Design Education for the Future

> Sure, I would bring [my computer] to school, if we had the proper connections in studio. Most arch schools that I have looked at had connections in the studio. – **Undergraduate (junior)**[1]

Abstract

Design studio is the core of architectural education. Not only is studio the place where students integrate the various kinds of design knowledge, but the student's individual studio desk serves as the "home base" for the student. Therefore, the transformation of the studio environment promises not just the transformation of the teaching of design, but the complete transformation of architectural education at the University of Washington.

We propose to transform architectural education by providing computing infrastructure support in the design studio environments across Architecture Hall. By infrastructure support we mean providing network wiring, license served software and high quality input/output graphic devices for Architecture Hall (where almost all architectural students have their assigned studio spaces) so that students can bring their own computers to the studios and "plug and play." To seed this transformation, we also propose the creation of a model "Digital Design Studio" as a demonstration environment where cutting edge design computing technology can be applied.

With the infrastructure upgrade and a model Digital Design Studio, this transformation promises impact across the educational culture of the Department, while also providing a substantially enhanced level of service to students of the Department and the College. This transformation proposal will enhance the quality and excellence of design studio

[1] From a survey of UW architecture students' attitudes about computing (November 1999).

education, of architectural education generally, and will support the creation of sustainable linkages between architectural education and design computing research.

I. Introduction

> The profession and the world are moving quickly toward the use of technology in every aspect of personal and professional life. Investments in computing do not compromise the core elements of an architectural education but serve to give us a leg up into a world of technology that is moving very quickly. **– Third year graduate student**

Architecture students who will create and improve built environments of the future must be well-versed in computer applications and information technology in addition to the broad range of technical skills they have traditionally learned.

Architectural education is centered on the design studio, where students integrate the various kinds of knowledge and skills required to produce architectural designs. These include drawing, engineering, social and cultural factors, history, design and others. The design studio is similar, although not identical to, actual architectural practice. The education offered in design studio is strongly experiential, and the thought processes that students learn have been characterized by educational theorist Donald Schön as "reflection in action."[2] Instead of passive recipients of classroom instruction, students in design studio are actively involved in hands-on integrative experience. Students learn to use different media such as pencil and paper, bass wood or clay models, to see, to think, and to express ideas about design problems. They engage in heated debates and discussions among themselves and with their "critics"—design studio instructors, visiting architects, or their peers—about their design ideas.

[2] Donald A. Schön, *The Reflective Practitioner: How Professionals Think in Action* (New York: Basic Books, 1983); and Donald A. Schön, *Educating the Reflective Practitioner: Toward a New Design for Teaching and Learning in the Professions* (San Francisco: Josey-Bass, 1987).

Design studio, as the center of architectural education, also serves as the student's physical "home base." Within the studio room a student is assigned a personal work space for the quarter. Thus, in off-hours, students typically work in the studio space, not just on their design projects, but also on other coursework. Any change to the studio environment will have impacts all across architectural education.

Professional architectural practice in Seattle and elsewhere has been and will continue to change rapidly as the profession embraces computing and information technologies. (This is particularly true in the Puget Sound region due to the vital community of software developers and companies.) Therefore, to prepare for a lifetime of technological change in the workplace, architecture students must gain experience with new tools and technologies, must understand how they affect the practice of their discipline, and must learn to respond to the pace of technological development. A key approach to addressing this challenge is to transform the design studio environment by adding substantially greater support for computing technologies. Only by bringing design computing directly into the studio for all students will computing become fully integrated in the design processes all students are learning. Only if computing capabilities are available in studio will students learn to move seamlessly between traditional and digital media.

II. Current Situation and How it can Change

> … we are at least 4 or 5 years behind design computing standards of the industry and except for those few of my peers who have taken it upon themselves, by extraordinary (even heroic) extra-curricular efforts, we are going to have a lot of catching up to do when we get out of here. – **Third year graduate student**

Recent years have seen the architectural profession move rapidly to employ computing in everyday design practice. Frankly, the College and Department have not kept up with the pace of the profession or with programs at many peer institutions. As a consequence, our graduates are increasingly less well-prepared for the technologically integrated professional design practices they encounter upon graduation.

