Wilson writes that technology presents the possibility of creating the continuous learning environment that many believe is essential to national economic development and world economic growth. He describes the incorporation of technology into the undergraduate curriculum at Rensselaer Polytechnic Institute, particularly via the introduction of studio courses that replace large, introductory, lecture-based science and engineering courses. Wilson believes that innovations at the institutional level can readily be applied to the burgeoning corporate education market, and to help satisfy the need for continuous learning in the workplace and home.

The forces that have caused such upheaval in global industry are also stimulating change in the education of the workforce. The old paradigm of discrete educational experiences is being replaced by a new paradigm of continuous education. At a recent meeting of the American Society of Engineering Education, Christopher Galvin, president of Motorola, declared that the company no longer wanted to hire engineers with four-year degrees. Instead, he said, they need employees with 40-year degrees. Motorola is representative of the many companies where continuous learning is crucial, making learning the killer application of this generation of computing.
In spite of these often adverse global trends, universities and corporations are called upon to make significant increases in quality and accessibility of the educational experience, without the advantage of additional resources. In many places this has led to re-engineered courses and curriculum that incorporate technology and often break the constraints of place and time.

The old paradigm of on-site versus distant learners is blurring rapidly as the increasing availability of network resources and collaborative software stimulates a convergence. Technologies originally designed for meetings and conferences are now being pressed into service to provide the competitive edge to corporations for education, training, sales support, and customer interaction. Technologies such as desktop video conferencing promise the ability to reach anybody, anywhere, at nearly any time, and at much reduced cost. Realizing the promise of these technologies will take creativity and courage, as well as a deep understanding of the way we learn and retain information.

Corporations and universities are examining the forces mandating change, exploring the technologies facilitating change, and illuminating the choices and challenges they face in navigating toward the networked, collaborative educational environments of continuous education. Each institution must examine carefully its role and mission to understand exactly how it must change. Some institutions will become the Walmarts of education, bringing commodity education to a wider range of students at the best possible prices. Others will be brand name institutions, known for particular specialties delivered with high perceived quality at correspondingly higher expense.

**Evolution of Computing**

Learning is the killer app of this generation of computing. Every generation of computing has had its killer app: In 1965, computer specialists began writing programs to undertake complicated scientific calculations. The killer applications of the first generation of computing were primarily scientific and technical. It was not long before accountants discovered that computing was a real aid to accounting as well.

In the early 1980s, the magazine, journal and book publishing industry began using computers extensively. Word processing, the killer app of that generation, soon displaced the ubiquitous typewriter on every editor's desk. In a few more years, page make-up software eased the transition from editorial copy to laser printed, publication ready pages. The job functions of typesetters and paste-up artists disappeared almost over night—these job holders either became computer page make-up specialists or sought employment with less radical employers.

Shortly after this all began, spreadsheet programs became popular and provided managers with the endless flow of management information they all craved (or thought they did). Complicated “what if” problems became as easy as 1-2-3.

Later, multimedia titles with flashy graphics and embedded video were created. CD-ROMs became
fairly popular in technical circles, and the new field of multimedia was born. During this period we thought computers were really TVs!

Lately, Web fever has devoured our campuses and corporations. To many, it looks like the real use of the computer is as a full color sales brochure.

Calculator, typewriter, television or sales brochure, the computer is just now coming into its own as a powerful communication device that is changing the way we work, live, love and learn.

Curriculum Reform at Rensselaer

Rensselaer Polytechnic Institute has undertaken a systematic restructuring of its curriculum, involving collaborations with many other campuses and educational and industrial leaders. With faculty leadership, over the past seven years Rensselaer has been engaged in the development of innovative approaches to undergraduate education. These innovations include:

- Introduction of studio courses to replace large introductory lecture-based courses in science and engineering with a format that is far more integrated, incorporates technology, and is a better learning environment for students and a better teaching environment for faculty.
- Development of an integrated core curriculum that offers multidisciplinary courses as part of each student’s program.
- Top to bottom redesign of every curriculum into the "4X4 Curriculum," which encourages students to take four four-credit courses (and no more!) each semester.
- Emphasis upon bringing education to the student and particularly to the workplace.
- Creation of new tools for network based Continuous Education.

