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ABSTRACT

This paper describes Stanford Online, a distance learning program at Stanford University (California) that utilizes the concept of asynchronous learning and the growth of the Internet to make Stanford courses, seminars, and lectures available anywhere, any time, and on demand in order to address the continuing education needs of busy professionals. Highlights include: (1) background on the growth of distance learning at Stanford, including the Stanford Instructional Television Network (SITN), the core program of the Stanford Center for Professional Development; (2) the Asynchronous Distance Education Project (ADEPT), including the use of Quicktime and video-streaming technologies, VXtreme and its Web Theater product family, and hardware used for authoring and for the World Wide Web and video server; (3) faculty and student reactions to Stanford Online; and (4) the future of Stanford Online. (DLS)

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Stanford Online: The Stanford University Experience With Online Education

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Overview

Stanford University has one of the largest distance learning programs in the world, and through which the Stanford Center for Professional Development (SCPD) reaches professionals who want to pursue an advanced degree or satisfy a need to enhance their skills and knowledge while they maintain the momentum of their careers. The changing dynamics of the workplace puts employee time at a premium and pressure on educational institutions to respond to the educational demands of a rapidly evolving global business environment. Technological advances have led to the advent of asynchronous learning and a growing acceptance among educators. Utilizing this concept, and building upon the growing ubiquity of the internet, Stanford Online program makes Stanford courses, seminars, and lectures available anywhere, anytime and on demand in order to address the continuing education needs of today's busy professional.

Background

Distance learning at Stanford University has grown hand in hand with Silicon Valley, and Stanford's program has been widely considered a contributing factor to Silicon Valley's growth. The founders of Hewlett-Packard, Bill Hewlett and Dave Packard—themselves graduates of Stanford's School of Engineering—worked closely with Fred Terman, then dean of the School of Engineering, to establish the distance learning program called the Stanford Instructional Television Network (SITN). The ability to pursue graduate engineering education was, as it is now, a significant recruiting and retention tool for the high technology companies based in Silicon Valley.

Today more than 300 corporations enroll their professionals in courses and programs offered by SITN, which is the core program of the Stanford Center for Professional Development. SITN offers 200 courses each year via distance learning, and nearly all of the courses in the computer science and electrical engineering curriculums may be found on the SITN schedule. In addition to television broadcast, two-way video, and videotape, a subset of the SITN schedule is now also available via the internet through Stanford Online.

Stanford Online evolved from research on asynchronous learning at Stanford funded by the Sloan Foundation in 1994. This project was called the "Asynchronous Distance Education Project" or "ADEPT."

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Stanford Online

When the Asynchronous Distance Education Project (ADEPT) at Stanford University's School of Engineering was introduced in the 1995–96 academic year, participants had the ability to take graduate-level courses on demand. This technology allowed working engineers flexibility in scheduling their professional and academic lives. While this ground-breaking effort was heralded as a significant milestone in distance education (SCPD was given "The Most Significant Advancement of Research in the Field of Distance Education" award by the U.S. Distance Learning Association), the technology itself was deemed, at best, a first step in the right direction.

In the ADEPT project, the end product for the student was a Quicktime movie with a frame rate of 0.4 fps (standard television is 30 fps) sized at 320 x 240. However, the file took up so much disk space that to accommodate end-users the course videos had to be downloaded in four 25MB segments. Dependent upon the stability and speed of the end-user's network connection, the download process was often quite taxing.

Throughout the project, simple refinements were made to enhance the viewing experience. A Quicktime plug-in became available so students could begin to view initial video files while the course was still in the process of downloading. The frame rate was increased to 1.0 fps by capturing the video in 8-bit color depth and new authoring tools allowed quicker and more consistent performance. Still, the problem of downloading files to the local disk drive and the dependency of the internet connection remained critical concerns. Furthermore, the inability to access specific points in a lecture made reviewing materials frustrating for students.

In the 1996–97 academic year, video-streaming technology became a viable option for the Stanford Online. While the major draw in Quicktime technology is its cross-platform abilities and industry-standard reputation, streaming technology allows end-users a means to view video without requiring downloading the files to computer hard-disk. Streaming video technology allows compressed video to playback without interruption by buffering segments of the file discretely. Video is played back sequentially by segment, with each played segment replaced by an incoming segment. This constant "stream" of new segments allows the video to be played seamlessly. It became quite evident that streaming technology would alleviate many of the ills that plagued ADEPT.

Stanford Online chose VXtreme and its Web Theater product family, which offers solutions to many of the components that were on the production wish list. The technology enables 10 fps streaming video which alleviates the download time and hard-disk space requirements, provides a full table of contents which allows students the ability to access the material they need without wasting time locating the pertinent material on the class video. To combat the small size of the video frame (160 x 120), the majority of the web page houses a frame called the flipper which is capable of displaying any augmenting graphics/text information in a window roughly two-thirds the size of the screen. All of the course notes are presented in a much larger frame than the original ADEPT video. Finally, all of the components are in perfect sync with one another allowing a completely interactive learning experience. When a student clicks on a specific topic listed in the table of contents, the video clip and the appropriate slide automatically load and present the requested information.

