Life on the Wired Campus: How Information Technology Will Shape Institutional Futures

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Introduction

Colleges and universities pride themselves on their sense of sustaining mission and the stability of their modes of operation. Many within the academy see themselves as holdouts against such "business fads" as restructuring and reengineering—not to mention the substitution of capital for labor that has driven two centuries of business productivity improvement. What banks, retailers, manufacturers, hospitals, and governments have undertaken cannot be taken for granted within the academy. This aphorism, coined by Clark Kerr and the Carnegie Commission, brings home the depth of higher education's sense of constancy:

> Taking, as a starting point, 1530, when the Lutheran Church was founded, some 66 institutions that existed then still exist today in the Western World in recognizable form: the Catholic Church, the Lutheran Church, the parliaments of Iceland and the Isle of Man, and 62 universities.... They have experienced wars, revolutions, depressions, and industrial transformations, and have come out less changed than almost any other segment of their societies. (*Policy Perspectives*, 1994).

Higher education's constancy is truly venerable, but does it stem from innate characteristics of the institution or from the constancy of its underlying technology? A look at history from the modern perspective suggests the latter. Since the Gutenberg Bible was printed in 1456 using movable type, the technology of information storage, retrieval, and transmission—the university's basic technology—has remained essentially constant until the current era. Indeed, the use of written records to supplement oral teaching goes back to the fifth century B.C. Since their inception, universities and colleges have relied upon lectures, discussions, and the written word because these were the only technologies available.

Information technology has opened new and fundamentally different options for teaching and learning. History demonstrates that fundamental technological change ultimately begets significant structural change, regardless of whether the affected participants choose to join or resist the movement. The changes that universities have weathered over the centuries did not upend their basic technology. Information technology does.

Information Technology vs. Teaching-as-Handicraft

This volume's other authors have described how information technology can and is being used to improve teaching and learning. It seems to me that the benefits can be captured in this brief statement:

> *Information technology permits teachers and students to project themselves across space and time, to locales and circumstances that best meet learner needs, with substantially less degradation than was possible with predecessor technologies.*

To put the statement in perspective, consider the classic "gold standard" for education: Mark Hopkins and his student on a log. By delivering education via one-on-one dialogue, it is said, the Williams College president could tailor content to his student's needs, interests, and capacities. He could draw the student into an active learning posture, then assess his performance and make corrections in real time. But even the gold standard scenario is not without limitations. It is expensive in terms of student-faculty ratios and it requires a high degree of synchronization: Mark and the student must balance themselves on the same log at the same time.

Mark Hopkins, the student, and the log provide a quintessential example of a handicraft process. Every output is produced to order using "one-off" methods conducted mainly at a single venue. The process does not involve much capital, aside from the human capital embodied in the participants. The process is regarded as mysterious—even the participants themselves cannot describe it in detail, let alone replicate it through "engineering. " The only way to produce the next generation of Mark Hopkinses is through apprenticeship.

Colleges and universities have tried various stratagems for mitigating the difficulties associated with their handicraft methods: offering set-piece lectures to large groups, assigning reading and homework, providing laboratories and internships, and breaking down space barriers via television. But each approach engenders its own difficulties: passive rather than active learning; less access to faculty expertise and insight; and limits imposed by the printed page, the teaching laboratory, and the television screen. Information technology doesn't eliminate all of the difficulties. But it does reduce them to the point where colleges and universities can break away from their handicraft traditions for a substantial portion—though probably not all—of their teaching and learning activities.

The process of breaking away won't be quick or easy, but colleges and universities do not stand as unique in this regard. Consider the replacement of steam engines with electric motors in industrial applications, for example. The factory of the early nineteenth century was a multistoried affair, expensive to build and inefficient in organizational structure and materials handling. One had to live with these constraints because economies of scale dictated a single steam engine which, given the bearing technology of the time, had to be linked to the work stations by vertical rather than horizontal driveshafts. The first electric motors simply replaced central steam engines, leaving other constraints in place. In time, however, it became possible to distribute the motors to individual workstations. This, in turn, led people to restructure the manufacturing enterprise, to "flatten the factory" and thus eliminate the inefficiencies of the multistory mills. Colleges and universities have only recently been distributing computing and connectivity to individual workstations on a massive scale. The task of “flattening the campus,” of restructuring to take full advantage of the new technology, remains before us.

