Quinn describes today’s explosion of technology and knowledge, plus the accompanying revolutions in economics, business, education, and learning. He believes that education will be profoundly different in the new knowledge-based economy, where intellect and innovation — not capital or products — are the preeminent economic drivers. Higher education’s traditional role as the leading research source and knowledge creator has already been overturned, largely due to the possibilities the Internet presents for such endeavors. Quinn urges campus leaders to recognize the new higher education structure and to develop strategies as to how they can best move their institutions forward within it.
Powerful economic, technical, and social trends facilitated by the Internet are revolutionizing all traditional concepts of economics, business, education, and learning. Their effects on higher education are especially profound. The word “education” — in the formalistic, programmatic fashion we usually think about it — may even be obsolete. Knowledge is deepening and broadening so rapidly that formal programs cannot hope to keep up with it. Over 90 percent of the relevant literature in many technical fields, such as biotechnology, astronomy, computers and software, and environmental sciences, has been produced since 1985. Daily, terabytes of information are entering the GenBank, environmental and space databases. And two billion new minds connecting to advanced countries’ marketplaces between 1995 and 2010 are rapidly adding more new insights and discoveries.¹ Traditional programmatic approaches to education simply cannot keep up with the outpouring.

The Innovation Cycle in Services Education

How will education respond to this explosion and the Internet technologies that support it? It is likely to go through the five-step sequence all other services did when confronted with major new technologies.²

1. New economies of scale created by the technologies caused consolidation of key activities into larger institutions.
2. New economies of scope developed as these institutions reduced the cost of the technologies, made them more flexible, and used common capabilities to serve multiple (formerly discrete) market niches.
3. *Increased complexity* was handled by the new technologies at significantly lower costs.

4. *Totally new service concepts* and alliances emerged as new customer sets interacted with the technologies and activated new sets of innovator-entrepreneurs.

5. *Disintermediation and redecentralization* occurred as the technologies became powerful enough to support sophisticated localized interaction and use with the benefit of more personal contact.

Virtually all service industries followed this sequence. As large banks, retail stores, and financial houses automated their back offices, they lowered costs and drove out or consolidated smaller competitors. If their systems were properly designed, they could mix and match elements of their large knowledge bases to create and target their services more precisely for customers. They could then reach out directly to customers (through ATMs, local broker affiliates, mail, or telecom connections) to provide much more powerful and accessible local services. Hospitals, wholesalers, accounting firms, and even airlines also went through similar cycles. Education is now following suit.

**Delivering Education**

In delivering educational products, universities have already used Internet economies of scale to provide online lectures to wider audiences, virtual courses for the public, and tailored lecture and interactive courses for industry. As more individual lecture and course segments are captured electronically, they are easily tailored into specially timed and sequenced packages for individual audiences, providing further economies of scope. More complex topics can be explained
more clearly and fully with superb graphic, interactive, or game effects to heighten interest and learning. As the recipients become more sophisticated, totally new services — such as strategy, design, or individualized model building — are added on for specific customers. Satellite locations for the great universities and their teaching hospitals have become common, and a very high percentage of all advanced skill and factual update education is done online (without intermediaries), at the workplace, or in the home, which in some cases may be the workplace.

In content terms, many concepts (and precepts) about scientific phenomena, technology, economic activity, social interactions, personal development, and enterprise management are undergoing repeated and more frequent revolutions, not just evolutions, at all levels. Neither students nor universities can afford the costs entailed in presenting and taking formal classroom programs. Because of my background, I will focus on scientific-technical and business-economic education rather than social, humanistic, and artistic education, although there is a strong relationship between the two. Techno-economic forces largely drive society’s needs, knowledge capabilities, and capacity to support education and the arts. Both users (students) and producers (faculty) tend to migrate toward new opportunities, driving new educational program and investment patterns toward these frontiers.