Over the last decade, in an attempt to address concerns regarding design computing, the Department of Architecture curriculum has grown to include a number of classroom-based computing courses. Though these classroom-based computing courses offer techniques applicable to design such as modeling, rendering, animation, drafting, simulation, theory, web-based activities, and micro-studio experiences these efforts have been limited because software and access are currently only available in teaching labs and not at the students' home base, the studio environment. The teaching labs have been an effective solution for introducing different software applications in a classroom setting. However, this approach fails to make much impact in architecture design education because space limitations and budgets limit the number of machines available and ease of access. As a result, the available facilities require a reservation system and controlled access, and they are not integrated with the core experiences of the architectural education program.

With the arrival of new faculty who specialize in Design Computing, the Department has seen a significant increase in interest among students in applying computing technologies in design studio. Students are eager to employ not just traditional pen and pencil drawing on their drafting table, they also want to use digital media to represent and explore their designs. Unfortunately, students are experiencing growing frustration because the present infrastructure does not allow them to apply computing technology directly in studio. Currently, for students to use drafting and modeling software, they must carry

their big drawings from their studio environment to a computer lab (if a workstation is available) and then in the lab in Architecture Hall and in some labs in Gould, they must squeeze their drawings in between the tightly packed machines.

Students are seeking modernization of their education: They want to take advantage of digital media and information technology in their design work. They are aware that they will be expected to be able to operate in a digital environment when they enter professional practice. Thus, this proposal asks to transform the architectural education offered at the University of Washington. The combination of faculty members who are national leaders in design computing and a highly motivated student population presents an unprecedented opportunity for transformation across the Department's design curriculum.

Based on these observations, we recognize that:

(1) although the classroom based instruction in design computing instruction is acceptable, it does not and cannot address the full range of students' thought processes and activities taking place in integrated design studio learning;

(2) the College and Department cannot keep allocating space for more and more labs;

(3) the College and Department cannot keep buying and maintaining new machines in large numbers; and

(4) because the design studio is the "home base" for each architectural student, transformation of the studio will reverberate across the entire architectural education experience.

Therefore, we propose that the architecture curriculum must undergo an innovative transition to strengthen our core teaching in the studio environment. Instead of buying more machines and finding more computer lab space, the Department should:

(a) provide infrastructure (i.e., connectivity, software, storage space, and high-end input-output facilities), which, in turn, will

(b) get students to bring their own computers into studios, while, simultaneously,

(c) the Department also develops a "showcase" Digital Design Studio for advanced instruction based on new research, which will also demonstrate new models for studio activity and applications.

Because Architecture Hall serves as the center of design studio education (and, therefore, as the center of architectural education at the University of Washington), we propose to transform all studios in the Architecture Hall building in this way. To achieve this goal, we must provide the infrastructure support (in the form of networks, output devices, and the like) and to offer high end computing support beyond the level that students can be expected to afford. Further, this transformation can become self-sustaining because once "up-front" capital expenditures provide the necessary infrastructure and support to studio, we can impose a "fee for service" attached to each studio course to generate continuing funding for staff support, maintenance, upgrades, and new equipment and software.

Finally, because most faculty across the Department teach in design studio, but many have not previously taught in a "computing-rich environment," many may need some support to help them address the integration of computing into their teaching in studio. Thus, opportunities and incentives for faculty skill improvement are also included.

Funding this "Tools for Transformation" proposal would significantly move the Department forward to catch up with and overtake our peers. It will provide the basic infrastructure and facilities to sustain and develop our move toward national pre-eminence in Design Computing.

III. Transformation Proposal

> I would like to see some experimentation of paperless end-of-quarter presentations. I'm thinking of something like the computer projectors hooked up to a laptop (or desktop) setup in the presentation room. …perhaps a browser and a VRML model of the project [could be] used so that we might take the reviewers through the project to particular points in the building they wish to examine more closely. **– First year graduate student**

We propose to transform the design studio curriculum through an infrastructure upgrade of the design studio spaces of Architecture Hall, and to outfit and begin teaching a Digital Design Studio as a model for students and instructors teaching studios throughout the building.

Infrastructure

The primary goal of this "Tools for Transformation" proposal is to transform architectural education at UW by providing support for the computing and information infrastructure in the design studio environments. Further, to encourage students to participate in the transformation of design education and to bring in their own personal computers to Architecture Hall to "plug and play," we must provide needed sharable resources: network wiring, license served software and high quality input/output graphics devices.