The studio courses are particularly designed to bring the interactivity often found in small enrollment interactive courses to meet the needs of the large enrollment courses. Lecture, recitation and laboratory are combined into one facility, the studio, where the faculty conducts hands-on interactive learning sessions. The campus-wide process team on the introductory curriculum, “The Crossing the Threshold Team,” recommended that all introductory courses move into these interactive formats over the next few years. Rensselaer is well on the way toward achieving that goal: there are now 16 studio classrooms, each of which can support the education of 500 students per week in a single class.

The Comprehensive Curriculum Reform program that will lead to the reanalysis of each undergraduate major is also being implemented. This is often referred to as the 4 X 4 program, since the goal is a flexible program of four courses of four contact hours each as the standard student load. This program was proposed by the campus-wide process team on “The Design and Delivery of Curriculum,” and was approved unanimously by the Faculty Senate Curriculum Committee and ratified by the entire Senate.

One challenge presented by this strategy is to find a way to make the pervasive use of computing...
both accessible and affordable. Toward that end, a model of the Client Server University in which student computing provided by laptop computers is linked to powerful servers of multimedia courseware, applications, and compute power is being developed.

The boundaries between on-site and distance learning are blurring. Rensselaer presently educates about 900 students per semester in interactive distance learning formats, and is among the leaders in research on this format. Our goal is for the distance learning student to have the same learner-centered studio experience as our on campus students.

Rensselaer has earned widespread national recognition for its achievements in this field. The 1995 Theodore Hesburgh Award was presented at the 1995 annual meeting of the American Council on Education. Richard Riley participated in the presentation of the award at the meeting, which was also attended by President Clinton. Rensselaer also was the recipient of the first annual Boeing Outstanding Educator of the Year Award in 1995. From 37 nominees, Rensselaer was selected to honor its achievements in undergraduate education in the engineering, manufacturing, computing, mathematics, physics and chemistry disciplines. In 1996, Rensselaer was honored with the Pew Charitable Trust Prize. Rensselaer is the only university to have been awarded this “triple crown” of higher education awards.

**Studios**

Our introductory courses in Physics, Calculus, Computer Science, Chemistry, and Introduction to Engineering Analysis each educate 600-1000 students per semester. The traditional approach (until about 1992) was to divide the courses into two lecture sections with 300-500 students each and then sub-divide further into about 25-30 recitation sections of less than 30 students, and 30 to 40 labs of less than 25 students each. The lectures were team taught by two or more faculty, the labs were taught by teaching assistants, and the recitations used a mix of faculty and teaching assistants. This meant staffing 57-72 “events” each week. There were also two laboratory support staff and one lecture demonstration support person. After compiling the actual cost for this in 1993, we were surprised to see just how expensive this traditional model was. We were able to identify several alternatives that were economically competitive and promised far better educational effectiveness. This stimulated us to design the studio courses. The CUPLE Physics Studio, Studio Calculus, and the Laboratory Introduction to Embedded Control (LITEC) were the first courses created. The model has since been adapted to Chemistry, Biology, Economics, Computer Science, and Engineering courses, and is being adapted to Electric Circuits and Electronics and Instrumentation courses. Plans for future courses span the undergraduate curriculum.

The studio courses are particularly designed to meet the needs of the large enrollment courses. The traditional large lecture format is replaced by a studio approach that is not only economically compet-
The courses are highly structured and are not self-paced. They use very advanced-function computing technology, including computer-based video and video data acquisition, microcomputer-based laboratories, and powerful data analysis and visualization tools. Research faculty who have taught in the pilot courses report that it is a friendly environment in which to teach, one that reminds them far more of an undergraduate research setting than it does of the large enrollment lecture classes.