**New Economic Drivers: Frequent Revolutions**

The most important economic trends affecting education are the following:

- The shift from a “materials” to a “services and knowledge” based economy.
SERVICES AND TECHNOLOGY

- The resulting disaggregation and globalization of technology, economic activity, and hence educational needs, in all fields.
- The preeminence of intellect, innovation, technology, and software, not capital or products, as economic drivers.
- The explosion of knowledge generation, innovation, and technological progress rates dynamically and constantly renders obsolete the knowledge constructs, physical plants, and government structures.
- The need for new educational, economic, social control, knowledge and wealth distribution, and environmental improvement concepts to support long-term growth.

FROM A MATERIALS TO A KNOWLEDGE- AND SERVICE-BASED ECONOMY

As late as 1980, when the National Academies of Science and Engineering sponsored a program on the interactions among science, technology, and economics, there was essentially no literature interrelating technology, services, and economic growth. Now about 80 percent of U.S. employment is in the services industries, and another 12 percent of total employment is in service activities (such as research, development, design, engineering, accounting, marketing, logistics, and personnel) within product-based companies. The most important elements of both are knowledge-based service activities (see the definitions below). The mobility, disaggregating capabilities, and advanced knowledge needs of such services are revolutionizing educational demands and structures worldwide.

Educational and policy awareness of these needs has not matched reality in large part because national economic models, government data collection, national policy, media re-
ports, and public attitudes still reflect the myth that wealth depends on material goods. Services data are notoriously misleading (because of general understatement) in

1. capturing the impacts of quality and flexibility improvements,
2. measuring units of services output,
3. implicitly transferring services productivity improvements to other sectors,
4. measuring the value of knowledge- or service-based assets, and
5. not reflecting the value (or the alternative cost of not having) software or services activities within product based companies.9

Most serious is ignoring the international and multiplier effects that services like telecommunications, education, healthcare, or public services (police, legal, or environmental activities) produce for other industries and the productivity and well-being of the society. Many studies have shown national returns on these investments (although now largely unmeasured) to be well in excess of those for industrial investments.10

In higher education circles, little has been done to shift traditional attitudes. Until the recent run-up in dotcom stock prices, few business schools had significantly adjusted their curricula to reflect either service activities or the software management needs of a service society. The prestigious National Academies of Sciences and Engineering are notoriously underrepresented (and hence less supportive of research) in the services field. Despite the facts that

1. over 80 percent of all business billionaires,
2. the highest paying jobs (entertainment, law, medicine,
services jobs are still strangely derided in popular rhetoric as “hamburger flipping” or “taking in each other’s laundry.” Because of U.S. Congressional committee structures, there is little federal support for services research other than in health and aerospace. Consequently, concepts, social attitudes, knowledge, and skills involved in developing and delivering better services or intangible outputs are under-emphasized in most university research programs and curricula. In addition, despite services’ huge scale, there are as yet no parallels in services to the land grant (A&M) universities and programs that enabled and supported the growth of the key industries of the late 1800s and 1900s.

In business and economic curricula, the implications of the vague definitions and limitations of economic measurement systems need to be repeated until they are understood or corrected. It is surprising how few, otherwise quite sophisticated, executives and analysts understand these limitations and their effects on policy. Improvement metrics itself should be a major area for university research. Interestingly, the improvements themselves are likely to rely on enhanced IT databases. Much independent university research will be needed on the newly emerging measurement, legal, and ethical problems generated by the Internet and new technologies. Ranked high among these must be international wealth distribution, public versus private wealth, and environmental economics trade-offs. Although long underemphasized, with new and better data from the Net, more complete theories integrating these three elements will doubtless emerge. For example, economics now considers environmental improvement as an ex-
ternality (which it clearly is not in a systems sense) or a cost (by definition to be minimized), rather than as a job-, profit-, and value-creating market to be optimized along with other market opportunities. The results have been misunderstanding, antagonism, higher than necessary costs, poor policy, and lost job and profit opportunities.\textsuperscript{11} Large opportunities exist for improvement in university research, theories, and curriculum rebalance in these subjects.