The details of this “Tools for Transformation” proposal are described below:

(Note: Some costs will be shared by Department and/or College.)

1. Provide infrastructure to allow every student in every design studio in Architecture Hall access to a high-speed data communication network: Upgrade Architecture Hall to Category 5 Ethernet wiring. Provide sufficient 8-16-24 port hubs in each studio for individual student access (studio room sizes vary, accommodating from 10 to 28 students)

2. Provide key shared software in a network License server – College currently has an existing License Server for networked Form•Z modeling software. All other computer aided design software (AutoCAD, PageMaker, PhotoShop, etc.) is currently installed individually on each computer. To enable students' computers to access software from plug-in personal computers, we will need to purchase more networked licenses and operate a License Server. [CAUP to verify]

3. Provide a multi-platform File/Print server

   File server storage space is needed so students don't need to walk around with Zip disks and transfer files constantly between different machines (the present situation). The server must be accessible from both Mac and PC platforms because in the design process, different tasks are often performed on different software platforms.

4. Input and output devices

   • Provide low cost color printing in each studio – students provide supplies (this is likely a temporary measure, until Department and/or College can provide better networked centralized services).

   • Some large format color and black and white printing – this requires also management of services (a) a fee/use system that allows students to pay per use of costly services; (b) supervision needed for after business hour operation (GSA)

   • Video projectors in review spaces.

   • CD-ROM Recorder

   • Slide Writer

5. Studio TA/GSA support -- develop a cadre of students who can serve as digitally literate TA's and GSA's for studio.

   • Funds for 2 Graduate Student Appointments for three years –

   The graduate appointees' efforts are to be dedicated to developing and continuously improving project-based studio courses with technical knowledge to help student "plug & plays, help with questions, etc. (After three years the Department picks up the costs from fees charged for studios.)

6. Faculty training – to better prepare design studio faculty for the use of design computing in the design studios that they teach;
7. Faculty release time—time for design computing faculty to supervise the studio TA/GSA training and operation.

Digital Design Studio

To demonstrate how students (and faculty) can use information technology in their design studio learning, we will also create a “Digital Design Studio of the Future” as a showcase, model, and “experimental test bed” for the rest of the building. This Digital Design Studio will offer students a setting to try the latest in new architectural and graphic software and will also serve as a test site for faculty and student research projects.

The Digital Design Studio will be a hybrid of a "smart classroom" and the traditional "design studio." Each student's drafting table will be augmented with a networked computer, and shared scanners and printers will enable students engage in design seamlessly between traditional and digital media. This model studio will also advance the culture of the department and the college by demonstrating how to integrate technology with design studio teaching and learning.

The proposed Digital Design Studio will build on existing strengths and enthusiasm in the Architecture Department and throughout the College. As part of its teaching mission, the Digital Design Studio can foster the integration of computing into teaching design in a variety of ways and at various levels. For example:

• an "electronic design studio" would employ a range of CAD tools in developing an otherwise conventional design project. Students would use 3D modeling and rendering software to visualize and present the project, and lighting, solar, and thermal simulation software to understand their building's performance.

• a "virtual design studio" would employ available collaborative design software to work with students at other schools, to access design critiques from experts at other universities and in professional firms around the world.

• A "cyberspace studio" would explore the effects of the Internet and Web on our conceptions of community and public space. For example, a project to design a virtual university would include both the physical campus as well as the virtual space inhabited by on-line learners.

• An "intelligent building" studio would explore the implications of smart materials, embedded sensors, actuators, and microprocessors on buildings of the future.

The devices needed for the Digital Design Studio of the Future include 12 student work stations, a tabloid size color printer, video projector with a laptop on a cart for instruction (similar to such a cart now being created for use in Gould Hall), a flatbed scanner, a CD-ROM recorder, wireless network Airport hub, and a rear projection digital whiteboard (to be installed in the seminar/conference room adjacent to the digital design studio).

