Audiences

Who saw the student web pages? Of the 53 students responding, more than two-thirds (35) showed the pages to family, 31 shared them with their Arch friends, 21 shared them with their other friends. The estimated audience size ranging fairly evenly from 0 to 15, with a small group showing them to more than 20 people. Few (4 each) showed their pages to potential employers or design professionals, partly reflecting the timing of the survey which came immediately after their final reviews.

There was quite a range of how many of their classmates, pages the students had seen. (Charts 7 & 8) It was probably the same enthusiastic group that showed everyone their web page that looked at more than 20 of their classmates, pages (16%). The rest of the students were spread between the 0 to 15 range with more students (35%) looking at 5 or fewer. To increase the effectiveness of the Web pages as a learning tool, reading and critiquing their classmates work could be assigned.

For me, the involvement of the families was unexpected. Parents appreciate being able to follow their students, education. When given a chance to view to view their children's records and look at course information at Gettysberg University, they appreciated the possibility to understand where their investment is going.<sup>8</sup> Teachers need to look at what benefits could come from opening up particular kinds of information to particular audiences and where should privacy or ownership issues should curtail opening up. We also need to figure out the logistics so that we can involve practicing professionals in giving student feedback.

## Faculty attitudes

The teachers all had good ideas about how to make the Web portfolio efforts more effective. They had different backgrounds and attitudes towards technology that shaped their ability to use the Web's communication potential. For those less familiar with the Internet, my questions became a vehicle for learning more about these potentials. Those well-versed in digital media found it a good opportunity to extol about the virtues of technology. Thoughtful ideas of how to best target Internet communications came from both ends of the spectrum, technology-averse and technology-empowered. The following thoughts are drawn from 8 of the 12 faculty members involved in the Winter/Spring design studio teaching.

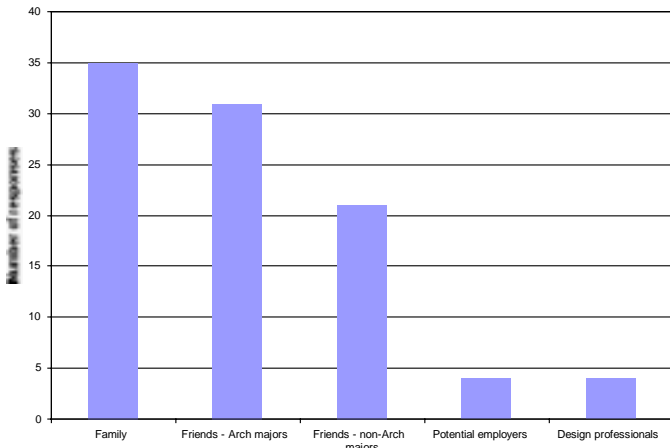
In addressing the integration of Web Portfolios, the teachers spoke directly of the pedagogical and the technical challenges and indirectly of the challenge of group dynamics.

## Teaching Challenge

Many of the teachers were concerned about overwhelming the beginners with an over-ambitious agenda. As a group, the Spring 182 teachers often revisited the need to edit our agenda and teach the very basics more thoroughly. While documenting work in process can be worthwhile for eliciting design feedback, presenting finished projects is suspect because we value the ability to keep refining ideas further. The web authoring was seen outside of the design process due to its slow nature: students were not quick enough to log the design process as they went along, instead they were used towards the completion of projects or after the deadlines.

But even documenting "completed" projects has some value. Thomas Kvan observed that the

Chart 7: Web Page Audience - by Category



Virtual Design Studios naturally provide learning steps that are missing from the design jury process: reflection and abstraction.<sup>7</sup> In this spirit, the Spring term portfolio assignment was written as a opportunity for the students to re-examine their work after the mid-term review and articulate a response to reviewers, comments.

