Experiences In E-Learning: Portland State University Systems Engineering Program

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Abstract. The demand for professional education is changing higher education, made even more dramatic due to the convenience and richness of the Internet as a learning environment. The Systems Engineering program at Portland State University (PSU) has offered Internet courses every term since the spring term of 1999. During that time, a variety of issues were addressed, covering everything from technical requirements, development tools, teaching methodologies, learning approaches, program promotion, diversity of a global student body, student services, student satisfaction, and faculty buy-in. Many of these experiences have been distilled into a number of "lessons learned," related to our courses and program.

Background. The systems engineering program grew out a need to provide new learning vehicles to support the strong industrial technical community that has been developing in Oregon for the last 15 years. A study conducted in 1994-95 [1] cited the growing inability of Oregon to provide technically competent professionals for these expanding high-tech companies. In response, several initiatives were funded by the state legislature to develop professionally-oriented programs at state universities. PSU's contribution included six new SYSE courses and a new Master of Engineering in Systems Engineering, all designed for the Internet <www.eas.pdx.edu/Systems>. In addition, other PSU departments modified existing courses for the Internet, available for use in SYSE master's and certificate programs.

Another factor contributed to the creation of the PSU systems engineering program, namely, the vision of the newly appointed Dean, Dr. Robert Dryden. Bob had spent over 15 years as head of the systems and industrial engineering program at Virginia Tech. That program had gained world recognition for the content of its courses as well as for the expertise of the faculty, including Ben Blanchard and Wolter Fabrycky. Further, Brian Mar, Boeing Professor at University of Washington and one of the founders of the INCOSE, provided the material necessary to create several courses. Brian also encouraged the use of "active learning," a widely accepted approach for peer-to-peer learning [2]. In active learning, three levels of learning are offered to the student:

- receiving (knowledge, comprehension)
- responding (application, analysis)
- valuing (synthesis, evaluation)

The higher levels involve a greater degree of teaching to those at lower levels <www.eas.pdx.edu/Systems/stud_help/active_learning.html>.

WebCT is the browser-based learning environment used at PSU. It provides a set of course tools that helps the instructor design and deliver material online. WebCT <www.webct.com> includes tools, such as home pages, e-mail, chat, glossary, calendar, quiz, and grading metrics.

SYSE Courses

The following observations have been distilled from two years experience, primary from numerous interactions with course students via the telephone, email, bulletin board postings and chat/discussion group sessions. Other sources include meetings with other students, faculty and industry, as part of continuous assessment.

Some E-Lessons

1. The only significant platform (PC vs. Mac) dependent issue concerned the CD-ROM disk that was provided to each student. This CD was produced on a PC, so Mac users occasionally experienced some difficulty in access its files. As a work-around solution, files were duplicated and placed on an FTP site, accessible to all students.
2. This CD contained all of the material available on the web site. The need for the CD arose from potentially long download times for some of the web material by some of the students. Also, many students wanted to view the course content continuously without links or the need to page to another file.
3. A companion issue was the need for all files to be in platform independent formats, either HTML or PDF formats. This would allow both PC and Mac users access to the files. Further, PDF files have the advantage of better resolution than typical browser (HTML) files.
4. The instructor creates the course, monitors student usage of the course and generates statistics when logged-in as the course developer. But, to insure that the students see what the instructor intends and to verify the functionality of the web-based tools, the instructor MUST log in as a student.
5. We had great plans for course chat sessions as a vehicle to stimulate discussions. Unfortunately, the reality was somewhat different. The following captures some of the challenges with chat:
   - Realistically, chat sessions must be fairly limited in size, since the instructor can only handle dialogs with about five students. Even with small groups, i.e., five students and the instructor, responses to questions are slow, not immediate. An accomplished typist can only type so fast. Perhaps a voice translator could be installed that would allow the instructor to speak, instead