The Department of Architecture has a strong history of pedagogy involving not just design but also fabrication (studios in design/build, furniture, light fixtures, etc.). We propose to extend this pedagogy to the Digital Design Studio through investing in CNC (computer numerically controlled) tools such as a 3-D input/output device—for example, a Rapid Prototyping Machine or laser cutter for digital model building. This kind of device would allow students to design and model forms and shapes which would be difficult or even impossible for conventional model building techniques. This would allow students to move into realms of design that are only made possible by using computing in the design process. This would truly move us into a leadership position in design computing education, while at the same time building on the existing pedagogical strengths of our program—the connection of design to physical fabrication.[3] (Note: If necessary to spread costs, funding for CNC tools could be delayed to the second year, as the digital design studio comes on line and students are ready to try out new fabrication technologies.)

The establishment of the Digital Design Studio of the Future will not only provide students with on site hands on experience with current technology integrated into their education. but also will facilitate a test site for the direct application and evaluation of new software developed in the adjacent Design Computing Research Lab. Learning in the context of design computing research will offer students the skills they will need to succeed in the work place not just when they graduate but into the future.

[3] For example, the architecture program at Columbia provides one rapid prototyping machine, MIT also provides at least one such machine, and Harvard's GSD has two such machines to allow students to engage in advanced explorations as part of their design educations.

In sum, this "Tools for Transformation" proposal will not only integrate computing across the design curriculum, but will move the Department from its present position toward one of achieving national leadership in design computing within three to four years. This proposal aims to integrate the two primary missions of the University: teaching and research, and to obtain the resources to fulfill these goals. Thus, this proposal addresses both the infrastructure requirements to integrate computing across the design curriculum and to create the advanced "Digital Design Studio of the Future" where cutting edge design computing technology can be applied.

IV. College & Departmental Contributions

> It is good to see enhanced interest by part of the department in the use of computational technology as it relates to design. I'm all for anything and everything that would prepare us for and help shape the future for design…. The only reason I don't [bring my own computer to school] now is that there is no network connection in studio. It would be every helpful to have this. – **First year graduate student**

This "Tools for Transformation" proposal should be viewed in the context of a number of other significant efforts underway in the Department and the College including: the recent hiring of three design computing faculty in the Department of Architecture and the establishment of a Design Computing Research Lab; a Tools for Transformation grant awarded to the College to develop support for Web augmented teaching and learning, and the successful UIF 2/2 proposal to sustain the College web center; a 1999-2000 Tech Fee award to the Department of Architecture that provides a long-needed upgrade to general access machines.

The College of Architecture and Urban Planning and the Architecture Department have already committed to enhancing the design curriculum by three recent hires of design

computing faculty (see section V). When the University allocated funding for new design computing faculty, funding was also provided for the establishment of a design computing research lab and the adjacent digital design studio in the form of space and high-speed (100 M bit/sec) network access. With construction under way, we anticipate completion of the network and space renovation in Architecture Hall to house computing facilities for teaching and research by March 2000.

Space for the Digital Design Studio of the Future in the basement of Architecture Hall is committed and currently under renovation. However, the space has not been equipped. This Digital Design Studio of the Future will be directly linked with (and physically adjacent to) the new Design Computing Research Lab. The current research initiative will upgrade Architecture Hall's connection to the high-speed network backbone of the University, providing 100Mbit/sec network connections to the Digital Design Studio and Research Lab. With added infrastructure as provided in this "Tools" proposal, the whole building will be able to provide students with the opportunity to bring in their own computers and to "plug and play" with the College/University network. By establishing the Digital Design Studio, the program will include an advanced digital design experience on the cutting edge of design computing applications and research. This will entice students toward increasing engagement with computer applications in design across the curriculum as they see some of the possible futures of design in an advanced computing environment. In turn, this will add to the attraction of integrating computing in their own design processes in studio.

This "Tools for Transformation" proposal thus lays the foundation for a comprehensive path-breaking program in "technology enhanced architectural education" at the University of Washington. This transformation will build upon individual and collaborative work already undertaken over the last several years in the College of Architecture and Urban Planning, and the Department of Architecture.

The College and Department contributions for this project are listed below: ($250-300k)

College:

Subnet costs. The College has already recognized the need to expand Internet access. In the near future Architecture Hall will receive a 100Mb link to the campus "backbone" (and will be placed on a separate subnet), funding for which will be provided by the College. C&C will pick up the LAN riser backbone and 100Mbps uplink to the router upgrade costs. Already funded, these costs are not included in this proposal.

