Anyone who began reading this report with the expectation that simple prescriptions would be given for increasing productivity in higher education using information technology might be confused at this point, if not disappointed. Far from sketching an easy fix, we have reviewed a wide array of Internet and Web-based applications for education and training. And the applications are not just numerous; they differ along many dimensions:

- **Distance-learning systems** aim (at least primarily) to increase access to learning while reducing costs.

- **Cutting-edge applications**, such as intelligent tutoring systems and simulation-based trainers, increase the quality of learning but will not help institutions deal with shrinking budgets (at least in the short term).

- **Individual publishing** may be the best way to provide a new generation of learning materials that are responsive to consumer and business needs (although this approach is much newer and less certain than traditional publishing).

- **Online communities** might help in meeting many challenges in higher education (yet most seem to operate outside current institutional structures rather than within them).

- **External providers of training and educational services** are making some of the most innovative uses of the Internet (but it is rarely clear how higher education should use these models and whether to do so in new markets, such as contract training, or in more-traditional venues).
In this chapter, we first look at what really works in information technology as applied to education, an area that is complicated at best. We then offer specific recommendations about how higher education should think about the Internet and WWW in its future planning.

**REALITY CHECK: WHAT REALLY WORKS NOW AND WHAT WILL WORK IN THE FUTURE**

We have reviewed many applications of information technology and the Internet in higher education, and many look enticing. But before beginning what might be an extensive and costly reorganization to accommodate them in classrooms, universities would, naturally, like some assurance that these new tools can really deliver what they appear to promise.

How solid is the evidence that the various Internet and Web technologies can really address important goals and problems in higher education? Not very. Without question, some educational tools have been evaluated very carefully. (See Figure 2.1 for examples.) Many distance-learning programs in higher education, for example, have demonstrated that the cost of delivering courses can be reduced substantially while keeping student outcomes approximately constant. A few “augmented” distance-learning programs have also improved student learning. For instance, at Stanford University, students learning physics through Tutored Video Instruction (whereby students watch videotaped lectures, replaying them off-campus, using a small-group, cooperative-learning format) outperformed students who actually attended lectures. Similarly, at both high-school and college levels, some of the best intelligent-tutoring systems have fulfilled their goal of increasing the quality of student learning. Algebra, geometry, and computer-programming tutoring systems developed at Carnegie-Mellon University, to take one of the most well-known successes, can raise scores on exams up to one full letter grade. On a broader scale, meta-analyses—which aggregate results of many separate experimental studies—show a smaller, but still statistically significant, effect of computer-based education.
What Works in Business

In many ways, the data for corporate training are both simpler and more compelling than those for education. Most companies want to train employees to become competent in relatively well-defined skills (using word processors, spreadsheets, or more specialized tools and software, for instance). Improvements in proficiency in these skills can be easily measured. By the same token, it is easy to gauge how much is saved by delivering this training through video rather than using in-person instructors, as are the additional gains in flexibility and further cost reduction achieved by moving from conventional video to Web-based TV delivery systems. For many corporations, the results are impressive enough to justify investing billions of dollars each year in technology-based training.

But these clear successes of information technology in education and training are limited in many ways. First, as the examples from corporate training suggest, most of the solid evidence concerns a few very well-defined skills. Standard tests can reliably measure how accurately a spreadsheet is used, how fast an algebra problem is solved, and even how well a software routine is written. However, although these are valuable talents, they only scratch the surface of the kinds of abilities we want higher education, if not corporate training, to foster. Complex skills—some specific to particular subjects, and others more generic, such as collaborative problem solving—are difficult to measure; therefore, it is difficult to show that information technologies improve how they are learned. But then, for these skills, it is currently impossible to demonstrate that any method of instruction delivery, whether it exploits the Internet or not, leads to improved learning. If this limitation disproportionately affects tools for learning and teaching that make heavy use of information technology, such as the Internet or Web, it is because they are often strongly associated with curriculum reforms that advocate teaching new, probably valuable but certainly ill-defined, kinds of knowledge.

A more straightforward reason for the scarcity of data demonstrating the value of Internet-based learning is that these applications are very new. While earlier generations of distance learning have acquired a certain pedigree with time, distance-learning courses that rely on high-bandwidth networks are now at most a few years old—barely enough time to turn a raw course prototype into a production-
quality curriculum, let alone to collect a serious body of data showing how well students learn or how much schools might save.

These facts lead to a broader point. In general, the information-technology applications about which we know most are the ones that have been around the longest. Conversely, the newest Internet and Web applications have little evidence to prove, or disprove, their value for higher education. Unfortunately, these applications are the ones that, at least in theory and by logical argument, hold the most promise for confronting key challenges for higher education. So, anyone who insists on an airtight case before adopting a WWW technology will certainly be inclined to disregard, at least for now, some of the most cutting-edge ideas and applications. Digital libraries that amalgamate holdings across institutions, individual publishing ventures, cyberspace lecture halls, electronic communities of practice, and virtual universities—none of these can claim yet to be sure bets for higher education.