The Post-Handicraft Era

Asking what colleges and universities will be like in the post-handicraft era raises the specter of fear as well as the stirrings of opportunity. Frequently asked questions include: Will educational quality be improved or undermined? Can and should technology be used to improve institutional ‘productivity—and what is productivity anyway’? Those who work in higher education institutions also ask, “How will information technology affect faculty roles and responsibilities? How will it affect professorial numbers and the size of administrative and support units? Will schools pay for technology by reducing labor cost? Will the quality of work life be better or worse?” These are the kinds of questions I will address in this chapter. I will deal mainly with four-year residential institutions, though the benefits of technology will by no means be limited to such schools. One can argue that the benefits of technology are more unequivocal and can be obtained more easily in the nontraditional settings than in the traditional ones—if so, these questions are perhaps even more germane in the four-year residential institutions.

Let me begin by going out on a limb and offering some quick answers—answers which I will try to justify later. I believe that the wired four-year residential institution will look about the same as it does today when viewed from afar, but that the view from within will be quite different. That is, the wired institution will still be a campus—populated by faculty, staff, and students—and not just a connecting point for dispersed information nodes. However, because equipment, infrastructure, and outsourced course materials will cost more than at present, faculty compensation will represent a smaller fraction of the expenditure base. Support staff in the academic areas will probably grow as a percent of total inputs, though whether the overall percentage of cost represented by nonfaculty labor grows or shrinks will depend on the degree of extra efficiency obtainable in central administrative and support areas.

Faculty are quick to ask whether information technology will add to or reduce their numbers. They worry about technological obsolescence: “That’s a great lecture you just put on tape, now we don’t need to pay you to give it anymore.” Or, perhaps more likely, “We can buy Nobel Prizewinner “X” on laser disk, so we don’t need you.” However, it seems clear that technology can’t replace the human factor in education. It can leverage faculty labor, but it can’t replace it. The faculty role will change from being mainly a content expert (“the professor’s job is to profess”) to a combination of content expert, learning process design expert, and process implementation manager. Faculty also will be motivators and mentors, interpreters (especially of non-codified knowledge), and, as a colleague recently put it, "expert learners"—people who lead the learning process by breaking trail and setting the right personal example. Technology can leverage faculty time, but it cannot replace most human contact without significant quality losses.

It seems clear that technology will shift higher education's expenditure mix and change faculty roles and responsibilities. But will technology actually reduce cost? The conventional wisdom inside the academy says "no," but a good many outsiders (especially those responsible for providing funds) are increasingly prone to say "yes."

The answer depends less on technology than on society's willingness to pay for educational quality. Bowen's Law states that "Universities (and colleges) will raise all the money they can and spend all the money they raise" (Bowen, 1980). Institutions that can pay for technology *and* sustain faculty-student ratios will surely do so. They will reap the quality-improvement rewards associated with having their cake and eating it too—of becoming *both* capital and labor intensive. Institutions where enrollment increases outstrip funding will sustain faculty numbers while serving more students at lower unit costs and, they hope, with undiminished or perhaps even enhanced quality. Institutions with static enrollments and fiscal constraint will have to reduce faculty numbers to make room in their budgets for technology and support staff. They won't like it, but competition will force them to do so. So the answer to the cost reduction question is, "It depends." Technology will improve productivity as measured by the quality of learning per unit expenditure, but whether the dividend is taken out as more quality at the same cost or lower cost for the same quality will depend on political and market choices.

Three Stages of Transformation

One cannot appreciate information technology's capacity for inducing change without parsing its effects on the teaching and learning process. Technology can be brought into the educational process in three ways.