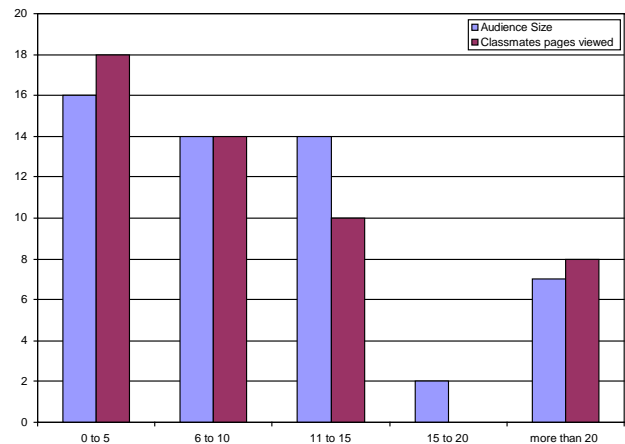
The faculty suggested that the recording effort could be more rewarding if the pages developed would be strong shared resources. For that reason, creating carefully done precedent case studies, site analyses and selected student design projects would be more valuable than cataloging every students, first efforts at design.

In weighing the needs of the students, one of the instructors said, "3-d modeling is useful and the preparation of graphic reports/information (scanning images, graphics & writing combined, integrating input from other computer programs (energy scheming, structures, etc) for presentations. I'm more concerned to see strong graphic presentations printed out than the need to post everything on the web. There is such a thing as having too much unedited information floating around, taking up space." On the converse side, having work online eliminates bottlenecks at shared output devices, a logistical difficulty at hand-in time.

## Technical Challenge

What,s achievable with Web portfolios from a teaching standpoint depends on the quality of the media. From their understanding of how work can be presented on the Web, none of the teachers would use remote critics without also having face-to-face critics for the students, work. Compared to looking at a wall full of images, wading through a sequential presentation on a single monitor is more laborious.

Chart 8: Web Page Viewing: Estimated Audience Size & Classmates Pages Viewed



In addition, they were assuming that the reviewers would look at the Web pages without a means of live interaction (such as video-conferencing). They value the way that a reviewer in a live review can read non-verbal clues and clarify things on the spot, which is especially helpful for the less articulate beginning students.

We should be able to get beyond these reservations by using better technology and by figuring out how to use it smarter. In addition to providing high-quality video-conferencing with multiple large-scale displays, we need to develop ways for making better online presentations of environmental designs and develop more savvy in how we interact with the presentations. Even with the constraints of a 17% monitor, we should be a be guiding the viewer by providing an introductory overview and key plans.<sup>9</sup>

## Group Dynamics

In reflecting on the adoption of Web authoring at the University of Hong Kong and the University of Oregon, I realized that the experiences were completely shaped by human factors and group dynamics.

Several factors could be responsible for the quick adoption of Web authoring at HKU. The culture values pragmatic technical skills because of their earning potentials and pirated software is easily accessible. In Hong Kong, top-down authority is the norm, part of the Confucian attitude. As the teacher of the basic computing course, I could say what students needed to do and if they did not obey, they flunked. A strongly cooperative group ethic among the students meant student leaders were quickly emulated. I was also lucky to have a department head and teaching colleagues who ardently shared an interest in developing computer skills in studio. Web

authoring tremendously increased the visibility of a school remote from its peer institutions.

While at Oregon we also have a supportive department head, I worked with a larger team of teachers (total 8 rather than 4) with different points of view, including some healthy skepticism towards the idea of mandatory Web portfolios. Since the educational outcomes are unclear, some of the skepticism towards the web portfolios may be well grounded: plunging into new methods has risks involved. Our democratic group process that slows down decision-making has served the department well by passing over fads and maintaining strong traditions.

In promoting technology adoption, my challenge is how to help people find ways to use technology for their own purposes. From the Web portfolio initiative, I see that it is possible to give a group Internet course resources, but unless the group members are engaged in shaping or using them, the website's full potential is not realized. The one adjunct teacher who used the Internet all the time to communicate with his students saw the most value in the efforts. While instructors are best positioned to shape the content of course websites, we often lack the time, skills and energy. There is little incentive for faculty to develop these websites as the activity does not count towards tenure and the ownership of intellectual property on university servers is muddy. By creating a cadre of Web-savvy students, I hope to make the process of developing educational resources easier.