\textbf{University Implications of the Societal Shift}

The role of the university in the knowledge- and service-based society is, must, and will be changing rapidly. Because of Internet capabilities, the university’s traditional role as the leading

- research source and knowledge creator,
- archivist and gateway to knowledge,
- disseminator of advanced knowledge, and
- referee and evaluator of truth

has already been overturned. Universities perform only 2.2 percent of all U.S. research and development.\textsuperscript{12} The vast majority of communications, software, advanced computer, food and agriculture, chemical, aerospace, energy and materials R&D is performed in industry, government labs, or consortia. In “management,” business practice almost always precedes academic experiments, techniques, and knowledge insight. Further, since university libraries are only one of many possible nodes on the Net — and access is so much easier — researchers now tend to go to the original sources for their data. New concepts are exchanged directly across the Net among scientists, industry users and suppliers, and the public.
Already, the public directly accesses .com or .org information sources far more than .edu information sources. Internally, the university libraries’ roles are rapidly shifting from keepers of collections to accessors and guides to electronic sources. Publication in the learned journals occurs months behind dissemination on the Net. Most new inventions are introduced and in wide use long before publication, with the possible exceptions of those that need international patent protection. Even the university’s role as truth referee is changing as actual use, online critiques, and rapid electronic tests and exchange of experiments replace university referees. Both the National Science Foundation and National Institutes of Health have established Web sites for open reviews of current scientific works similar to that of Barnes&Noble.com and Amazon.com for reviews of current books. The problem remains how to evaluate the reviewer’s own remarks and knowledge base.

DISSAGGREGATION AND GLOBALIZATION

The most critical impact of the services economy on education lies in its disaggregation and internationalization of economic activities. As the service sector has grown, individual specialized service firms have become very large and sophisticated relative to the scale and expertise individual staff and service groups can have within integrated companies, whether in services or manufacturing. Independent service providers, often much larger and more sophisticated than internal staff groups, can offer greater knowledge depth, invest more in software and training systems, be more efficient, and hence offer higher wages and attract more highly trained people than can the individual staff groups of all but a few integrated companies.
As monitoring and managing techniques to oversee resources have improved, companies are effectively outsourcing an ever-wider range of more strategic activities. Outsourcing has progressively moved from simple parts, subassemblies, and menial tasks toward more sophisticated knowledge specialties (such as software development or compensation system design), entire business processes (energy or risk management), and finally to innovation.\textsuperscript{13} To realize maximum benefits, companies have moved steadily toward core-competency-with-outsourcing strategies. If a company is not “best-in-world” at an activity in its staff services or value chain (including transaction costs), it gives up gross margin and competitive edge by producing that activity internally. Profitability in many industries correlates highly with the degree of outsourcing.\textsuperscript{14} This fact increasingly lies at the heart of the large-scale outsourcing, as well as of the organizational, geographic, and international disaggregation, that we see today.\textsuperscript{15} The scale is impressive. General Motors and Daimler Chrysler alone recently combined to form a coordinated information base to handle their $490 billion annual outsourced purchases, as well as to assist their suppliers in other large outsourced markets. Entirely new questions about intellectual property and antitrust laws are raised daily.

\textbf{Self-Amplifying “Puddles” of Knowledge Value}

One can already see the much-touted knowledge economy’s structures (companies, national economies, and world competition) disaggregating into “puddles” (centers) of highly specialized knowledge interconnected by invisible communication networks and alliance agreements. Each knowledge center develops its own skills in depth around its core competencies and broadcasts its needs and capabilities to the oth-
ers, combining with them to solve specific problems as required. (See Figure 1.)

Governance is through mutual need, common interest, and intellectual respect, rather than ownership or formal authority links. The keys to success in these systems are “T-shaped skills” (best-in-world knowledge depth in one’s selected competencies, but a capacity to appreciate, understand, and relate to other fields). These skills are distinctly not a strength of universities’ past rigid adherence to discipline-based departments and specialist journals.