1. *As productivity aids for individuals.* Such productivity aids allow teachers and learners do the kinds of things they now do—in addition to things yet to be invented—faster and more effectively. Examples include word processing, spreadsheets, graphing programs, and electronic mail. These tools should always be available and used as a matter of course, like telephones and pocket calculators.

2. *As enrichment add-ins.* Enrichment add-ins inject new materials into the teaching and learning mix without changing the basic mode of instruction. Examples include information acquisition on the Web, and the use of video, multimedia, and simulation to enhance classroom presentations and homework assignments.

3. *As stimulants and enablers of education process reengineering.* Reengineering starts by mapping the current process and evaluating it in terms of quality and cost goals. Then the reengineering team designs a new process which optimizes the available technology to better serve the client. The result is a mix of the old and new, each contributing what it can do best.

Education process reengineering means challenging tried and true pedagogical methods, many of which have been in place for decades or even centuries. (Recall how the electric motor eventually flattened the factory.) Examples include the lecture and laboratory, the course as the basic unit of instruction, the academic calendar, and in some cases the role of campus-based instruction itself. Higher education is ripe for reengineering because extant processes have been frozen for a long time, because student needs are changing, and because technology has opened important new possibilities.

Most information technology applications in higher education have been of the first two kinds. Enrichment add-ins improve educational quality, but they do not save either time or money. Productivity aids release faculty and student time for other tasks. Faculty time savings usually are reinvested in research—that is, they fuel the academic ratchet (Massy and Wilger, 1992). Student time savings enhance learning or leisure but they rarely reduce the time and tuition required for the degree. Hence the individual productivity aids do not save money; indeed, they usually add to the institution's cost base. No wonder, then, that so many pundits question whether information technology can ever save money.

A Reengineering Vision

Imagine how information technology might be used to leverage learning if the bars of convention were dropped. The following vision provides a reference point for the discussion that follows. It builds on Massy and Zemsky (1995), which in turn was inspired by the "studio model" described by Jack Wilson elsewhere in this volume. Our hypothetical example can go further than Wilson's real case because we are not constrained by the academic calendar or by the availability of facilities and equipment. We have not quite abandoned the course as unit of instruction—even though, in the fullness of time, all such constraints will have to be rethought.

Consider the teaching of microeconomics: first according to traditional methods, and then, after reengineering to optimize the use of human and technological resources. The traditional method usually involves a combination of lecture and discussion sessions on a fixed schedule, supplemented with reading and homework assignments. The reengineered method might employ a combination of lectures, interactive studio sessions using simulations and multimedia packages, and small-group discussions with faculty about meaning and relevance—discussions rich in personal interaction and mentoring as well as knowledge transmission—all on a flexible schedule geared to student needs.

Figure 1 (page 9) shows how the reengineered method might appear to students as they learn microeconomic theory and its practical applications, and to faculty as they carry out their teaching duties. We do not claim this scenario to be the best that can be achieved, or even that it would work exactly as described. But it does illustrate the kinds of qualitative benefits—for students and for faculty—that can be achieved through reengineering.

The scenario also illustrates the other important benefit from reengineering: it relaxes traditional constraints on the economics of the educational process. For example, faculty labor is applied at the times and in the circumstances needed rather than in fixed quanta defined inflexibly as courses per semester ("teaching loads"). Technology substitutes for some of what has traditionally been viewed as faculty work, but faculty labor is redeployed to tasks that professors can do best. Support staff and graduate student time may be used to a greater extent than in some kinds of institutions currently, but it is concentrated in areas where faculty do not have a comparative advantage—not in places where a professor's wisdom can confer important benefits, as in small-group discussion sections, for example.

The basic economic message is that reengineering breaks the widely perceived linkage between expenditure per student (or the student-faculty ratio) and educational quality. Massy and Zemsky (1995) offer a hypothetical example where total cost after reengineering, including the cost of technology, is equal to cost before reengineering even though educational quality has been improved. Scenarios where cost declines are possible (Jack Wilson provides a concrete example elsewhere in this volume), though even greater benefits can usually be obtained by increasing expenditures.