The question is how best to deal with this uncertainty. Plainly, an ultraconservative approach, one that accepts only proven technologies in higher education, is likely to be as irresponsible as a radical approach that embraces everything that looks appealing. In the latter case, costly errors may be committed; in the former case, valuable opportunities may be missed. In deliberating this choice, it may be instructive to reflect on lessons that businesses have learned, often painfully, in integrating information technologies into the workplace over the past 15 years.

To simplify only slightly, businesses generally have taken a very radical approach, early on adopting information technologies with relatively little forethought about which ones would best meet their needs or how they might change work practices. As a result, it has taken many years—and many billions of dollars—to demonstrate that significant productivity gains were attributable to information technology. But, finally, these gains have materialized, partly through a careful evaluation of technology options, partly because the structure of the workplace has transformed to make the best use of these new tools, and partly because productivity itself has been redefined.
What Higher Education Can Learn from Business

Higher education, now poised to take a similar plunge into information technology, can learn several lessons from these experiences. The first is that, eventually, the Internet and Web will probably live up to some of the promises offered by the examples we have reviewed. Second, it is likely that this success will materialize—slowly; that many applications that now appear to be most promising will not realize those promises; and, conversely, that some that will eventually succeed spectacularly are not even on the horizon today. Third, as we have suggested several times, many successful applications will require modest or substantial organizational change on the part of higher-education institutions.

One lesson we must not draw from business experiences, however, is that higher education should be willing to spend billions of dollars just to begin to see returns on investments in information technology. The resources required for such a radical strategy simply do not exist, even if traditional educational institutions had the stomach for such wild experimentation (a questionable assumption, to be sure). Nor, we argue, is this necessary. Having let business bear the brunt of being the earliest adopters, higher education can, we believe, take a less radical and less costly approach and still reap the gains. But a substantial commitment is still required (not an ultraconservative strategy), and careful planning is needed to avoid as many pitfalls as can reasonably be foreseen. The remainder of this report considers some of the pieces of such a strategy.

POLICY ISSUES BYPASSED AND THOSE DISCUSSED

Our discussion has raised, but has not resolved, dozens of important research questions and policy issues. Here we focus on just a few, selecting those that have received relatively little discussion in higher education and sidestepping a few that recently have benefited from in-depth analysis. For example, several studies outline new methods of learning and teaching afforded by information technology (more-authentic and project-based curricula, among others) and the changes in class organization, as well as teacher education, needed to realize these practices.
Instead of repeating these discussions in higher education (most educational technology research and policy work is at the K–12 level), we focus on several broader issues:

- Rather than sketch how a particular higher-education institution can increase its Internet capacity, we present an overview of the issues that confront higher education as a whole in acquiring the hardware and capacity needed to realize Web-based learning on a broad scale.

- Rather than advocate specific ideas for teacher education, we consider how universities (and schools of education) might broadly be reorganized, exploiting Internet technology to facilitate faculty learning and to encourage the creation of high-quality products for learning.

- And, rather than discuss the costs, benefits, and processes involved in realizing particular technologies (say, a virtual university), we outline the types of questions that need to be answered to select from among different technology models.

HOW WILL HIGHER EDUCATION ACQUIRE SUFFICIENT INTERNET INFRASTRUCTURE?

On the surface, possibly the greatest barrier to moving higher education onto the Internet and Web in a big way is technical feasibility. Many higher-education institutions are now developing and implementing plans for distance learning around technologies having much less functionality than the Web will shortly offer—for example, videotape sent through the mail, one-way TV (over cable channels) augmented with two-way audio (through telephones), or two-way video-conferencing using special-purpose hardware. To some of them, a proposal to use the Internet and Web for fully interactive, high-bandwidth, and multimedia courseware must look very premature. Perhaps, some will say, this is the Cadillac (if not the Mercedes) we all might be able to enjoy ten years from now, but we need to get started today—even if it means beginning with an Escort (if not a Yugo).

Is the idea of using the Internet and Web on a broad scale in higher education today very unrealistic? Is this functionality beyond the
admittedly modest, if not shrinking, pocketbooks of universities and colleges? It is true that many higher-education institutions have little Web presence at this time. California’s community colleges, for example, represent over 100 schools and serve more than 1.5 million students per year, but as of April 1997, some of the schools were not connected to the Internet at all.\(^1\) Of those that are wired, nearly one-half provide just brief electronic brochures advertising the campus and its mission. This is certainly a long way from the ample Internet capacity education institutions will need to support richly interactive course materials and electronic learning communities.

However, in one sense, this example is looking at the glass as half empty. Higher-education institutions, in general, are very well represented on the Internet, which is hardly surprising: For its first 25 years, the Internet was inhabited mainly by universities, nonprofits, and government agencies. True, colleges and smaller universities still lag behind, but the larger schools remain among the most extensive and most sophisticated users of Internet and Web resources—even today, as commercial sites rapidly take over cyberspace. Web sites such as GNA and Athena already show that higher education can manage mid-sized, if not yet large-scale, Internet enterprises. Put most positively, the Internet is probably the only form of information technology with which higher education has more than kept pace with the business world, both in its raw capacity and its skill in creating useful products. (On a given day, the average university classroom surely logs more Web-site hits than phone calls.) In one sense, then, to realize the many uses of the Web we have reviewed, higher education needs to preserve its position on the Internet more than it needs to gain new ground.