To some extent, the studio format is designed to transfer some responsibility from the faculty to the student. The focus is on student problem-solving and projects, and not on presentation of materials. The emphasis is on learning rather than teaching.

In the studio, the approximately 700 students enrolled in the large introductory courses can be divided into 12 sections (12 events) of 50-60 persons. The courses were reduced from six contact hours (two lecture, two recitation, and two lab) to four contact hours in length, or in two 1.5 hour and one one-hour periods. The reduction from six to four contact hours is an important aspect of stewardship of both student and faculty time and resources. In spite of the 1/3 reduction in contact hours, evaluations are demonstrating that students learn the material better and faster. Each course is led by a team of one faculty member, one graduate student, and one or two undergraduates. The mentoring of graduate students and undergraduate students is an important side effect of the re-designed course structure.

**Facilities**

The re-engineering of introductory courses led directly to a re-design of facilities. During 1993-96, we completely renovated seven classrooms for the Studio Calculus, Physics, Chemistry, Biology, and Introduction to Engineering Analysis courses. This year the total grew to 16 studio classrooms. The classrooms accommodate 46 to 70 students in comfortable workshop facilities. There are work tables 6 feet long, each designed for two students, with open workspace and a computer workstation. Often the tables also contain the equipment for the day’s hands-on laboratory. Several arrangements of the rooms are possible. In one, the tables form three concentric partial ovals with an opening at the front of the room for the teacher’s worktable.

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**Figure 4-1**

<table>
<thead>
<tr>
<th>Traditional Course—Weekly Schedule</th>
<th>Studio Course—Weekly Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>700 Students</strong></td>
<td><strong>700 Students</strong></td>
</tr>
<tr>
<td>One 2-hour lecture</td>
<td>Two 2-hour studios</td>
</tr>
<tr>
<td>Two sections of 350 students each</td>
<td>OR</td>
</tr>
<tr>
<td>One 2-hour recitation</td>
<td>Two 1.5 hour studios</td>
</tr>
<tr>
<td>25 sections of approximately 14 students each</td>
<td>and one 1-hour studio</td>
</tr>
<tr>
<td>One 2-hour lab</td>
<td>Totals:</td>
</tr>
<tr>
<td>35 labs of approximately 10 students each</td>
<td>Four hours</td>
</tr>
<tr>
<td>Totals:</td>
<td>24-36 sessions per week</td>
</tr>
<tr>
<td>Six hours</td>
<td></td>
</tr>
<tr>
<td>62 sessions per week</td>
<td></td>
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</tbody>
</table>
and for projection. The workstations are arranged so that when students are working together on an assigned problem, they turn away from the center of the room and focus their attention on their own small-group workspace. The instructor is able to see all workstation screens from the center of the oval, and thereby receives direct feedback on how things are going for the students. Other configurations include those in which the students face forward and work at laptops, in which students sit at tables arranged in “T” shapes, and in which they sit at modular, tulip shaped tables.

In the Physics course, the work-stations run the CUPLE software system, have full access to networked multimedia, and include a microcomputer-based laboratory system for data acquisition, analysis and visualization. The Calculus course makes heavy use of the Maple symbolic mathematics program. Biology uses the Bioquest materials. Other courses have their own materials under development.

In any course, when the instructor wants to conduct a discussion or give a mini-lecture, he or she is able to ask the students to turn back toward the center of the room. This removes the distraction of having a functioning workstation directly in front of the student during the discussion or lecture period, yielding a classroom in which multiple foci are possible. Students can work together as teams of two, or two teams may form a small group of four. Discussion as a whole is facilitated by the semicircular arrangement of student chairs. Most students can see one another with a minimum of swiveling of chairs. This is particularly important since only about 20 percent of the time spent in the classroom is actually on the computers; the remainder is devoted to group activities, hands-on laboratories, and discussion.