“Cluster development” of needed supplier groups around highly outsourced industries has also become an accepted methodology for stimulating education and economic growth, regionally and in foreign countries. Partnering companies have a positive interest in developing the higher skills they need locally as well as in improving local health and communications infrastructures. In less developed countries such interests may be the only way the country can participate in
very advanced technologies, with computer and Internet technologies allowing less formally educated people to participate in world-class processes. Outsourcing across national borders also provides a critically needed demand for highly educated people in host countries, without which advanced education systems there may founder and the few trained people quickly emigrate to advanced countries. Outsourcing also generates reliable flows of funds, income, needs and technology transfers, and an expanded interest in those countries’ economic progress. The Internet provides the primary low-cost methodology by which individuals, enterprises, educational institutions, and businesses in developing countries can now connect and interact directly with, and educate their people to participate in, the most advanced economies in the world. Interestingly, it is also allowing single mothers (the most disadvantaged subgroup in the U.S.) to hold jobs, upgrade their skills, and work their way out of poverty.

University Implications of Disaggregation

Worldwide disaggregation depends heavily on software and the Internet as its coordinating and disciplinary forces. As multiple foreign suppliers and markets become ever more intimately connected with each other’s systems, computer languages are becoming the lingua franca of commerce. In various studies, many paraphrased the view that “We do not have to understand other parties’ spoken language to communicate. All we have to see is their computer models, simulations, or formulas [as one might do in trying to communicate with extraterrestrials] in order to understand what they are saying.”

In fact, computer language is much more precise in many respects. Software forces communicators to convert vague
terms like “larger,” “rounder,” and “redder” into measurable dimensions. In time, translation programs will also make foreign-language knowledge sources as transparent as domestic ones and written verbal exchanges (including differences in international legal meanings) much more precise. Genuine computer language and network literacy will become essentials for any advanced degree. Truly educated persons will have developed T-shaped skills with sufficient knowledge depth in specific areas to

1. contribute knowledge advance,
2. innovate totally new concepts, and
3. trade for knowledge from others.

They will also be able to contact, empathize with, and understand other disciplines (the horizontal part of the T) to tap other knowledge areas, cultures and opportunity sets. Creative uses of Internet technologies will be the key to maintaining both sets of skills.

ENTREPRENEURSHIP, TECHNOLOGY, AND SOFTWARE AS DRIVERS

Until recently, “technology” meant primarily physical devices and constructions. Software has been expensed in business and national accounts, implying no residual value. Mainstream developmental economists have measured well-being primarily by what nations had in “objects” (such as factories, physical consumer goods, roads, and power generation plants) or “object gaps” (shortfalls) in these objects. Fortunately, a new conceptual school of economists, including Paul Romer, Brian Arthur, Richard Nelson, and Paul Krugman is now focusing more on needs for intellectual, technological,
and system infrastructures using more dynamic, though often less formal, models. But these, as well as models emphasizing effective wealth distribution as opposed to generation of wealth, are penetrating academic and policy circles very slowly. Both curriculum content and incentive changes are clearly essential.

Fortunately, the marketplace does not wait for academia to catch up. In measurable terms, since 1990 services have produced approximately 22 million jobs despite corporate downsizing of several million jobs, and more than half are in the top 30 percent of earnings. In the past three years U.S. stock markets boomed based on new entrepreneurial ventures largely in software, whose primary impacts will be outside the software industry. At the national level, the multiplier effects of these companies on others are enormous, though officially unmeasured. Even now, very few business schools have courses in software management (not programming or computer use), which will be the key to growth in the next few decades.

At the micro level, the primary beneficiaries of software and services technologies are customers rather than those companies creating the actual innovation. Sun Microsystems estimates that its customers make 20 times more money on its products than does the company itself. Clearly, the users of Microsoft or Oracle systems in their numerous locations make an aggregate of returns significantly beyond Microsoft’s profits or market value. Because of interactivity effects, these technological multipliers or ripple effects will be extraordinarily but immeasurably large for In-

Since 1990 services have produced approximately 22 million jobs despite corporate downsizing.
ternet use. The multiplier effects of billions of Internet interactions are likely to dwarf all other sources of value growth in the near future, yet academics still have no way to predict, quantify, or precisely conceptualize these effects.

AMPLIFIED INNOVATION AND TECHNOLOGICAL PROGRESS RATES

Well-designed software accessed over the Internet can compress and facilitate all aspects of the innovation cycle. They lower cycle times, investment costs, and risks by factors of 60–90 percent while increasing output values by orders of magnitude.