Department:

Software. The department has been providing software licenses for the various computing labs. The Department will seek software grants where possible. This resource will be transferred to the new key-served License Server requested in this proposal. Cost share of software will be approximately $10k. [VERIFY—is this what we currently fund from the Dept.?] (Note: In the future, some basic software costs may be shifted to students once the new infrastructure support comes on-line and students can count on being able to use the software they individually purchase (possibly with volume-discounted pricing for site-licensed software—if allowed by manufacturers) in the studio environment.)

Furniture. The Department and College will provide matching funds (1:1 match to "Tools" request) to upgrade desks and supplemental furniture in the design studios to accommodate the students' computers. In the digital design studio the Department and College will provide matching funds (1:1 match) for ergonomic desks and chairs (We estimate $6k for the Digital Design Studio of the Future (of which the

Department/College provide half), and we estimate $17.5k to upgrade of the rest of Architecture Hall studios (for which the Department and College provide half), based on addition of arms/brackets to hold monitors at $75. ea. for approx. 225 student desks).

Peripherals. The department will continue to provide basic input/output devices such as a Tabloid (11x17) postscript printer, and a legal-size flatbed scanner. (Cost of about $1000)

Fee. Students are willing to pay a quarterly fee attached to the design studio course if services are provided. This fee is discussed below in detail under Section V titled "Sustaining the Transformation."

Student Tech Fee (total of $97k)

Machines. The most recent Tech Fee grant (to the Department) has funded 16 Pentium computers and 8 Macs that were obtained as "general access machines." As the new infrastructure comes on line, and students have their own machines, we propose that some of these machines may be distributed into different design studio spaces. However, some of these will need to remain as general access machines.

Peripherals. Tech Fee has also funded one Tabloid (11x17) size color printers, four flatbed scanners, and a large (36x48) color printer, and a slide scanner.

CAUP Web Center

Web Instruction. The CAUP Web Center is a resource center to support Internet utilization in design curricula. The Center is adopting a set of standardized web design and implementation tools to accommodate a broad range of teaching and learning needs. It also supports faculty efforts to enhance existing courses, and develop distance learning courses with Internet tools. (The Web Center resources was

funded by total of $128k "Tools" grant and will be sustained through the College 1999 UIF 2/2 proposal recently approved.)

V. Sustaining the Transformation

Recognizing that "Tools for Transformation" awards are one-time grants of funds, we have carefully considered the sustainability of the transformation. In this proposal, new design computing infrastructure will be provided in Architecture Hall. This will create a need for staff support for maintenance and trouble-shooting, as well as funds for future updates and replacements. The College of Architecture & Urban Planning has previously sought, and will again seek, either differential tuition or a tuition surcharge to support technology and similar improvements across the College. Should that proposal be approved, the Department of Architecture, with 45%-50% of the enrolled students in the College will receive a significant revenue stream to fund continuing staff support, maintenance, upgrades, licenses, etc. Our goal is to generate at least $60-75k annually to sustain the services that will be initially funded through this "Tools" grant.

This proposal will provide significant new support to the design studio environment; thus, students can also be charged a fee, associated with registration for design studio classes to cover the "consumables" that will be used in the studios—paper, toner, etc. A small fee, perhaps $20-$25 per student enrolled in studio should easily cover the costs of supplies the students will consume.

(Note: If the College proposal for differential tuition or a tuition surcharge is denied, then this "transformation" of the studio environment would need to be supported by a increased studio fee; that is, the fee would need to be "ramped up" to about $100 per student enrolled in studio per quarter to cover more than just consumables. This is not our preferred strategy to sustain this transformation; however, we indicate this to

demonstrate that we do have a way to sustain this transformation under any future condition.)

In summary, the "Tools" grant helps get us past the "chicken-and-egg" problem; once we are providing improved service, students should understand the need for differential tuition or a tuition surcharge. The "Tools" grant provides the initial investment to get this transformation going and the tuition proposal (plus the studio fee for consumables) support the long-term continuation of the transformation once initiated.

Currently the College has been spending $800-$1000 annually to license and outfit the general access labs with 3-D software such as Form Z, and the Department is also spending $2500-$5000 annually for software such as AutoCad and others. The College also maintains workstations in the general access lab in Architecture Hall (and general access labs in Gould currently used by Architecture students). The Department and College will continue these contributions and support at least during the three-year transition period. However, to upgrade the licenses for access by 200 students will add some initial and continuing costs; for example, to upgrade Form Z for 200 users will require an initial fee of $4000 and an annual fee of $850. Eventually, this kind of software should be purchased individually by students, and College and Department contributions should be redirected to maintenance and upgrade of high-end output devices (those requests in this "Tools" proposal) as well as to faculty support in computing.