of typing. Technology improvements in integrating voice over the Internet may help in future, but not until the majority of students have larger bandwidths, i.e., DSL or equivalent fast connections.
- Bulletin board postings or discussion group postings provide a threaded hierarchy of past responses. These other mechanisms are asynchronous, unlike a "chatroom" that requires everyone to be on at a give time.
- WebCT chat had some problems, mainly with the Java applets. The back-up plan was to download MS-Chat, meet in MS chat room with instructor as host to control who had access to the public room.
- Chat sessions were poorly attended, even when mandatory.
- Logs of all chat sessions were available from the course bulletin board, located on the home page.
- The chat sessions were offered in the evening, after work. The later times (past 8:00 p.m.) seemed to work better for most folks, especially since many had children that need attention during the earlier evening hours. Also, most folks quickly came to appreciate the ability to log into chat from home, rather than drive back to work in the evening to access chat. Unfortunately, lots of students hadn't properly set up their home systems to be Internet compatible before taking the course.

6. Email and threaded discussion lists worked best for communications with students, either singularly or as a group.
   - Everyone is experienced with email applications.
   - Almost everyone uses email at work to communicate with project team members, especially with those located in different parts of the country.
   - Email messages can contain threads, so that anyone could read through the email to view previous discussions.
7. All the course material is available and can be read at student's pace, within the constraints of the academic term. Some students, due to work travel, are out-of-phase and interact little with other students. Most students can and want to interact using the Internet. In either case, an important aspect of systems engineering is team dynamics, which is best learned by doing and teaching others. As a consequence, most courses have a mixture of synchronous and asynchronous activities. A generalized model for this mixture has not been formulated. At present, the success of the courses depends on faculty, who orchestrate student activities.

Things That Worked. A number of our approaches worked well.
1. Regular homework that is graded and returned on a weekly basis. Best approach was having students address each other's inputs.
2. Timely posting of homework and instructor responses and student critiques.
3. Clearly indicating when all homework modules were due, especially for student working at a self-paced level
4. Email, individual and group, at least twice a week
5. Bonus points for finding bad links and other web-based problems (not for grammatical errors)
6. Instructor/course developer must frequently log into the course as a student (quality assurance/quality control issue). The instructor must see what the student sees.
7. A Calendar application, listing homework due dates and test schedules.
8. A Bulletin Board application, as a repository for homework and critiques.
9. Course advertisements and registration material must emphasis the web-based nature of the course, including team participation and active learning approach.
10. Active Learning appears to improve learning and retention by utilizing interactivity among all the students, the instructor and the information.
11. Course assessment is essential given the newness of the learning environment, distance faculty, and a diverse study body. In our experience, assessment has helped with connecting course work to program objectives and with determining if students have achieved course objectives.

Program Considerations: What Has Worked. Three areas are discussed.

Internet Format. Our decision to commit to Internet format involved several factors:
1. The concept of interdepartmental collaboration was considered important right from the start, not only to satisfy the need for interdisciplinary activities, but also because available resources could be used more effectively. Even on a small campus, collaboration manifested itself in email, shared documents over the Internet, and sharing of courses. Given the availability of the Internet, this concept of collaboration was easily expanded to other institutions and faculty from around the world.
2. Delayed video offered a proven approach to sharing courses and distance learning. In many ways this approach is convenient for the instructor, because the familiar face-to-face lecture style may be used. Various studies of students' preference do not rate delayed-video very high [3]. Alternatively, web courses were familiar to the program director and several instructors. Even though straight web courses do not rate much higher than delayed video in some studies [3], the Internet offered tremendous potential:
   - easy to implement asynchronous learning
   - aside from faculty time, low cost to develop,
   - low cost to offer,
   - accessible to any learner with a browser and Internet access,
   - new dimensions of learning

using links, resources on web, etc.
3. Faculty may be located anywhere on the Internet. The systems engineering program at PSU is small and could not offer a variety of high quality courses without involving off-campus faculty.
4. Students may be located anywhere on the Internet. This diversity of students' backgrounds enhances the learning experience, as students are encouraged to collaborate on many assignments.