In Both Basic and Applied Research

Most literature searches, database inquiries, exchanges with other researchers, experimental designs, experimental modeling, analyses of correlation and variance, initial hypothesis testing, modeling of complex phenomena, interactive reviews of experimental results, first publication of results, enhancements to existing databases, and so on are performed through software. Software structures and access to a large extent determine what data researchers see and what questions they ask. In many frontier fields, such as astronomy, environmental studies, nanotechnology, semiconductors, and microbiology, researchers may be able to sense, observe, measure, or precisely envision phenomena only through electronic measures or models. Software actually makes discoveries (for example, astronomy or new atomic particles) or suggests new hypotheses (as in epidemiology, economics, or environmental studies).
At applied research levels, practical data about market, economic, or performance phenomena are introduced. In many fields, data about the marketplace, user patterns, environmental, or health factors come directly from software that monitors these external forces. Such inputs can help researchers evaluate and prioritize various possible research programs for or in academia. In network-based innovation, users and producers increasingly interact in real time. Since a very high percentage of innovation occurs at the user level,\(^22\) this increases both the quality and amplitude of technological impacts. Universities can participate directly and much more effectively in large-scale research projects, yet maintain their independence, and thus substantially increase the opportunities for and the impacts on university research.

The rates of advance in scientific, technical, and user needs for most fields are so great that no single enterprise acting alone can hope to keep up with or surpass the interaction capabilities of all of its customers, competitors, suppliers, and knowledge sources worldwide. Recently, this has vastly expanded the outsourcing of innovation — formerly a strategic heresy — which has led to further radical new concepts of organization, innovation management, and industrial structures worldwide.

**Independent Collaboration: University Effects**

These new arrangements have moved well beyond the era of ownership or authoritarian control, structured mergers and acquisitions, and formal team and contract relationships to a much more dynamic mode of interaction, best described as “independent collaboration, in which universities can be uniquely effective.”\(^23\) In independent collaborations, individuals and enterprises — including outside researchers, special-
ized materials suppliers, distributors, and combinatorial chemistry groups in pharmaceuticals — operate independently in their own self-interest, yet collaboratively toward the same desired results through shared goals and incentives. Complexity has become so high that single enterprises acting alone can rarely achieve major innovations. Large-scale independent collaborative efforts like the successful Human Genome Project, Clinics Without Walls for ALS (Lou Gehrig's Disease), the Joint Strike Fighter, the Cochrane Collaboration, Linux, the Y2K bug resolution, and combinatorial chemistry products in biotechnology and pharmaceuticals have become common new modes of organization.

Such collaborations illustrate how nonacademic science and technology sources will increase in importance relative to academic sources. In many fields, such as biotechnology, materials, thermodynamics, aerospace, astronomy, structures, microbiology, and chemistry, basic parameters have become so well understood that virtually all experimentation is first performed on computers. Research can be performed anywhere by relatively small units that connect as nodes to others with different specialized expertise or to coordinating models. These small units often can quickly obtain external funding at levels that would be difficult for universities to duplicate. Lowered experimental costs like those in combinatorial chemistry, structural design, or environmental modeling have led to an unprecedented outpouring of knowledge, new experimental options, and possibilities for small enterprises in other cultures worldwide to contribute or exploit frontier findings.

Researchers can use worldwide databases and update models instantly as new knowledge becomes available. Sharing of knowledge through the Internet is crucial to the accuracy and power of such knowledge diffusion, but universities may be only minor contributors to the advances. Virtually all design of new buildings, boats, autos, structures, molecules, systems,
textiles, machines, services, or consumer products are first created in software. This results in lowering costs, risks, time to market, and investments by orders of magnitude and allows smaller units to join in developments worldwide. This starts new ripples of awareness and permits applying knowledge for development more quickly in each region.

Given the rapidity of worldwide knowledge and technological advance, people cannot (and do not) go back to universities for knowledge updates as they once did. Most education is self-learning (much from electronic sources) using outreach or in-house programmatic learning as a supplement. The factual learning that used to characterize university postgraduate professional schools (law, engineering, business, and medicine) is now often better taught by well-developed electronic programs. Learning how to access, learn from, and update desired network-based knowledge is becoming the crux of factual training, leaving classrooms for interpreting nuances and relationships among knowledge clusters. There is little question that students can now be (and generally are) better informed than they were a few years ago. Universities need to hone their capacities to analyze, interrelate, and communicate about these facts. The university has gone from the “center” to an “access node” on the knowledge network.