Implications for Productivity

The main impetus for embracing information technology will be to improve the quality of learning. The aforementioned reengineering vision called out some of the ways in which quality can be improved, and more complete accounts are provided by the other contributors to this volume. We shall now turn to a more detailed explanation of technology's implications for college and university productivity. The chapter concludes with a discussion of the quality of the faculty's work life in the post-handicraft era.

At root, the shift from traditional handicraft methods to more capital-intensive ones involves the embodiment of significant educational value in courseware. This requires up-front investments, but it frees faculty from having to recreate these value elements for each new student cohort. The ability to capitalize educational value elements produces three kinds of benefits: economies of scale and scope, more significant institu-

Figure 1: A Reengineered Course

"What is microeconomics and what is it good for?" These natural questions are addressed in a series of three or four lectures at the beginning of the learning process. The department recruits its most charismatic lecturer for this assignment and the professor gives her all in preparing and delivering the material. Because these lectures are designed to provide one-way communication, each is given only once—to the full group of students taking the course. Convening in a large group provides a sense of excitement, which the professor reinforces by using state-of-the-art multimedia to illustrate and punctuate important points—the students will remember these sessions many years later when much of the detail that comes later will have faded. The lectures also have become major events for the professor. They do not occur so frequently as to become routine; in fact, being chosen for this assignment becomes an important element of recognition by one's colleagues.

Next the student embarks on a series of interactive studio and individual exercises using simulation and multimedia applications (supplemented with the familiar textbook) to develop competence in the course's first content module. Take the economic model of supply and demand, for example. Active learning using simulations, data analysis, and multimedia yields a far better grasp of the content and power of this well-codified theory than could be gained in the conventional setting by passively viewing curves drawn by a professor at the blackboard. Moreover, the courseware's interactive character produces real-time diagnostics about student progress and difficulties as a byproduct of the learning process itself—diagnostics that can be used to design mitigations or control entry to the next learning stage. From the department's standpoint, the fact that much of the intellectual content is built into the materials enables more independent student work and more flexibility in staffing. For example, much of the work needed to bring students to proficiency with the courseware are handled by graduate students or support staff without any loss of effectiveness—perhaps with even greater effectiveness than would be delivered by busy faculty.

Once students have mastered the codified knowledge specified for a course module—say after one or two weeks of individual and studio effort—they move into small-group discussions with faculty about the non-codified dimensions. "What does the theory say at its deepest level? Why did it develop this way? What objections have been raised and are there competing world-views? How can these concepts help in one's career and life generally?" Because students move into the small-group sessions only after they have demonstrated a requisite degree of understanding, the time with the professor is not dominated by elemental questions. Professors will find their students better prepared and more able to engage. The conversations are more fresh and interesting than the typical lecture-discussion format, and they may actually require less faculty preparation than a formal lecture. But regardless of preparation time, these sessions take better advantage the faculty's unique skills than restating codified wisdom in class after class.

Students advance to the subsequent course module when they have completed the cycle for a given module. This may be gated on an individual basis, as when a student moves begins the next phase of technology-based independent work, or control may be through completion of the discussion sessions described in the previous paragraph. Either way, student progress will not be bound to a fixed syllabus determined by the average student's ability and motivation. Students needing more time will get it—and still pass the course providing they attain the requisite learning threshold in a reasonable period of time. Better students can move ahead quickly, thus enabling them to gain more education or, at their discretion, reduce the time and cost of attaining the degree.

tional learning curves, and better cost trajectories. I noted earlier that such benefits do not drive the unit cost of education—cost per student is determined by what society is willing to pay, not by the technology employed by educators. However, we shall see that technology can provide tangible economic benefits that will be harvested one way or another as improved educational value for money.