Faculty Motivation. Given the immense amount of work needed to develop an Internet course, incentive for faculty to participate remains a significant problem. Systems engineers take the future of their profession very seriously, and realize the value of education — especially education that is high quality and accessible to practicing engineers, whenever and wherever they wish. Also, systems engineers like a challenge and like new things—Internet education provides both. Because of these characteristics, several systems engineers have gravitated to the program. They are self-starters and work well together even using email as primary mode of communication. We're not sure what generalities can be made to help other Internet learning programs — possibly to involve systems engineers!

Student Motivation. By some measures, our courses are not asynchronous — there is expectation that students will work together on many homework assignments, and courses are phased with the term. Regardless of these two limitations, working engineers taking our courses enjoy the self-paced nature of reading material that was specifically organized for a web course. Also, as stated above, the Internet allows a student anywhere to take a course from a respected systems engineer, who is probably at another locale.

Program Considerations: What Needs Work

Program Promotion. The program is expected to cover its costs through student tuition. Thanks to the dedication of the systems engineering community, development and instructional costs have been relative low. Nonetheless, administrative costs are high. As mercenary as it may sound to some academicians, the program will probably not survive to the point of being a viable e-business if it does not market and promote itself. Systems engineers may be in a better position to promote this program, compared to discipline-specific engineers, by the very nature of their positions in their companies." The student body consists of two types: 1) local product, process, software engineers, who are interested in applying systems engineering skills to improve their development environment; 2) seasoned systems engineers from around the world that like convenience of Internet courses or like the reputation of an instructor. Promotion differs for each type, respectively: a) personal visits to discuss the benefits of systems engineering; and b) global marketing and competition.

Internet Collaboration. Two programmatic issues need to be addressed: scholarship fostered by student and faculty interactions and organized partnership between the program and industry. One approach is to improve Internet interaction at a number of levels, using a combination of software, hardware and peopleware. Below are some preliminary ideas – ideas with plenty of room for additional suggestions:
1. Student-to-Student. Email is available, and WebCT provides modules for shared documents and chat sessions. These are good starts, but we must also move into shared engineering tools. The course organization might also be modified to better match-up students with similar learning styles (or not match them up) and students with similar schedules.
2. Student-to-Faculty. Video streaming, even if only a short clip, connects students to the instructor as an individual. The extent of this video may vary depending on the course and instructor. In addition, courses should include assistants and mentors to help answer questions, technical or otherwise, and to facilitate student discussions.
3. Faculty-to-Faculty. Internet meeting software may help. Personal cameras and audio and video over the Internet are also being considered.
4. Program-to-Industry. Since most companies are international, they already have the infrastructure to collaborate on engineering projects and may have a global training network. The program needs to learn more about their approaches, and share facilities when appropriate.
5. Program-to-Program. The major problem may be academic constraints. New models are needed to co-teach, co-advise, interchange courses, offer joint degrees, and share facilities on a visitation basis and over the Internet.

Conclusions. On the basis of experiences to date, we offer six conclusions.
1. Web-based courses require significant start-up time to design and develop. An Internet course must be substantially completed by the first day that the course begins.
2. The course must be designed to provide maximum learning, beyond the obvious convenience of text, graphics, and links. For example, objectives must be clearly and meaningfully stated at the start of each week's material. Mechanisms, like weekly discussion-threaded questions, must be used to engage the student and encourage learning through discussions with other students. New learning environments, such as Active Learning, must be attempted and assessed.
3. The instructor must monitor and respond to any student query on a daily basis, i.e., the instructor must be on the Internet every day. Nothing will destroy the success of a web-based course than lack of daily feedback from the instructor.

4. The program must support student services from its web site, with email and phone back up.
5. Internet courses are a key ingredient in a global network of faculty, information and students. Improvements in collaboration, through software, and hardware, and their thoughtful utilization are needed before this network becomes a campus.
6. The Internet presents the challenge of marketing to both local and global students, meeting high expectations for service and quality learning, and competing with other universities worldwide.

References

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Biographies

John E. Blyler *has developed and taught web-based, asynchronous graduate program in systems and software engineering for both Portland State University and the Oregon Masters of Software Engineering program. He has recently co-authored an IEEE Press book on systems and is the west coast editor for Wireless Systems Design magazine.*

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