Because the streaming technology was initially only available for the Windows platform, Stanford Online chose to author classes in both VXtreme and Quicktime formats. Spring Quarter '97 showcased three courses fully authored and available on-demand and two courses that were actually streamed live using VXtreme's Live Theatre product. This enabled live streaming over the internet of some of our most popular seminars with a nominal six-second delay.

During the summer of 1998, Stanford Online will migrate to Microsoft's NetShow Services in order to incorporate much of the technologies inherent in VXtreme (which was purchased by Microsoft in 1997). NetShow will make it possible to simultaneously capture, encode and stream courses live. It will also be made available on multiple platform clients (HP-UX, Linux, Solaris, Macintosh, WindowsNT, Windows95/98, Windows 3.1x, SunOS, IRIX).

One of the most commonly asked questions asked is if the size of the video can be increased. With NetShow, the video is now fully scalable. In addition, the streaming ability is far more reliable as the client can detect bandwidth congestion and "thin" the video dropping frames between key frames, in order to maintain the video stream and ensure continuity.

Stanford Online uses Compaq Computer systems for content authoring and encoding. Hardware includes 10 Compaq Professional Workstation 6300 2D systems, each running the Microsoft Windows NT Workstation 4.0 operating system and equipped with dual 300-MHz Pentium II processors, 512-KB cache, 64-MB RAM, 4.3-GB hard disk drives, and a Winnov video capture card.

Compaq ProLiant 2500 servers are used for both the web server and the video server. Each ProLiant 2500 system runs Windows NT Server and has dual 200-MHz Pentium Pro processors, 256-KB cache, 64-MB ECC RAM and multiple 4.3-GB Wide-Ultra SCSI hard disk drives with RAID 5 protection. The Web server has seven ProLiant 9.1-GB Wide-Ultra SCSI drives with RAID 5. The servers include the Integrated Remote Console and full remote server reboot capabilities, and Compaq Insight Manager, which monitors hardware performance for early detection of potential problems.

User Reactions to Stanford Online

Stanford faculty in the School of Engineering are accustomed to teaching on television. In fact, it is expected of faculty in the departments that benefit most from participation in the distance learning program. Faculty members have found that corporate-sponsored students have brought "real world" experience to the classroom which in turn benefits the full-time campus-based student. The advent of Stanford Online has alleviated the delay inherent in the program for students participating by videotape, and the faculty has welcomed this program improvement as well.

Students on campus have taken advantage of Stanford Online as well. All classes broadcast by SITN are available on the campus network as well as on videotape in the library. Having courses available asynchronously via Stanford Online improves access for the campus student to view their courses on a more convenient schedule and eliminate long lines for videotape viewing in the library. With faculty approval, students may also register for classes that are scheduled at the same time, and participate in one asynchronously via

Stanford Online. Stanford Online has also been used to by the Stanford Overseas Program. During Spring '98, several courses were made available to Stanford students located at the Stanford overseas campuses in Berlin and Kyoto, which allowed students to stay current with their program schedule by taking classes offered on the main campus.

An average of 700 passwords are issued upon request each quarter to registered student, although campus students are not required to have passwords. Surveys reveal that 31% of Stanford Online participants would not have taken the course if it were available only online, and 84% indicated they would take another course using Stanford Online. When queried about the value of the video insert to the overall learning experience, 69% felt it contributed positively. Although asynchronously delivered education does not allow for real-time interaction, 55% of the respondents felt the lack of live, two-way interaction did not limit their ability to learn the course material. In summary, 88% felt satisfied learning the course material via Stanford Online.

The Future of Stanford Online

Future enhancements to Stanford Online will include live online 24/7 technical support through a paging technology, an online calendar, virtual problem sessions, moderated chat-newsgroup, software download wizard, online registration, virtual whiteboard integration, multiple audio tracks, variable playback speeds, closed captioning, and multiple video windows.

Combined with the growing ubiquity of the internet and widespread use of corporate intranets for training, Stanford Online technology will allow Stanford-based content to be distributed asynchronously via the network to customer organizations and corporations. Stanford Online content could be used by training organizations to enhance or augment internally-designed training programs by incorporating specific lectures, or modules of Stanford courses. A server with Stanford content could be licensed to a corporation and placed on their intranet for pay-per-view access. The Stanford Center plans to develop custom-designed instruction for professional development online delivery.

Autobiographical Sketches

Carolyn Stark Schultz is the Director of Business Development and Marketing Services for the Stanford Center for Professional Development at Stanford University. Her responsibilities include corporate outreach, development, strategic planning, marketing, and program launch. She works closely with high technology companies in the ongoing education and training of professional engineers and computer science professionals. Ms. Stark-Schultz has been at Stanford for ten years, after spending eight years at AT&T. She has a graduate degree in organization development from the University of San Francisco, and is also a graduate of Indiana University's School of Business.

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