Many of these activities were introduced into the traditional classes in 1990-93. In 1993, the first full studio was deployed. During the fall 1994 semester, the CUPLE Physics Studio was expanded to full deployment in all Physics I sections and Physics III sections. There was a one-section pilot deployment in Physics II. In 1995, the Physics department voted unanimously to end the traditional course in favor of the full deployment of the studio. The studio has since spread to every science department and across engineering and management. The curriculum reform implementation team has called for the creation of at least 25 Rensselaer studio classrooms. With 16 in operation in the fall of 1997, we expect to reach a full complement by the end of 1998.

**Integrated Science-Engineering Curriculum**

In addition to changes to the learning environment, Rensselaer has been conducting a careful reexamination of its undergraduate curriculum. One example is the core engineering program that brings engineering into the freshman year and provides a common set of experiences for all four years of the undergraduate engineering experience. Portions of Physics I, Statics, and Linear Algebra were incorporated into a new course in Introduction to Engineering Analysis taught in the first semester of the freshman year. Physics is then delayed until the
second semester, combined with dynamics, and becomes Physics/Mechanics. Chemistry has been combined with topics from materials engineering into a two-semester sequence of chemistry of materials. There are several one credit specialty courses, such as Engineering Processes, Engineering Graphics and CAD, and Introduction to Engineering Electronics. An Introduction to Engineering Design course is taken in the sophomore year. Thermodynamics, Dynamic Systems, Laboratory Introduction to Embedded Control, Modeling and Analysis of Uncertainty, and Computer Science I make up the remainder of the core.

**The 4 x 4 Plan**

As part of its institution wide re-engineering efforts, Rensselaer has challenged itself to develop a new curriculum that delivers a higher quality undergraduate education at fundamentally reduced cost. During the 1994-95 academic year, several process teams reviewed various aspects of university operations. Each team was made up of faculty, students and staff, including at least one person from each school. The “Design and Delivery of Curriculum Team,” recommended comprehensive curriculum reform, which came to be known by the nickname, “The 4x4 curriculum,” because it proposed that students take just four courses of four hours each per week, in contrast to the typical five or six three-hour course schedule.

This is only one aspect of the reform program, but it is important because it:

1. Allows students to concentrate on fewer courses at a time and go into more depth on each.
2. Requires faculty to rethink the relationships between various portions of the curriculum and revamp each discipline’s programs.
3. Does not allow the status quo as an option.
4. Reduces the disciplinary requirements for each major, dual majors, and cross-disciplinary minors.
5. Provides more flexibility for elective courses.
6. Reduces the number of courses taught by approximately 25 percent.

The Rensselaer community discussed the team’s recommendations at great length, and the Faculty Senate endorsed this curriculum reform in the spring of 1995. The vote by the Faculty Senate Curriculum Committee was a rare unanimous vote. A three-year transition program was undertaken in fall 1995.

**Changing the Nationwide System**

Rensselaer has been working with the National Learning Infrastructure Initiative of EDUCAUSE (now EDUCAUSE). EDUCAUSE, the national organization devoted to the development of educational computing, founded the National Learning Infrastructure Initiative (NLII) in 1994. This group is made up of universities, corporations, publishers and nonprofits that have decided to work together
to build the National Learning Infrastructure that corresponds to the National Information Infrastructure (NII) that many hope (and some fear) will change the way we work, live and learn.

EDUCAUSE has asked Rensselaer to help lead other institutions through the same change process that it has embarked on. The focus is on large introductory courses. Initially, it was thought that perhaps 5 to 10 other institutions would want to join the partnership. After two national EDUCOM NLII meetings that were used for preparation, interested universities were invited to send teams of faculty and administrators to an NLII partnership planning conference in 1995. Over 80 representatives attended. This was far beyond expectations and is a dramatic expression of just how seriously universities are taking these changes.

**Going the Distance: The Virtual Studio Classroom**

Is there any university that does not aspire to becoming a virtual university? The ubiquity of this buzzword belies the difficulty of actually designing and building such a beast while retaining the excellence of the traditional local interactive formats.