Economics of Scale and Scope

Handicraft production processes are not very scalable. That is, production of the n^{th} unit costs nearly as much as production of the first unit. In higher education, the cost of planning and organizing a course usually is small relative to the cost associated with contact hours, office hours, and student evaluation. Variable cost dominates. Even when students can be added to a section with empty seats (in which case the marginal contact cost is zero), the requirements for out-of-class teaching and evaluation grow proportionately. While individual faculty can achieve preparation economies by teaching multiple sections of the same course, teaching-load norms and intellectual fatigue limit the benefits.

Because institutions view unsponsored research as bundled with education, expenditures on faculty tend to increase in proportion to average cost during periods of enrollment expansion (Zemsky and Massy, 1995). Institutions try to maintain their student-faculty ratios when enrollments grow, even though they argue that faculty represent fixed costs when enrollments shrink. Maintaining the student-faculty ratio also protects teaching loads and class sizes. If the student-faculty ratio is forced upward, the result is, first, larger classes and then as a last resort, increased teaching loads (Massy and Wilger, 1995).

Information technology can shift higher education away from the handicraft tradition if it is used to trigger reengineering. In the reengineering example given earlier, more than the traditional amount of faculty time would be allocated to planning the course, selecting and perfecting the technology, training those who will assist in its delivery, and preparing the introductory lectures. These costs are mostly independent of the number of students. There also are fixed costs during the delivery phase, since the time needed to coordinate the course elements does not vary proportionately with enrollment. Because direct faculty-student contact is focused mainly on the small-group sessions and associated out-of-class contact, the overall variable cost per enrollment is lower than with traditional methods. Much of the fact transmission and evaluation burden is carried by the technology and by nonfaculty assistants who are paid less than faculty.

If the total cost for a given enrollment level is the same for the traditional and reengineered processes but fixed cost is greater, it follows that the variable cost will be lower using information technology. This means that the reengineered process will enjoy better economies of scale. Additional students can be enrolled with less-than-proportionate cost increases and undiminished quality. The iron linkage between faculty size and student numbers will have been broken. There can be no question that these changes will profoundly affect competition among higher education institutions.

Technology-driven reengineering also can provide economies of scope. Because faculty put more time into course planning and less into the routine aspects of pedagogical delivery, they should be able to adapt educational content and methods to new student groups and new settings more easily than is common with conventional teaching and learning methods. Self-pacing plus closer and more interactive contact with students in the small-group sessions should help as well. These scope economies may not result in cost savings, but they may be expected to improve educational quality for nontraditional and disadvantaged students. By freeing faculty from the routine drudgery of teaching, one allows them to direct more of their time and energy to adapting educational strategy to learner needs.

Exploitation of the Learning Curve

Not the least of the advantages conferred by improved focus is the opportunity to build cumulatively and institutionally on experience in pedagogy: in other words, to exploit the learning curve. By "learning curve" I mean the well-documented tendency for quality to improve and unit cost to decline with the cumulative number of units produced by a given organization. Traditional teaching methods limit such improvements for at least two reasons:

- Because most faculty spend relatively little time thinking about teaching methods (Massy and Wilger, 1995), they tend to repeat the traditional approaches again and again. Individuals get better with experience (for example, they become better lecturers or discussion leaders), but the scope of improvement is bounded by thetraditions of working alone and limiting the amount of time thinking about how to do better.

- Because faculty do not work together on teaching to any great extent (Massy, Wilger, and Colbeck, 1994), the experience gained by individuals rarely gets propagated across the department—let alone across the school or institution. Often technology-based enrichment add-ins, on which one professor may have labored mightily, get dropped or diluted when a new professor takes over the course.

Reengineered teaching and learning methods should mitigate some of these difficulties. More conscious effort in the course planning stage offers an opportunity to assess the work of others and see how it might be applied to current tasks. But perhaps even more important, the up-front commitment to use technology-based tools requires the course team to make choices: continue to use the existing tools or adopt new ones; develop materials in-house or use materials developed elsewhere.