However, commercialization of the Internet and Web is sometimes viewed as jeopardizing that position and as a threat to the small academic community that used to be cyberspace. Much of this concern is well-founded; today, most of the early, free-wheeling, and unregulated “electronic frontier” is long gone. One of the specific complaints against commercial expansion of the Internet, however, is that it will steal capacity, soon filling the pipes with cybercasts of

\(^{1}\)See Web site http://www.cccco.edu/cccco/list/ccc-list.htm/ for a list of California Community College online locations.
Instant Baseball, for instance, and potentially crowding out quality educational material. Maybe so, in the short run, but over the long term, commercialization actually may benefit higher education in several ways.

To begin with, capacity shortfalls triggered by huge increases in demand for Internet services are being met quickly, as providers rapidly lay down new fiber-optic cable and devise clever ways of using old physical infrastructure (copper telephone wire, cable TV, and the broadcast spectrum) to meet new needs. All of this upgrading is being driven by the commercial sector, of course, but education can benefit too. Not only will this capacity expansion mean that educational material need not be crowded out; it actually suggests that education should have even more room in which to work than in the past, and better tools to make use of that capability.

One of the reasons skeptics view the Internet as an inadequate infrastructure for distance learning is that, even in its pre-commercial glory days, it did not supply the bandwidth needed to deliver rich instructional material, such as two-way video, in real-time. Today, for example, viewing short (and noninteractive) video clips using a 28.8K modem and a Web browser is a painfully slow experience—enough to make educators take refuge, again, in instructional TV. Commercialization of the Web will change this. A collection of new software and hardware products—from cable modems that provide hundreds of times the capacity of old phone lines, to digital wireless connections, to fractal compression algorithms that shrink movies so that they fit comfortably on old phone lines—will permit the Internet to carry interactive multimedia courseware, including video, from education servers to most homes (those that have cable TV or home computers, at least) and businesses.

At the same time that commercial interests have expanded the capacity of the Internet, new tools, along with economies of scale, are

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2Instant Baseball is an Internet site that uses a Java-animated ballfield to present, in virtual real-time, nearly every play in a major league baseball game. Instant Ballpark provides animation, lineups, the status of all current games, and personalized replay of any part of any game played during the current season. See http://www.instantsports.com/.
causing prices to drop dramatically. For example, video conferencing (in business as well as in educational settings) used to require special-purpose and costly hardware. Now it can be done equally well on the Internet, using ordinary PCs equipped with cameras (some machines come with cameras already built in) and running software tools such as CU-SeeMe. Although costs and features vary somewhat from site to site, Internet video conferencing probably costs, on average, about one-tenth the cost of special-purpose systems. (CU-SeeMe itself is free.) And this savings does not factor in the greater flexibility of Internet video conferencing: special-purpose video conferencing systems deliver instruction in only one way; networked PCs can be configured for video conferencing or for many of the other instructional models we have reviewed here.

**Issues and Policies for Acquiring Internet Infrastructure**

In short, then, far from threatening higher education’s position, commercialization of the Web is providing the tools and capacity needed to create and deliver interactive, multimedia courseware at very low prices. But knowing this is still a long way from saying how specific institutions should go about building their Web products, how they can be guaranteed the broadest and least-expensive Internet access, or how much it might cost to wire universities and colleges. Several recent studies have offered cost estimates for wiring primary and secondary schools on the information superhighway, describing the characteristics and prices of various connectivity models. We are not aware of comparable analyses at the post-secondary level, and it is beyond the scope of this report to offer one. However, we discuss a few broad issues and specific strategies that can help higher education keep Internet costs to a minimum while increasing access and functionality.

**Coordinated technology plans and purchases.** The simplest such strategy that higher-education institutions—actually, all educational...
institutions—should have is to change their model for technology acquisition. Today schools at all levels buy (piecemeal) hardware, infrastructure, software, and support services for computers and networking, usually through funding mechanisms that provide only small, yearly technology allocations and that rely heavily on intermittent donations from large foundations or corporations. Sometimes these windfalls enable institutions to build impressive technology-intensive centers through substantial one-time investments. But to put together broad technology infrastructures, higher education would do much better to plan technology purchases more systematically, as corporations do, and especially to coordinate acquisitions across a whole campus, institution, or even a system of schools.

Currently, telecommunication providers generally regard education as a collection of small, sporadic buyers of computing goods and services, rather than as large consumers whose purchases are driven by a well-designed technology plan. As always, big, organized buyers will get much more for their dollar than small, inconsistent ones. This is a pity, because education is actually a huge industry, but one that is handicapped because of its fragmentation. By coordinating purchases around a coherent vision, higher-education institutions would obtain much better prices; perhaps more important, they could command the kinds of personalized services that only major industries such as aerospace and entertainment now enjoy.