For the virtual university to be successful, it will have to replace the traditional modes of distance learning—such as satellite video, teletraining keypad response systems, and interactive video conferencing—with a more robust educational model. The goal is to provide the distant learner with as much of the studio experience as possible. In this model of interactive multimedia distance learning, one creates a virtual studio with students connected together over a network that carries data, voice and video to the students’ computers. Each student has access to multimedia materials created for the course and delivered from CD-ROM or across the network.

Part of any virtual classroom will be synchronous activity in which the students and instructors interact through live voice and video while working together with a synchronous collaborative software package. Another part of any virtual classroom will be asynchronous activity, or activities completed at the students’ own time and pace. The actual mix of synchronous and asynchronous activity will be adjusted to suit each course and audience. The bigger the portion of the course that is conducted asynchronously, the more flexible the course can become.

What prevents the course from becoming fully asynchronous? If the goal is anytime/anyplace education, then a fully asynchronous course sounds quite desirable. Why should students be bound to a particular time, if not a particular place? There are many efforts underway to do just that. The Sloan Foundation has a program that is funding universities to develop Web or Lotus Notes-based courses that are taken at the students’ convenience. Interactivity is included through asynchronous use of e-mail, news groups, or other electronic discussion modalities.

Once again, history and experience provide a cautionary note. There is a rather long record of efforts to break the constraints of place and time, some based upon text delivery and others on com-
puting. The completion rate for students in these self-paced courses is often less than can be tolerat-
ed. If the education experience is not critical to the student’s progress or if the student is well motivat-
ed, there may not be a problem. If alternative approaches are available, then the self-paced mod-
els will work very well with the highly motivated.

Michigan State has long offered its students a modularized and self-paced physics program, called PhysNet, that was designed along the lines of a Keller Plan course. If students are not highly moti-
vated or if large percentages of a group of students must be moved through certain educational experi-
ences, an asynchronous approach might not work. Hank Lenox, a Ford Motor Company Vice President concerned with education and training tells a story of creating a CD-ROM to introduce a new technique to certain Ford employees. The CD-ROM was designed to support about 15 hours of instruction, but the users were only averaging 1.5 hours. The results were disappointing.

A careful balance must be struck in the trade-
off between synchronous and asynchronous time. Certainly there is a place for asynchronous tech-
niques, but a structure of continuous feedback and interaction that ensures a satisfactory success rate must also be incorporated. The more instruction is moved in the asynchronous direction, the more flex-
ible the environment will be and the greater will be the gains in economic efficiency. When the balance is struck, it is unlikely to be 100 percent asynchronous or 100 percent synchronous.

Experience at Rensselaer indicates that a course in which most of the activity is asynchronous but which also includes regular synchronous meetings might be effective, flexible and efficient. Perhaps 10-20 percent of the course activity should be synchronous. The synchronous activity also allows one to incorporate the discussion, small group projects, and role playing that are so impor-
tant to student learning.

Recently the American Association of State Colleges and Universities and the Annenberg/CPB Project sponsored a workshop of faculty and admin-
istrators on the topic of “Redesigning a Course of Study.” At that meeting, two similar projects were presented. Each was designed to link classes at a rural, predominately white college or university with those at a diverse urban university. The subject of study was appreciation for other cultures. Group A linked a rural Pennsylvania college with an urban Washington, D.C. university in an e-mail and Web based approach to discussion of the controversial issues. Group B linked a rural California university with an urban one through interactive video confer-
cencing. There was a striking qualitative difference in the results. Group A was strongly convergent and intense. By the end of the project, they had fallen into stereotyping each other as “naive ignorant rural hicks” and “intolerant urban degenerates.” Discussion in the group B mode was tense and sometimes heated, but began to converge around an appreciation for how much they really shared in spite of their obvious differences. It is not clear how common these results might be, but they do agree
with experience at Rensselaer in the use of e-mail and video-conferencing technologies.