Moreover, because subject-matter content and pedagogical strategy must be built into the courseware, and because the courseware will be updated from time to time, the materials available through outsourcing will themselves benefit from cumulative experience. The levels of investment required to build and market successful courseware will induce developers to do research to find out what works and then incorporate the results into their products. (The market will penalize those that fail to do so effectively.) New tools will become available regularly, and they will embody the experience of teachers and learners wherever situated. In other words, the tool developers—whether within or outside the institution—will be exploiting the experience curve. The experience of business school faculty in using materials from the Harvard Case Clearing House demonstrates the power of distributed continuous improvement. Because new materials are shared widely, quality-enhancing innovations flow naturally into courses as a consequence of local faculty choice.

Departments' ability to exploit the learning curve also can be enhanced by consciously adopting continuous quality improvement (CQI) principles along with technology as part of reengineering. These principles include focusing on customer needs, developing feedback systems to track performance and diagnose difficulties, and committing to proactive and continuous improvement efforts. By focusing greater attention on course planning and management, faculty ease the adoption of CQI. In fact, there is a natural synergy between CQI and exploiting the learning curve with technology.

Cost Trajectories

The widespread adoption of information technology almost guarantees an increase in the capital-labor ratio for instruction. Even if faculty size remains constant, increased expenditures on hardware, software, and communications will boost the ratio. In other words, spending on technology means that a smaller fraction of total expenditure will go for salaries and fringe benefits. This will reduce cost-rise pressures even if current expenditures are not reduced.

The "cost disease" argument (Baumol, et al., 1989) illustrates why the high labor ratios associated with handicraft production produce regular real cost increases. Consider the classical string quartet playing to a live audience. A thirty-minute piece requires two labor hours, the same is it did centuries ago. Improving "productivity" by playing faster or dropping the second violin (which some might consider redundant) would diminish quality—which is what many believe happens when college class sizes balloon. Yet the musicians' real wages will escalate due to productivity growth elsewhere in the economy. If musicians did not share in the fruits of such growth (to which they arguably have contributed by improving the quality of life), the supply of new entrants to the field could not be sustained. So the classical string quartet, like traditional education, is what Baumol and his colleagues call a "stagnant industry": doomed to become ever more expensive in real terms, all the more so as the economy advances.

Baumol argues that higher education, though a stagnant industry by his definition, can continue to prosper even as it becomes more expensive—by virtue of its value and because an advancing economy makes the cost increases affordable. However, trimming unit costs where possible remains important, and technology offers this possibility. By making its business and support processes more efficient, the string quartet might at least defer some real cost increases.

But technology may do much more than trim expense. For example, by recording its music, the string quartet can reach thousands at low incremental cost. The profits from recordings can cross-subsidize ticket prices for live concerts, thus providing access to many who otherwise would be unable to attend. As long as the real cost of recordings and associated playback equipment continues to drop, the string quartet can hardly be called "stagnant." As long as capital is a significant fraction of total cost, and the cost of technology falls in real terms, the quartet will enjoy steady productivity gains. Baumol might argue that, eventually, the cost of technology may fall so much that it becomes a negligible part of the quartet's expenditure mix—at which time the industry would once again be stagnant (Baumol and Blackman, 1983). Perhaps, but it would be operating at a lower cost base and its experience with innovation would alert it to the potential for future technological breakthroughs. Having broken away from handicraft methods, an industry is more likely to take advantages of future innovations when they occur.

We have already argued that one should not expect the adoption of technology to produce immediate cost savings in higher education. Because the old ways must be continued while innovation proceeds, cost may rise during technology's phased-in. Indeed, during the adoption period the university will pay double because it is *both* labor and capital intensive. But eventually the phase-in will end and the university will begin to reap the benefits of a larger capital-labor ratio. Price declines for the technology component of total cost will improve the institution's instructional cost trajectory.