Exploiting a window of opportunity provided by the Telecommunications Act of 1996. As important as it is for higher education to develop long-term technology plans and form large-scale purchasing alliances in order to negotiate effectively for Internet infrastructure, taking less-direct policy actions may be even more crucial. State and federal debates are now setting the stage for regulations that will influence the quantity, quality, distribution, and cost of telecommunication infrastructure and services over the coming decades. New laws forged during these deliberations will certainly change the character of the Internet in many ways, potentially affecting educational applications just as profoundly as they do commercial applications.

The centerpiece of this legislation is the Telecommunications Act of 1996. With the act’s passage, many think the best window of opportunity for influencing policy so that it will benefit education is now gone. Not so. In fact, the act ignores several critical issues, delegates
some decisions, and defers yet others to later dates. A brief sampling of some of these still-open opportunities (Figure 6.1) shows that Internet capabilities available to higher education, and their costs,

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<th>Issue</th>
<th>Implications for Education</th>
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<td><strong>Universal Service.</strong> The act provides only broad guidelines for universal service. The real fights will take place at the state level, between the FCC and Public Utilities Commissions.</td>
<td>Local battles will decide what universal service means now, and how it evolves over time. Eventually, it could include Internet and broadband access for all. Now, it just covers phone service.</td>
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<td><strong>Consumer Protection.</strong> Federal and state regulatory agencies still must set rules governing competition in local phone (and often cable) markets. Long-distance companies are already fighting for a &quot;modem tax.&quot;</td>
<td>These local battles will have direct effects on consumers' choices and rates. They may also affect Internet costs, which are currently low and independent of distance. Long-distance phone companies are challenging this situation.</td>
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<td><strong>Intellectual Property.</strong> Decisions concerning intellectual-property rights were not addressed in the act. Congress is currently holding separate hearings on them.</td>
<td>At stake is whether current principles of fair use and public domain will apply to electronic communications. The current administration's White Paper would make even browsing copyrighted documents an infringement.</td>
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<td><strong>Spectrum Auctions.</strong> Spectrum decisions were initially part of the act, but were stricken at the last minute. At issue is whether networks will be granted spectrum for free, or whether it will be auctioned by the FCC (garning tens of billions of dollars).</td>
<td>If the spectrum is auctioned, proceeds could be reinvested, for example, to wire schools and fund educational services. Alternatively, if the spectrum is not auctioned, TV networks could be required to dedicate fixed amounts of bandwidth to education and training.</td>
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*Figure 6.1—What the Telecommunications Act of 1996 Doesn't Tell You*
could look very different, depending on the outcome of political fights still to come in Washington and state legislatures. In the best of all worlds, consumers would pay modest amounts to access courseware across the Web, regardless of distance, providers would have multiple paths along which to distribute their courseware, and both would be relatively free to use copyrighted material for learning purposes. In the worst of all worlds, consumers would pay substantial sums to access courseware at a distance, providers would enjoy few options for distributing materials, and the content produced and consumed would be severely limited by extremely tight intellectual-property laws.

Whether the world turns out closer to the best of all, or more like the worst of all, will depend, in part, on how effectively advocates argue higher education’s case over the next year or two. Based on history, prospects look bleak indeed. While publishers, cable, and telephone companies have powerful lobbies in Washington, education’s cause in the telecommunications-reform debates is being championed by only a few educational organizations and a handful in Congress.

When it comes to political advocacy, higher education is about as fragmented as it is in technology acquisition, and with similar results—or lack of results. However, if higher education could patch together its uncoordinated constituencies, it could achieve the size, and eventually the clout, of a powerful lobbying organization such as the American Association of Retired Persons. A group with even a fraction of that weight might help steer many ongoing telecommunications debates in favor of education. But to do so would require that different institutions unite behind a broad common vision of what they want to do in education and what technology tools are required to get the job done—to become, if necessary, a single-issue group that sends a consistent message about the telecommunications infrastructure it will need in the next century.

**How Will Individual Learners Access Internet-Based Education?**

Even if higher-education institutions can secure the infrastructure needed to supply generous amounts of richly interactive courseware across the Internet, only one-half of the problem is solved. The rest
will be accomplished when consumers—students of all ages—are able to interact comfortably and cheaply with these products. Many already can, of course. But, if education on the Internet is to be as readily available as education in the classroom, students of all ages will need almost universal access to online courseware. Today, this is not the case.

Assuming that cable TV, upgraded phone lines, or new wireless paths can bring the Internet to the door (admittedly a somewhat open question), students still need machines on which to display, process, and even create digital courseware. Right now, the only machine that does this is a personal (or bigger) computer, which, adequately equipped for Net surfing, costs little more than $1,000—about one-half what a comparable machine cost just three years ago. Roughly one-third of U.S. households have at least one PC; however, while this number is steadily growing, the fraction is not changing very rapidly, in part because PCs remain several times more expensive than other information appliances, such as TVs. This means that the next decade, at least, will see a gap of 50 percent or more between the goal of universal access and the percentage of homes that are likely to have PCs. Can this gap be completely closed, and at what cost?