Generally, an effective interactive multimedia distance learning environment will have the following characteristics:

- Delivery on standards-based multimedia PC's equipped for live video/audio interactions and connected to a robust ip multi-casting network.
- A mix of synchronous and asynchronous activity.
- Use of Web and/or CD-ROM based multimedia materials.
- Use of professional quality software tools for CAD, symbolic math, spreadsheets, word processing, etc.
- Live audio and/or video interactions among the students and with faculty.
- E-mail interactions among the students and faculty.
- Small group discussions.
- Collaborative software for application sharing over the network.
- Access to rich resources on the network.
- Ability to pass the floor to students to allow them to lead the class through an activity.
- Course administration software to track student progress.
- Classes with a mix of students in traditional and workplace settings.
- Classes with a global perspective and global audience.

**Corporate Education**

Corporate education is a $60 billion market with huge potential for growth. Part of the cause of this phenomenal growth is the development of the communications infrastructure that makes it possible. What are the implications for higher education? Institutions are struggling with that—the cost burdens are both new and high. Higher education must come to terms with the rise of distance education, just-in-time education, and corporate education.

The traditional model of distance learning has merely pushed back classroom walls, using a lecture-based format with one-way transmission and no interaction. This is the mainframe model, akin to the old-style mainframe computer with several dumb computers hooked up to it. We need to progress instead to the client server model already described, wherein every student and every faculty member is a resource, comprising a rich interacting community of learners.

The key to establishing an effective collaborative model is to set up the network so that everyone becomes a resource. For example, Rensselaer has nearly 1000 students who are not on campus, but come in through interactive video and audio network technologies. Many of these students are employees of General Motors. They may be in Detroit or Luxembourg, or perhaps in Mexico City. Some of them are on tape delay, many are live interactive. Courses are richer for the presence of these
students, because of their real world experiences. Students in the on-campus classes frequently have come straight through the educational system, without work experience, whereas the General Motors students bring their experiences to bear on issues raised in class.

This client server model generates pure teaching, a key component in the learning process, where students teach one another through interaction and cooperative learning. The task for the use of the technology is to figure out how to facilitate such communication and how to best use synchronous versus asynchronous interaction.

Faculty concern that they may be replaced by a CD-ROM or a web site is based on the mainframe model of education. But with the client server model—the distributive collaborative approach—there is no possibility of being replaced. Faculty can become more productive, but that doesn’t mean replacement. Further, the corporate distance learning environment offers great potential to enhance revenues, and thus to help stabilize institutions. For that to occur, however, it is crucial that merely bolting technology on top of what is already being used, which invariably costs more, be avoided whenever possible. Instead, technology should be used to change the learning process.

In 1992, Rensselaer was challenged by AT&T to create a collaborative interactive multimedia distance learning environment. A course from AT&T’s University of Sales Excellence (USE), an internal training and education organization, was redesigned. The course, “How to Make Money Grow on Trees,” teaches the features of AT&T Advanced 800 Services and how to apply them to customer applications. Rensselaer created the multimedia materials and did the workstation programming for the project. AT&T Bell Labs took on the network programming.

In 1993, the new environment was tested with live participants. An instructor in Cincinnati, Ohio delivered the University of Sales Excellence course. Student participants were located in Dallas, Chicago, and Holmdel, New Jersey. The first “students” were actually other AT&T instructors who volunteered to participate.

The results were thrilling, but work began immediately on developing an architecture that could go well beyond the first. In 1994, a company called Interactive Learning International (ILINC) was spun off from Rensselaer to design, construct and disseminate the new learning architecture, called LearnLinc.

To manage the bandwidth, the emerging ip multicasting protocol was adapted to allow any workstation to send to any other without having to put independent copies of the information on the network for each workstation. Without multicasting, N fully communicating workstations would need N(N-1) times the bandwidth of a single workstation. With multicasting this is reduced to N.