Skeptics may argue that increases in the quality of technology will offset price reductions. For example, today's Pentium computers cost as much as yesterday's 486 machines, which in turn cost the same as their predecessor 386s. But the institution controls the level of technology it acquires, and today's offerings already are powerful enough for many purposes. Hence technology-driven reengineering can be expected to provide at least a partial cure for the cost disease.

Implications for the Quality of Faculty Work Life

Many faculty and staff fear that the advent of information technology will change their lives significantly, and not for the better. Certainly no one can claim that technology will not affect them. Doubtless many will have to learn new skills, and some will be better at this than others. Some institutions that operate comfortably in the present environment will fare less well in the new one (the increased competition made possible by technology virtually guarantees that there will be losers as well as gainers), and the discomfort will be shared by the school's employees. At the same time, however, one can project that the wired campus will confer certain benefits on those who work there—especially the faculty. Therefore, I will conclude my account of life on the wired campus by briefly describing some of these benefits.

First, teaching and learning processes that have been reengineered to take full advantage of information technology also will permit faculty to focus on their highest and best uses. By shifting many of the routine and repetitive aspects of teaching and student evaluation to the technology, faculty will be able to concentrate on the kinds of intellectual questions that represent their comparative advantage. Because the effective use of technology demands that teaching and learning be viewed in systems terms, the new paradigms will invite a more effective division of labor among faculty with respect to educational tasks. Finally, as suggested in the reengineering vision, the new processes may improve research performance by concentrating faculty discretionary time—by leveraging the faculty's work and getting away from the lockstep "*n*-times-per-week" routine of the conventional course structure.

The new methods also may encourage more faculty to focus on teaching. Relieving teachers of repetitive drudgery will contribute to this end, as will the ability to exploit comparative advantage and optimize the use of time. Moreover, the advent of technology will invite faculty to develop projects that map the knowledge base of their discipline to the new educational paradigm. Such work will be considerably more interesting that revising a lecture yet again. It can also generate reviewable outputs that, in the fullness of time, may compete with conventional publications in faculty portfolios and the faculty labor market. Finally, the ability to leverage student as well as faculty time will mean that faculty will be able to engage with more prepared and motivated students. This will boost the intrinsic rewards obtainable from teaching—which, after all, provide the dedicated teacher's most basic impetus.

Conclusion

Information technology allows institutions to improve the quality of the education they provide. As in the case of health-care providers, schools will be pressed to do all they can to exploit the new technology. Technology costs money, but whether its use will result in lower or higher unit cost will depend on how much society wants to pay for education and how many people will choose to access its benefits. Technology doesn't impose answers to these questions, but it does open important new alternatives. One should not blame technology if higher education's funders decide to exploit the technology by making tradeoffs among cost, quality, and access rather than simply adding the new costs to the existing budget base.

No matter what happens to unit cost in the short run, information technology will improve colleges' and universities' production processes and economic structure, and the quality of the faculty's work life. The advent of technology also provides a badly needed impetus for reengineering the teaching and learning process. It will allow institutions to break away from handicraft traditions and deepen their use of capital. Schools will improve effectiveness through outsourcing, better exploit the pedagogical learning curve, and mitigate the effects of the cost disease. Technology will shift the professor's role from that of mainly a content expert to a combination of content expert, designer, manager, and mentor. By reducing the repetitive and less interesting aspects of teaching and bringing better-prepared students to the classroom, it will make the faculty's work more rewarding.

Technology will not make obsolete the interaction between student and faculty in a campus setting. Certain important educational and human values cannot be as well promulgated asynchronously or at distance as they can face to face. Technology will reduce the percentage of face-to-face contact in the optimal pedagogical mix , but it will not come close to eliminating it. Cost considerations will limit or perhaps supplant direct contact in some circumstances, but one can expect that the best and the brightest students—regardless of economic status—will continue to enjoy the benefits of campus-based education. Face-to-face interaction will be leveraged, but the optimal educational process will contain many recognizable elements. The wired campus will look different but it will remain, in its essence, a campus.

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