Technology changes, ushered in by commercialization of the Internet, certainly will shrink the gap somewhat. PC prices will continue to drop, which, combined with increases in computer demand (in part to access Internet and Web products), will draw some consumers on board. But, the advent of dedicated Internet appliances (at perhaps $500 per unit), or possibly Web televisions (which, for much less than $1,000 allow passive TV watching as well as more-active Web browsing), is likely to more immediately increase Internet access. How much and how quickly it shrinks the universal-access gap is anyone’s guess. One generous conjecture might be that, within a decade, 75 percent of households will have some kind of

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4The percentage of households that have access to a PC, of course, will be higher than the percentage that own one; some might use computers at the office, or perhaps at public sites such as libraries. Using computer-access figures rather than numbers for computer ownership, therefore, will reduce somewhat the gaps we calculate, but not enough to change our argument significantly. Moreover, one might argue that a level of Internet access adequate for education would necessitate PC availability “anytime, anywhere,” which, generally, is best achieved at home.
Internet machine—about midway between the percentages of households with cable TV (65 percent) and with VCRs (85 percent).

Given a serious commitment to universal access, policy instruments, rather than technological devices, probably will be needed to cut further into the remaining 25 percent gap. The policies that are appropriate will depend on who makes up this remainder. Many ideas have been considered: Universities could supply machines for students (some already do); older computers might be recycled to low-income students; libraries and other community services could provide Internet access; manufacturers might consider pay terminals (analogous to pay telephones); and governments could use vouchers as well as other forms of cross-subsidy.

It is beyond the scope of this report to articulate policies in detail, or to outline whom they should target. (See Anderson, Bikson, et al., 1995, for relevant analyses.) Suffice it to say that students most in need of help will have relatively low incomes and low education levels. In short, many of those who would profit most by Internet appliances will be least able to afford them.

**HOW WILL HIGHER EDUCATION ACQUIRE QUALITY COURSEWARE AND EDUCATE FACULTY?**

If universities and students soon enjoy lavish Internet capacity, they still will need quality Web learning products that make good use of this capacity. To judge by current offerings, obtaining such products will take a long time. As any Net surfer knows, most Web sites offer little of value, and what useful educational products do exist are difficult to find, because they are usually “hidden” in isolated pages rather than combined into well-organized structures akin to textbook chapters or libraries. Moreover, the first generation of tools for creating Web documents was far from user-friendly: Faculty who built homepages needed to be skilled word processors, understand the rudiments of HTML (the current de facto standard for Web products), have access to tools that translate files among several different text and video formats, and even program in Java, in order to develop highly interactive educational products.

In spite of these challenges, there are several reasons for optimism. First, as we have seen, Web-based courseware is already beginning to
flourish, and sites such as the World Lecture Hall, GNA, and MOLI are adding several layers of organization to these individual products. In doing so, they are both facilitating access by students and making it easier for faculty to find and build new online courses. A related bonus is that courseware is becoming easier to construct, in part because much Web publishing is based on a nontraditional model for creating content: Instead of being created from scratch, new courses are often built from previous ones, using simple digital cut and paste—just one example of how the Web encourages rapid development by facilitating layering of products, one on another. Layering means that individual faculty will be able to build much courseware using just simple editing tools; not all will need to master the programming skills usually required to create courseware from scratch.

Driven by a rapidly evolving commercial market, software vendors are now coming up with a new generation of tools that will automate much of the construction of Web courseware, so that it is becoming easier to create courseware from scratch when necessary. In the past, constructing even the simplest Web homepage required at least a bit of HTML coding. Now faculty can use off-the-shelf tools to create many multimedia products with almost no direct programming. Some tools convert existing documents into Web-ready format (e.g., Sunrise Packaging’s rtftohtml); others build new homepages through dialogues with users (e.g., Microsoft’s FrontPage); still others provide high-level graphical interfaces, delegating the synthesis of low-level HTML code to underlying software (e.g., SoftQuad’s HoTMetaL PRO). Predictably, a few Web publishing wizards have put together sites that organize many of these diverse authoring resources, providing a valuable starting point for those interested in learning about them.

Finally, and perhaps most important, online information sources and support communities abound. They will help even the least-Web-savvy faculty member develop the necessary Web and Internet skills. These sources take several forms, ranging from simple FAQs (lists of frequently asked questions, plus answers), to detailed hypertext documents on the art of HTML programming, to newsgroups and listservs that engage in active discussions on how to provide Web services. All these are free. For a fee, any of hundreds of start-up companies that now offer Web product-development support will
gladly design and implement Internet sites of any size, or will assist institutions or individual faculty in doing so.5

Issues and Policies for Acquiring Quality Courseware and Educating Faculty

Even if all these tools and supports help faculty become comfortable creating and teaching Web-based distance-learning courses, higher-education institutions will probably need to consider several kinds of changes and policies to smooth what might be a substantial transformation for many teachers. An obvious first step might be to offer courses that give faculty hands-on training with Web publishing technologies and, more broadly, that demonstrate examples of good Web courseware and principles for creating useful educational products on the Internet. But who will provide such teacher training services? We suggest several possibilities below.