By creating agents that could run on each workstation, the flow of video, audio and control information was managed before it got on the network. That reduced the total bandwidth to just twice an individual workstation. The network was
designed as a peer network so that any workstation could be a student, instructor, administrator or author. The agent software was given a persona. Each agent could act as an instructor, student, administrator, author, or any other persona defined by the administrators of the system. An agent could change its role in moments.

Students log into the LearnLinc system, which authenticates their enrollment and then loads their student profile. The student can browse through the sessions that are being offered synchronously and enroll in them according to the enrollment procedures. Students can also browse through the multimedia materials available on the system or network. Once enrolled in a course, the student is provided with all of the materials for the course and given access to any live sessions.

If a student chooses to join a live (synchronous) session, the live instructor video will come up on the screen and she will be added to the list of registrants on the instructor’s screen. As the instructor works through the materials, these same materials are displayed and annotated on the student’s screen as well. The student raises her hand by clicking on the hand raise icon, sending the signal to the instructor’s station and adding a hand icon to the student’s name on the class role. The instructor can then select the student and give her the floor. Then it is the student’s video and audio that is distributed, and the student can work the others through the materials. Eventually the instructor takes the floor again and brings everyone together on the same “page” on the system.

In 1995, the new software was put into use in production for the first time in an NSF Chautauqua program that linked Rensselaer and the School of Engineering at the University of Pittsburgh into a virtual classroom. Faculty from around the nation (and three from Hong Kong) came to the three-day workshop on multimedia in science, mathematics, and engineering education. On the first day, the instructor taught from Pitt; the following day he taught from Rensselaer. Students felt that the instructors were in the room with them no matter their actual locations. Observers noted that the students at Pitt would often communicate to one another while making eye contact through the system rather than trying to do so across the room. The program was repeated in 1996 and 1997.

In spring 1997, this method was used to teach a graduate course in Astrophysics that teamed a classroom at Rensselaer Polytechnic Institute with a classroom at Hong Kong City University. The course was taught in the early morning in New York and in the early evening in Hong Kong. Students met each day (often enjoying different meals together) in the twinning classrooms. Students made presentations from each site and came to know and work with counterparts whom they had never met.

Kent State University has deployed this system to teach nursing, business and English, to branch campuses across the state of Ohio. Rensselaer’s Center for Integrated Electronics and Manufacturing has been delivering a short course in chemical mechanical planarization to semiconductor fabricators such as Intel, Matsushita, Applied Materials, and others. One of the sites reached was in Osaka, Japan.
Conclusion

The important question for higher education is not whether technology is appropriate for education. Instead, the questions are how to use technology education, why to use it, when to use it, and what technologies to use. Technology is undeniably a part of all of our lives. Dissenters abound, however, about the role of technology in higher education. One argument asks, If a student can zoom the best teachers into his or her living room, what happens to the rest of the professoriate? Some believe distance learning means that one day all students could be taught by the same few star professors. But that falls into the trap of using technology to simply present information when it has the potential to create a rich and dynamic collaborative learning environment.

As higher education navigates these treacherous “continuous white waters,” Robert Zemsky and William Massy remind us that information technology will change teaching and learning profoundly, regardless of how traditional higher education institutions respond. That process has already begun. The University of Phoenix is the fastest growing university in the world. The governors of the Western states (sans California) are pressing forward with the creation of a Western Governor’s University that is based upon outcomes assessment and makes little effort to define an educational process to get there. Meanwhile, the brand name institutions continue to turn students away even as they struggle with the high costs of the traditional approaches to education. In the future, universities will differentiate themselves based upon their audience and core expertise. Some will endeavor to be brand name institutions that deliver outstanding education experiences with high perceived value in particular areas of core expertise. As we have seen, others will provide access to a commodity style education at competitive costs.

The advent of a continuous education system is upon us, one in which the education of 18 to 21 year olds in cloistered surroundings is but one small part. Growth in educational systems will come in providing the continuous education to the workplace and home that will be required by the learning corporation. This education must be provided in a global context and to a global audience. The prize will go to those who discover how to do this best.
Endnotes


2 ibid.