VI. Schedule

This "Tools for Transformation" funding is proposed to be allocated by Summer 2000. The funding for the Digital Design Studio portion of the proposal is essential if that studio is to be fully operational for students in Fall Quarter 2000. (Although the studio

will be in operation in Spring 2000, the furniture will be rented and equipment borrowed.) Ideally the funding to transform all of Architecture Hall will also be allocated by Summer 2000, so that the necessary work by C&C and others can be scheduled in the summer when many of the spaces are not in use. Given the breadth of the transformation that is proposed, the 2000-2001 academic year will be a "shakedown year" and studios may come "on-line" at different times. However, we would expect that all studios would be "wired" and the infrastructure fully in place by the 2001-2002 academic year. That would allow us to introduce the requirement that students purchase their own computers and software in the literature we send out (starting in September 2001) to applicants who would apply to enter our programs in Fall 2002. Thus, we foresee a two-year transition before the full impact of the transformation takes effect. However, once the funding is in place we will move to implement the full transformation as rapidly as feasible.

VII. Faculty Resources

The Department of Architecture has a large permanent faculty (approximately 24 FTE but with some appointed at less than full-time, and joint appointments based in other Departments, about 30 permanent faculty members) as well as a large part-time faculty draw from the local professional offices (perhaps 20 single quarter appointments each year). A high percentage of the faculty have expressed interest in implementing design computing across the Department's curriculum. Through the support of the University and the College, the Architecture Department has attracted outstanding young faculty who are recognized as national leaders or emerging contributors in design computing. These faculty members are eager to foster the integration of design computing across the Department of Architecture curriculum and to bring the results of their cutting edge research into the design studio environment.

Rather than listing the entire faculty of the Department, the following list focuses on those faculty members who will lead or contribute to the technology enhanced digital design studio education.

Core Design Computing Faculty

Gross, Mark D., Ph.D., MIT, 1986. Associate Professor, Director/Design Computing Lab

Gross's research interests include design methods, computing and cognition in design, and the effective application of artificial intelligence and human-computer interaction technologies in the development of more intelligent design environments. His peer reviewed papers in international conferences and journals focus on the development of more effective computer based environments for design, ranging from simulation of spatio-temporal processes in the landscape to constraint based interference avoidance in building subsystem layout. He has received over $600,000 in research funding from the National Science Foundation and other sources, and he has collaborated extensively with a diverse interdisciplinary group of colleagues, from computer science to civil and electrical engineering to anthropology.

Johnson, Brian, M.Arch., University of Washington, 1981. Assistant Professor

Johnson has taught and conducted research in design computing in architecture since the 1980's. While a Lecturer in the Department, he led efforts to bring additional computing resources to the College, and he has been a leader of efforts to bring Web-based teaching and research into the Department and College. His recent peer-reviewed publications in national and international conferences focus on Internet tools for collaboration, especially in architectural design. This work is based on his experiences coordinating Virtual Design Studios that engage UW architecture students in collaboration with design studios

at universities around the world, from Hong Kong to Zurich. He is currently president of the Association for Computer Aided Design in Architecture (ACADIA), the national professional association in architectural design computing. In 1999 as part of his ACADIA responsibilities Johnson helped organize an international design competition titled "Library for the Information Age"; as competition webmaster, he developed an on-line evaluation system for the competition, which attracted over 650 participants and was judged by a distinguished panel of well known architects. Johnson has taught courses in computer literacy, 2D CAD/working drawings, and 3D graphics for design visualization, as well as courses in Web technology and Web design.

Do, Ellen Yi-Luen, Ph.D., Georgia Institute of Technology, 1998. Assistant Professor

Do studied architecture at National Cheng-Kung University in Taiwan and at the Harvard Graduate School of Design before completing doctoral work in design computing at Georgia Tech, with a minor in cognitive science. Her research work focuses on the development of computer aided design tools to support freehand drawing as an interface to knowledge based tools. She has conducted empirical studies of design drawing and constructed computer software to integrate knowledge based applications with freehand drawing. She has also worked in the area of computer based visual analysis tools. Her papers have appeared in peer-reviewed international conferences on computer-aided design in architecture and civil engineering. Do has taught computer animation, multi-media authoring, digital design media, graphics programming, modeling and rendering with computers, and introduction to computing in architecture.