Who will teach the teachers? It is natural to expect that schools of education would continue to play a pivotal role here. Certainly they will need to revamp many programs to help faculty acquire new teaching skills that are better suited to technology-intensive classrooms—classrooms that will be less dominated by lecture and more driven by collaborative projects or online mentoring. But to delegate all training on Web publishing, as well as on new teaching practices, to schools of education might risk duplicating services unnecessarily since, as we just noted, online communities are already poised to do much of the job and offer yet another example of new electronic communities that crisscross the boundaries of traditional higher-education institutions. Higher education must find strategies for coordinating with such communities, if only because much of the literature and training they offer is good—and free.

Although courses and electronic communities might help faculty acquire skills in Web-based courseware development, one big question

5We do not discuss these providers in detail, in part because we assume higher education, unlike many other businesses, cannot afford to outsource such services. However, partnerships might be feasible if (as with Internet infrastructure) universities would coordinate their fragmented constituents, in effect becoming a large consumer that could command first-rate Web development services for cut-rate prices.
remains: Where will the time to acquire the skills and the money to pay for everything come from? We suggest that skills can be acquired at roughly current levels of funding, provided faculty can reallocate the time they devote to their various teaching activities. As we have noted, information technology is slowly beginning to displace some of the traditional teaching roles of faculty; students will spend more time working with smart software or watching digital lectures and less time listening to live discourses. This shift might tempt some schools to cut staff and thus reduce costs, but an alternative would be for faculty to be retained and to use their newly freed-up time to play other roles.

One role that may expand is intensive coaching, to help students learn when even rich interactive software is not enough. Or, faculty could spend more time creating courseware. Thus, one way to acquire better-quality online courseware, and to educate faculty to create and use it effectively, is simply to recommend that faculty be given more time and resources to engage in these activities. If the transition from lecture-intensive curricula to Web-based courseware is managed reasonably, this added course-development time may come at little or no increased cost to higher-education institutions. In effect, the outlay should come out of savings in direct teaching costs. (Over the long term, of course, it may also be more productive to hire new faculty whose strongest teaching skills are in courseware development rather than in lecture delivery. But that is a different policy decision.)

**Nourishing grassroots publication.** Higher-education institutions can also encourage the development of higher-quality Web courseware through tactics that help foster and manage the grassroots, or individual, publishing that is taking shape in online communities such as the World Lecture Hall. Universities and colleges could follow GNA’s lead and provide a common infrastructure for online courses. The fact that many contributions in these databases already come from higher-education institutions suggests that, even today, universities have much courseware to be organized. Perhaps they would do even better to copy proprietary institutions, e.g., MOLI, which supply such value-added services as establishing areas and goals for new courseware, offering technical assistance to courseware developers, and furnishing quality-control standards.
Setting standards for courseware format will probably be as important in the long run as setting content standards. If faculty develop materials in diverse formats that do not interoperate, the advantages of creating new courseware using simple cut-and-paste tools diminish greatly. Lecture overheads rendered in PowerPoint, for example, do not mix easily with Adobe Photoshop representations. On the other hand, if universities encourage faculty to build online courses that adhere to emerging Web-document standards, they will be inviting the sharing of course products. One of the great strengths of the early Internet, veterans will say, is that intellectual products—software and ideas alike—were shared freely. The past was never really quite so grand, but it is true that the tradition of "freeware," "shareware," and "open systems" has been strong on the Internet, and it will probably continue to be essential, in some form, if individual publishing in higher education is to prosper.

This culture of sharing faces several threats, and higher education should keep them in mind, if not actively work to keep them in check. One, discussed in Chapter Three of this report, concerns copyright and, more generally, intellectual-property rights. Legislation now being drafted in Washington may cripple almost any sharing of materials copyrighted to publishing firms. However, individual faculty publishers (or their institutions) also should have protection for their intellectual products. Many professors (and some universities) already make substantial sums selling courseware (usually as books, but increasingly in educational software). As with big publishers, they too may be reluctant to share their materials without being compensated. As always, the challenge is to strike a balance that rewards innovation enough to keep new ideas (here, courseware) flowing while also maximizing the social benefits of those new ideas (here, the sharing and use of courseware).

Individual faculty, their institutions, and higher education as a sector have yet to work out clear policies that define a feasible balance point. These decisions are tough enough when restricted to a single college or university but take on added complexity when courseware is shared across institutions or even states, not just within them. Virtual universities, such as the World Lecture Hall and MOLI, will catalog courseware from any publisher that meets their standards (standards are nonexistent in the World Lecture Hall), regardless of location. In so doing, they recognize that one of the most powerful
features of the Internet is that it encourages the free flow of ideas and course materials to any place in the country (and around the world)—an idea that most states and public universities have yet to come to terms with.