AUTOCATALYTIC GROWTH, UNPREDICTABILITY, AND RISK

Adding further impetus to the knowledge wave, software-based innovation leads to a new form of autocatalytic, or self-amplifying, economic and knowledge growth. A new concept offered on the Web is picked up by an innovator at another site, modified, or combined with that innovator’s added features and insights, and put back out as a distinct new set of
ideas, products, or services. Other entrepreneurs immediately see, use, and modify all combinations for their clients’ or customers’ particular benefit. Each spin on the concept opens an exponential new set of opportunities and use combinations, with customers at each level doing the vast majority of innovation (for their own or their clients’ use). Soon the originator, who did not anticipate these uses, modifies the original concepts and stimulates another round of innovation and growth. The “value in use” for customers is multiplied many times beyond the originating firm’s initial conception, with little further investment, as Microsoft’s software or Intel’s microprocessor created billions of dollars more for others than for their originators.

In the past, great spurts of knowledge and advance have occurred whenever a totally new database, problem, technology, or concept made it possible to intersect previously unassociated matrices of thought or to verify results in a new way. Galileo’s telescope opened myriad new hypotheses and confirmatory possibilities in astronomy. U.S. Navy submarine data about the ocean floor led to innumerable tectonic and ocean floor discoveries. And Watson and Crick’s discovery of DNA’s structure opened whole new scientific technical fields. In the Internet and software-based innovation world, such phenomena occur continuously, with new databases, combinations, and tests interacting quickly in software to open new intellectual pastures.

Adding further impetus to the knowledge wave, software-based innovation leads to a new form of autocatalytic economic and knowledge growth.
As is well recognized, these potential combinations also create enormous new potential risks. Education about existing facts, therefore, quickly becomes obsolete. Education should shift toward access methodologies, processes for analyzing alternatives, creative combination, and knowledge validation.

Restructuring the University for a Disaggregated World

In this fast-moving interactive milieu, it is essential that universities do not become closed, inward-looking enclaves, biased against real-world observation and interaction, as did many universities in Europe, the Far East, and developing countries in the mid to late 1900s. Even today, observational research is derided relative to clinical hypothesis testing in many fields. This is especially counterproductive where practitioners are the leaders in a given art and where events are not reproducible (as in ecological or economic systems) or could be catastrophic (hydrogen bombs or biological releases). Given the rapid and constantly interacting nature of today’s knowledge systems, educational strategies that try to target specific opportunities, define skills needed, and train for them rarely work effectively. The planned for skills are obsolete before the educational start-up and training cycle gets its product to the market. Similarly, research strategies of linear development (such as the space program), which target clearly defined user needs or markets and tailor programs through intervening needed milestones, are rarely as productive as active engagement with the moving wavefront of knowledge.

As IT costs plummet toward book-priced Web computers, the opportunities for Internet-based cooperation and knowledge sharing can achieve a research and knowledge explosion without heavily funded government targets or investments in
most areas, given the proper incentives. The true policy need is for objective evaluation and feedback of results, breakdown of internal organizational and institutional barriers to knowledge sharing, and flexible incentives to diffuse knowledge for and of successful innovations. This is the educational equivalent of the venture capital approach to developing products and services for other areas and letting objective market forces test value.

There is an old saying that “a faculty is a group of individuals connected by a common plumbing system.” Unfortunately, heavily discipline-based university structures often exacerbate isolation; just as the military prepares for past wars, teachers and disciplines may tend to focus conservatively on skills they are familiar with and to convey “verifiable facts” as determined by that discipline’s rules, skills, or models. Unfortunately, “scholastics” are masters of preexisting knowledge, and the very word “discipline” means the acceptance of existing rules, concepts, and intellectual models. A major challenge of education in a Web-based world is to help students develop their own valid mental models for analyzing across disciplines situations no one has seen before.