Design Studio Faculty with Computing Involvement

Vikramaditya Prakash, Ph.D., Cornell University, 1996. Assistant Professor

Prakash has a background in design and specializes in non-Western history/theory of architecture. He was formerly at Arizona State University. While his professional specialization is not in computing, he is a strong advocate for Web-based teaching. Two years ago he experimented with the use of web based technology in this design studio class: Students scanned and posted design work on their own personal web pages; then Professor Prakash invited his colleagues from several different countries to view and write critiques to students who received comment and reviews of their work from around the world. This experiment generated interest from students and faculty in the department. More recently Professor Prakash has explored development of interactive software for design studio allowing graphic as well as text-based critiques from distant locations.

Alex Anderson, Ph.D., University of Pennsylvania, 1997. Assistant Professor

Anderson has a background in civil engineering and architectural design and specializes in the history/theory of architecture. He formerly taught at the University of North Carolina at Charlotte where, in 1997, he was a co-recipient of a similar "Academic Program Improvement Grant" that provided funding for an intensive review of computer usage in the UNCC architecture curriculum, software evaluation, and faculty workshops aimed at developing digital techniques in studio courses. It also included digital infrastructure improvements in studio spaces. In 1998-1999 Professors Anderson and Prakash requested and received departmental funding for a model “visualization station,” which was deployed in an undergraduate design studio so that students could experiment across media as spontaneously as possible. For the past two years Professor Anderson has developed web sites for a variety of his architecture courses.

Part-time Design Computing Faculty

Stevens, Anne H., M.Design-Visual Studies, UC Berkeley, Lecturer (half-time appointment in Architecture, half-time appointment in Art beginning Fall 2000)

Stevens is a versatile visual artist who is equally at home with traditional media and with new digital media. A trained printmaker (a licensed intaglio printer in the Region of Tuscany), Stevens has lectured at public and corporate venues, including a presentation on "Science Imagined" at the Berkeley Art Center, and another on "Making Space" at Xerox FX Palo Alto Laboratory research center. Her work has been exhibited at galleries in the San Francisco area and throughout the Northwest. She is an accomplished Web designer and she brings her extensive graphic arts experience to bear on new graphic design problems in digital media. She has written articles for various arts publications; her recent article "Digital Resources for Printers and Book Artists" appears in *Ampersand*. Stevens teaches digital media courses in the Department of Architecture.

Davidson, James, M.Arch., Harvard, 1990, Lecturer (occasional one-quarter appointments in Architecture)

Davidson is a practicing architect who has worked extensively with the UW Human Interface Technology (HIT) Lab to develop virtual-reality models of proposed building projects. His GreenSpace projects, funded by Fujitsu Research, have used networked computers to accommodate remotely distributed multi-participants in virtual space and a distributed architectural design review. His research papers on the use of virtual reality in architecture have been published in peer reviewed conferences. Most recently, his work on community and environmental design and simulation was included in a book on "Designing Digital Space" for architectural professionals.

Improving Skills of Other Design Studio Faculty

Experience by faculty who have held visiting teaching appointments at other universities were computing is already integrated across the design studio environments indicates that faculty can adopt to use of computers in studio even if their own computer skills are not advanced. Because we propose an environment in which each student retains a traditional drafting table, we are proposing the *integration* of design computing with other studio media (not the replacement of other studio media by design computing). However, we anticipate that many faculty will wish to increase their computing skills. Some of this can be done through venues already provided at the University—for example, UWired. Other venues for faculty skills improvement will include summer seminars by TA/GSA (t be funded under this grant) during the first two years of operation, and through one-on-one consulting throughout the year with the developing cadre of student GSAs. The Department will develop the use of its limited funding for upgrading faculty workstations in an incentive program, with new workstations being provided for faculty who choose to upgrade their skills.