Such free flow is perhaps the biggest issue higher-education institutions will have to face in the near future. State and academy barriers are much tougher to defend against “invading” software than national barriers are to defend against, say, illegal aliens. Laws will need to be rewritten to reflect the fact that courseware that might be in college online catalogs will probably be derived from, or even wholesale copies made from, products found in other university databases. Nor should such sharing be viewed as simply bowing to the inexorable forces of network technologies that make editing and transmitting digital materials virtually effortless. If managed properly—for example, through careful quality controls and well-organized cataloguing services—the net effect of promoting such sharing can be a dramatic gain in the quality of Web-based courseware.

One cost of this freedom, of course, will be that the boundaries between different institutions may begin to blur, at least when it comes to course offerings, if not social functions and research reputations. (However, in some disciplines, inter-institution research collaboration is also increasing.) Such blurring suggests that, in the future, some universities might be more brokers of education, reminiscent of MOLI and GNA, than full-service providers.

Should all universities have course development as a central part of their educational mission? Answering this question goes well beyond understanding how higher-education institutions can help foster high-quality courseware on the Web; it touches on the deeper issues of new models of educational delivery that information technologies enable. In the next section, we briefly offer some answers.

**HOW WILL HIGHER EDUCATION MAKE CHOICES ABOUT NEW DELIVERY MODELS FOR EDUCATION?**

The preceding two sections address broad issues of feasibility and capacity, but not how such capabilities will be put to work. Assuming higher education has the financial, physical, and human
resources necessary to use the Web and Internet, what structures or models should it adopt for delivering educational services?

**No More One-Stop Shopping?**

The dominant model of delivery in higher education is still one-stop shopping: A single provider offers all educational services (including course creation, course delivery, counseling, student evaluation and accreditation, deciding which course collections will lead to degrees, and, often, support for job placement) at a single location. (Consumers are expected to come to the provider, not the converse.) But this model may be challenged for dominance. New information technologies add substantially to the set of models that providers can consider. Many of the case studies we have reviewed demonstrate that some of these different delivery structures already have moved from the drawing board into practice. Broadly, these models unbundle educational services and repackage them in different ways. Some highly specialized providers offer only a few courses rather than large sequenced collections, some broker courses rather than creating them, and others create and deliver courses, but in partnership with several providers rather than solo.

While mass education, including primary and secondary schools, vocational and training institutions, and colleges and universities may be the most common formal method of learning, many of us remember taking piano or dance lessons from highly specialized providers. Although marginal in this country, intensive apprenticeships have persisted as powerful learning methods for centuries—so much so that many hope that information technologies soon will make cognitive apprenticeships feasible on a large scale. (See Figure 2.9.) And new information technologies are not the only reason different models of education delivery are beginning to flourish. Growing markets for adult-learning services require changes in traditional delivery models; consumers of on-the-job training, for example, insist on courses that are highly tailored to specific needs, rapidly changeable, and delivered at the workplace, not in the classroom.

New information technologies are supplying most of the raw materials from which delivery models that meet these demands can be fashioned. In the past, regardless of demand, it was prohibitively ex-
pensive to consider, say, creating courses for a widely scattered and relatively small group of consumers. Now distance matters little in the economics of such services. And whereas, once, only the largest corporate-training clients could expect house calls from education providers, today size counts for much less, because on-site education can be done mainly through high-bandwidth network virtual visits. Time is also less of a factor: House calls from education providers never came on demand; now educational courseware can be accessed across the Web 24 hours a day.

Processes and Products That Specialize

The idea that information technologies can (and should) radically transform processes and products seems routine in discussions of manufacturing and service industries, but the idea that the Internet might help reduce costs of courses or improve the quality of students’ learning still draws doubts from thoughtful pundits such as Larry Cuban (1986), Neil Postman (1995), and Clifford Stoll (1995). But no one questions that the same tools help produce lower-priced, higher-quality cars. The view that technologies could help speed the creation of courses or help build courses tailored to specific learners seems original and offbeat, yet just-in-time manufacturing is familiar to anyone with even a passing knowledge of business. And while the idea that a monolithic education institution might be unbundled into a collection of services may sound altogether foreign, it is the industry conglomerate that sometimes looks out-of-touch with modern views that businesses often do much better by specializing, and perhaps partnering with others to develop products.

Questions in the Range of Alternative Education-Delivery Models

One way to encourage discussion of the different models of education delivery enabled by new information technologies such as the Internet and Web might be to try to systematically attempt to characterize the vast range, or space, of alternatives. However, doing so would probably be as cumbersome as trying to describe all the ways that businesses could restructure using new technologies. Instead, we limit ourselves to posing a series of questions—most stemming from the different applications of the Web and Internet we have re-
viewed—that summarize a wide range of ways the structure of educational services is changing to make effective use of new information technologies. We deliberately pose the questions as challenges to facets of the familiar one-stop-shopping model, not necessarily because that model is flawed, but because points in the “space” of alternatives nearby familiar models are likely to be explored, while more distant ones may go unnoticed. The list is by no means complete. We intend it as a spur to discussions of these unusual, and sometimes useful, alternatives.