The Tuck School at Dartmouth’s new Glassmeyer-McNamee Center for Digital Strategy attempts to attack this issue at multiple levels. Through advanced communications technologies, it will bring the most advanced thinkers about digital strategies and technologies interactively into student seminars. Together, students, academic thought leaders, and industry users will interact to develop and share learning processes (many from external resources). They will be asked to engage in the process of direct discovery, interrelating elements of multiple disciplines around real problems and opportunities generated by alumni and industry contacts. They will also engage in “white space analyses” to identify new opportunities and solutions in an experimental mode, and to
exchange opportunities and solutions with several courses in entrepreneurship in the curriculum. A conscious attempt will be made to engage faculty members from all disciplines in participating and in creating new solutions.

As Professor Philip Anderson, Director of the Center, noted, “Communication and process are our core competencies, not specific disciplines. In fact, we will operate from the premise of ‘ignorance’ with the ‘need to learn’ as the essential for any solution in the digital strategy world. The model of the Center is not ‘training’ (where the trainer has knowledge to impart to students) but rather ‘consulting’ where bright minds with different perspectives gather data, problems, and solutions from a wide variety of sources and then creatively combine them to define or solve problems.”

Students are expected to define, record, and share knowledge about the processes they use. To the extent that proprietary considerations allow, solutions and processes will be posted and streamed through Tuck’s extensive intranet, “TuckStreams.” Students will work with each other (and with professors and outside resources) directly and electronically. To facilitate efficient sharing, each person will have a “getting to know you” Web page to assist in identifying their knowledge sources and to avoid wasting time in developing such information during interviews. Such devices will let students and outside resources participate in asynchronous time as their schedules and interests allow. While allowing students to share and attack real-world knowledge and problems, the cost of preparing such electronic cases drops precipitously. Professors become process listeners, consultants, and evaluators. Learning shifts from a content to a process mode. As in any other project learning experience, content tends to be learned in greater depth when applied to specific solutions.

The center’s concept is neither complete nor fixed. Its overall development, program, and educational model will be in-
teractive and dynamic. But it does represent a frontier attempt to deal with some of the most interesting content and delivery problems currently faced.

THE INTERNET AND EDUCATION:
A REVOLUTIONARY INTERACTION

The only true summary one can make of the interaction between the Internet and education is that it will revolutionize traditional concepts. Today’s apparent solutions are merely first steps in a learning process that will soon restructure research, reference materials, organization structures, incentives, teaching styles, content, and the societal role of universities in new ways. I simply hope to have provided some interesting issues and insights concerning the interactions of these new knowledge-generating structures, the university, and methodologies for using the Internet.

NOTES

1. Forester, Research Reports, and Access Media International estimate today’s 140 million Internet users alone doubling at least annually through 2005.

2. J. Quinn, Intelligent Enterprise (New York: The Free Press, 1992) set forth a number of these patterns based upon seven years of services research.

3. The Amos Tuck School of Dartmouth College through its Whittemore Technology Wing has brought international business and academic experts directly into the classroom to interact, provides remote general and tailored programs for alumni and industry, provides seminars for international audiences, and, through some of its faculty and alumni, offers tailored simulation development and interactive electronic consulting services, and is beginning to design
educational satellites in key market areas. Dartmouth Medical School and the Dartmouth Hitchcock Medical Center are involved in many such services.

4. T. Kuhn, *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1970), contrasted these two levels of advance. However, they seem to be merging in the current context.


6. A combined electronic and card search we conducted interrelating these subjects in the library at that time turned up no relevant articles.

7. Services are generally defined as “intangibles sold in trade,” including such “service industries” as healthcare and delivery systems, telecommunications, banking, financial services, transportation, archiving, communications, entertainment, education, architecture and design, consulting, software, professional services, retailing, and wholesaling.

8. The true wealth of a country (assets that can be passed to the next generation), however, lies more in its service systems (education, legal, health, communications, and information) than it does in physical plant assets. This differential will grow as plant and equipment obsolescence rates dramatically increase because of innovation.


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PricewaterhouseCoopers, 1998), provides detailed statistics and a solid research basis for this conclusion.


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