## DISCUSSION

Students benefit from Web-portfolios in the following ways:

As in any documentation process, students learn from selecting, organizing, and editing their own work because the process requires reflection. Students benefit particularly from the Web because they have a larger and more equitable audience. They can get input from a much broader range of people. If they are required to get and give input to their peers, they take on additional responsibility for the class's learning as a whole. Reinforcement through additional Internet modes for teacher/student communication such as e-mail, chat, and conferencing software can improve learning by reinforcing or clarifying verbal information.

Teachers and administrators can use the portfolios to track results of educational initiatives. Dr. Frank Boswell, Dean of Southern University School of Architecture, is an advocate of using the Web to provide a link between academic institutions

and centers of employment. He sees that the web allows the efforts of the school to be visible to the larger community and that the community provides expanded learning resources. The profession benefits by seeing what students are able to do and by being able to select new employees according to accomplishments and the students benefit from a more level playing field.

## CONCLUSIONS

So while my vision of having an army of Web savvy experts did not emerge, I have been able to see in more detail how the Web portfolio initiative was accepted. Both students and faculty are challenged by new technologies, especially when we are still experimenting with their benefits. Educators can work together to develop the learning benefits of Web authoring, working with students to create Web resources, and examining how Web publishing can reinforce larger objectives. As we develop a body of Web portfolios, we can track student abilities, and then tailor our own courses with incentives and safety nets.

More data on how design schools are using the Web and how they are making it effective would reduce the associated risks. More data on how the present technologies fail and ideas on how they could be extended will shape the development of more effective tools. We need to document how the technology works in local circumstances so we can create good solutions that work in our learning communities. By showing our students and colleagues the strengths and weaknesses of the technology, we can get them to be part of the adoption process. Their interests, energy and even doubts can contribute towards using technology effectively.

----

## NOTES

1. See the Carnegie Foundation's Boyer-Mitgang Report on Building Community, the 1999 AIA Internship Summit and Thomas Dutton's Voices in Architectural Education.

2. Student Monitor Poll,  
<<http://www.studentmonitor.com/>>

3. Cole, Christopher, The Learning Connection: Schools in the Information Age, Washington, DC: The Benton Foundation, Sept 10, 1997.  
<<http://www.benton.org/Library/Schools/home.html>>

4. Teachers poll by Market Data Retrieval cited in the New York Times, Sept. 8, 1999.  
<<http://www.nytimes.com/library/tech/99/09/cyber/education/08education.html>>

5. U.S. Dept of Education Consumer Guides, Student Portfolios: Classroom Uses (Nov. 1993) and Administrative Uses (1993).  
<<http://www.ed.gov/pubs/OR/ConsumerGuides/>>

6. See the list of Virtual Design Studio projects catalogued by Jerzy Wojtowicz and Lisa Kwan as listed at <<http://www2.arch.ubc.ca>>. Additional projects have been published from Texas A&M, University of Melbourne, Kumamoto University and other European schools in ACADIA, CAAD Futures, ECAADE & CAADRIA proceedings.

7. T. Kvan, Designing Together Apart, Open University Ph.D. Dissertation, 1999.  
<<http://arch.hku.hk/~tkvan>>

8. Mendels, Pamela, College Opens Student Records to Mom and Dad, New York Times, Nov. 11, 1998,  
<<http://www.nytimes.com/library/tech/98/11/cyber/education/11education.html>>

9. See the presentation of the Digital House by Hariri and Hariri at the Museum of Modern Art, New York, to get an idea of how viewpoint can be conveyed. <<http://www.moma.org/exhibitions/un-privatehouse/projects.html>>

#### ACKNOWLEDGEMENTS

This paper was completed with assistance from Matt Eastwood and Ted Corbin. Financial support came from the University of Oregon Foundation and equipment was provided by the Intel Corporation.

---