**Knowledge chunks: Why are courses so long?** Courses in higher education usually extend across many weeks. Quarters and semesters vary in size across institutions, but not radically. And within institutions, there is little variation at all. Courses offered to corporations by external providers, on the other hand, often last no longer than a few hours and are driven by the needs of the client and requirements of the material, rather than by the conventions of the providers. One-size-fits-all courses certainly make bookkeeping easier for degree-granting institutions and probably are impossible to circumvent if classes must meet at scheduled times and places. But if students learn mainly at a distance, can choose to start a course when they wish, and can access courseware anyplace, anytime, perhaps courses of variable length, tailored to the needs of the subject (and, of course, to the needs and learning style of the student) are feasible.

**Course flexibility: Why offer only a few courses per subject? Why not add to course listings in an ongoing fashion?** Most universities and colleges change their course offerings slowly compared with MOLI and GNA. On the surface, increasing speed of course creation and the diversity of courseware could only help consumers, assuming value-added counseling services were available to help them select the products that best match their current level of expertise, educational goals, and learning styles. Tools that permit faculty to rapidly create new Web products certainly will help expand the range of courseware a university offers. However, MOLI and GNA enjoy even more flexibility, because they invite outside developers to develop online materials. Whether or not institutions can offer a large pool of courses, therefore, will probably depend on changes to other structural features, some of which are noted below.
**Why limit class enrollment?**  Most university courses place caps on the number of students they will admit, and on the size of individual classes. In prestigious institutions, this often means that demand outstrips supply in ways that more market-driven service industries never see. Recent experiments at the City University of New York and long-term successes at the Open University indicate that distance-learning technologies can open up enrollment while keeping costs under control and quality reasonably high. As demand for quality adult education continues to grow, various models of “partially open” enrollment might be worth considering. A school might, for example, allow anyone to take a distance-learning course on the Web for a nominal fee, subject to the constraint that he or she access only online resources (such as lecture materials and electronic quizzes seen in courses on the World Lecture Hall). Students could also pay additional fees for more labor-intensive services, such as online tutoring and proctored exams.

**Why should faculty spend more time directly delivering information rather than engaging in other functions, especially courseware development?**  If open or partially open enrollments become more common, the direct involvement of faculty in delivering education (e.g., through live lecture) probably will diminish, since more and more students will access recorded and interactive materials online, rather than attending classes. At the same time, other teaching functions, in particular the creation of courseware that is accessed at a distance, will become increasingly important. Models that emphasize content development over delivery will probably also change hiring practices; new faculty may need to be as skilled at multimedia publication as they are at playing “sage on the stage.”

**Why should universities develop courseware?  Why not concentrate more on value-added management and brokering services?**  Perhaps some universities could do away with courseware development as well as with direct course delivery. The World Lecture Hall and the Global Network Academy suggest models of educational services in which the functions traditionally bundled together as one-stop shopping are now separated. Institutions that specialize in organizing courseware developed by others could offer several advantages to consumers: warehousing of many courses on a single subject, giving consumers a wide range of choices; offering only the best courseware, from superstar faculty, as does The Teaching Company
(Figure 2.10); or concentrating on other important value-added services, as does the Western Governors University (http://wga-internet.westgov.org/smart/vu/vu.html). Western Governors University is not planning to develop or deliver courseware, but will conduct needs assessments to determine areas in which course offerings are insufficient, provide quality-assurance and quality-assessment tools to measure student learning (and course efficacy), and establish requirements for degrees and other credentials, as well as supplying centralized services, including libraries and repositories of student records. More broadly, in such models, higher-education institutions would supply high-level management, resources, and vision; many of the specific tasks would be done by specialized providers.

**Why not pool common information resources, such as libraries?** Some new-models universities might unbundle services and specialize in a few key functions. However, alternative models might bundle pieces that are typically separate. For example, pooling courseware across institutions would give consumers greater freedom of choice. By the same token, it makes good sense to aggregate electronic libraries across institutions: Students lose nothing if a virtual library is “moved” off-campus and will gain access to richer collections if their library is merged with other holdings. These are just two examples of educational models that try to exploit some potential benefits of the free flow of information across institution, state, or even national boundaries.

**Why not partner with for-profits as well as with other nonprofit and public providers?** If higher-education institutions explore delivery models that unbundle services, they will also need to consider various alternatives for partnering with other providers—institutions that provide those services that they themselves have decided to delegate, and with whom they will need to coordinate if they still wish to offer full-service education. In particular, given that the for-profit sector (mainly high-tech corporate training) is expanding much more rapidly than is traditional higher education, various heterogeneous models that include a mix of public and private institutions will need to be considered.

Today, this country spends about as much on for-profit educational services as on public education; shortly, corporate training alone will
exceed higher education in size. Thus, if higher education remains separate from these other participants in the adult-learning market, its presence will continue to diminish.