VIII. Budget

Part #1 -- Infrastructure

Item	Description	No.	Unit Price	Sub-Total
1	**Voice/Data and Video/TV communications infrastructure** Raceway for telephone and data outlets Category 5 Ethernet Wiring Conduit and Boxes (price per UW C&C)			$12,700
2	**Voice/Data, and Video/TV communications cabling and termination** distribution system from each new tele/data outlet to the existing termination location Cable tray Panel Modular Jack Outlet Box 100 MB Ethernet (price per UW C&C)			$4,000
3	**8 port hubs (or mix of 8 and 16 port hubs)**	32	$50	$1,600
4	**Electrical upgrade** (anticipate 1.8 amps per workstation—20 per 12 person studio—200+ students total) (actual price not yet received			(est.) $12,000

	from UW-electrical)			
5	**Software License Key Server** **Dell xxx or equiv.** 400 MHz Pentium-II 256 MB RAM 4 GB Hard Disk ZIP, CD-ROM drives 100 MB Ethernet 17" Color Monitor	1	$3,000	$3,000
6	**File/Print Server** **Dell xxx or equiv.** 400 MHz Pentium-II 256 MB RAM 20 GB Hard Disk Tape, CD-ROM drives 100 MB Ethernet 15" Color Monitor File/print server (plus software for 200+ students adds $3600)	1	$9,600	$9,600
7	Small Format Color Printer 11x17 plain paper Network connectivity	14	$500	$7,000
8	Large Format Color Printer Full color or B/W Postscript/HPGL Up to E size (36"x48") Network connectivity	1	$7,500	$7,500

9	Large Format B/W Plotter Network connectivity Postscript/HPGL Up to E size (36"x48")	1	$5,500	$5,500
10	Slide scanner	2	$1,250	$700
11	Color flatbed scanner	6	$200	$1,200
12	Software licenses			$24,000
13	Video Presentation Station Color Video Projector Laptop Network connectivity	1	$7,500	$7,500
14	CD-R writer	2	$1,200	$2,400
15	Slide Writer	2	$1,200	$2,400
16	Security: Omni-locks on Arch. 202, I/O room (Arch 14)	3	$500	$1,500
17	**Graduate Student Assistants** (assume one w/ work/study, one w/o work/study; at current rates totals $1700/quarter, for three years start-up)	2	$16,300	$16,300
18	Faulty Release Time (assume reduction of one course; replacement hired externally for two quarters total)	2	$8,000	$8,000
19	Incentive Fund for Faculty Workstations	4	$2,800	$11,200
20	**Contingency**			$5,000

			TOTAL	$143,100

Part #2 -- Digital Design Studio

Item	Description	No.	Unit Price	Sub-Total
1	**CAD/Modeling Stations** **Dell xxx or equiv.** 400 MHz Pentium-II 256 MB RAM 10 GB Hard Disk ZIP, CD-ROM drives 100 MB Ethernet 17" Color Monitor	6	$2,750	$16,500
2	**Imaging/Rendering Stations** **Macintosh G4 or equiv.** 400 MHz G4 256 MB RAM 10 GB Hard disk ZIP, CD-ROM drives 100 MB Ethernet 17" Color Monitor 14" Monitor	6	$2,750	$16,500
	Peripherals			
3	Small Format Color Printer 11x17 plain paper Network connectivity	1	$2,500	$2,500

4	Large Format Color Printer Full color Postscript/HPGL Up to E size (36"x48") Network connectivity	1	$7,500	$7,500
5	CD-R Writer	1	$700	$700
6	Slide writer	1	$850	$850
7	Wireless Network Hub (Airport)	1	$250	$250
8	Wireless Network Adapter	12	$50	$600
9	Slide scanner	1	$350	$350
10	Color flatbed scanner	4	$200	$800
11	24 port switch	1	$1,200	$1,200
12	Digital whiteboard/rear projector-Smartboard #1810 and compatible projector	1	$9,750	$9,750
13	Software for DDS workstations	12	$1,200	$14,400
14	“Roll-around” computer/video cart (w/ projector, laptop, software etc.) to allow instruction in any space to larger numbers of students (price based on current cart purchases for Gould Hall)	1	$14,500	$14,500

15	Digital Technology—CNC (computer numerically contolled) tools or 3D Input/Output devices (such as a rapid prototyping machine or laser cutter for digital model building) Note: This purchase could be made in the second year.	1	$100,000	$100,000
			TOTAL	$186,000