Research and Occasional Paper Series: CSHE.5.00

CSHE Center for Studies in Higher Education
UNIVERSITY OF CALIFORNIA, BERKELEY
http://ishi.lib.berkeley.edu/cshe/

SOME CONSEQUENCES OF THE NEW INFORMATION AND COMMUNICATION TECHNOLOGIES FOR HIGHER EDUCATION

Spring 2000

Martin Trow
trow@socrates.berkeley.edu
CSHE Faculty Associate and Professor Emeritus
Goldman School of Public Policy – UC Berkeley

The role of the new information and communication technologies in higher education is so very large, and growing so rapidly that it can hardly be sketched in a brief talk. We might recall that only five years ago very few people could have anticipated or even imagined the enormous explosion of communications worldwide over the internet, and the profound effects that has had and is having on our universities – both as research and as teaching institutions. What can we say that might be relevant to this information revolution in five years – that, it seems to me, is the minimum we might ask of ourselves if we are to be of any use to policy makers in this area.

Rather than summarize what is currently happening – an inventory of events and developments that would be obsolete before the words were on paper[1] – I will try instead to conceptualize part of what is happening, searching for a language for discussing it that is close to empirical reality and that will be useful longer than the latest short-lived bits of software and applications.

Defining characteristics of the information and communication technologies

Let me start by suggesting that the new information and communication technologies (ICTSs) have some general and defining characteristics that are likely to survive changes in the technology itself.

I see five such defining characteristics – characteristics which shape how the new technologies affect and will increasingly change the forms and processes of the institutions of higher education in every advanced society. They are:

1. The speed of change of these new technologies;
2. The tendency of ICTSs to weaken and blur institutional and intellectual boundaries of all kinds;
3. The democratizing effect of these technologies on higher and postsecondary studies of all kinds, both through the expansion of access and the leveling of the status of institutions.
4. The widely varying impact of ICTS on different academic subjects and kinds of education;
5. The quite different ways in which students of different talents and motivation use the new technologies.

---

[1] The literature on ICTS is already enormous, and growing rapidly. But for the most part this writing centers on current developments and those anticipated in the immediate future of interest to policy-makers. This paper is forward –looking. Instead of citations to this current literature, the alternative is to cite websites that are continually revised and in touch with contemporary developments in the future. See for example, Higher Education in the Digital Age: A Citation Database, at http://media2.bmrc.berkeley.edu/projects/edtech/index_js.html
That website has links to other sites bearing on ICTS in higher education, many of them also maintained. For a paper about ICTS with a shorter time horizon from a comparative perspective, See M. Trow, "From Mass Higher Education to Universal Access: The American Advantage," Minerva 37, Spring 2000, pp. 1-26.

A word on each of these defining characteristics.

Speed of Change

As for the speed of change, I need not give examples – they are all around us, in dizzying array. But the consequences of this speed of change have not been adequately identified and assessed. And that is because the speed of change of the information and communication technologies centering around the computer and internet is unique in history – we hardly know how to discuss its implications. There is, I suggest, no precedent for our situation with respect to ICTS. For one thing, the speed of change defeats broad comprehensive planning. Planning on any scale needs a reasonable time horizon – at least 3 to 5 years – in which the outcomes of plans can be anticipated, and some rational links can be made between a policy and its intended outcomes. But the ICTSs do not give us that time horizon. For example, an American college I know well cannot even decide whether to invest in the installation of glass fiber wiring in new student residence halls to connect them with the fast servers on the central campus, or to delay to see whether wireless connections to a central server on campus will do as well. The pressures from students and parents not to delay are very great; the costs of installation of a technology which may be obsolete in three years even greater.

Business firms and individuals are faced with these kinds of decisions constantly, without being able to make them flow from rational planning based on broad forward looking research. The meteoric rise and fall of the dotcoms remind us of the costs of having to make decisions about the new technologies and their use and applications without being able to predict very far ahead. In higher education one outcome is that many big American universities are not doing much if any institution- wide planning for the adoption of the ICTSs, but are giving these decisions over to departments and research units – a form of decision by trial and error which, if properly monitored, can at least be treated as small scale experiments. It is what an institution does when it doesn't know what to do – and in its own way it is a highly rational decision.

While American universities have adapted to the difficulties of broad institution or system-wide planning for the new technologies by not doing it, it is even more troubling to reflect that the speed of technological change affects our ability to do research about the new technologies and their effects. One of the important questions about the new forms of teaching on line is the need to discover more about the social psychology of learning under those conditions – how effective is it, in different subjects, and with different kinds of students, in different settings: younger and more mature students, more or less highly motivated, studying at home or on the job, and so forth. Currently we know very little about any of that, yet the answers obviously bear on the wisdom of making learning online a major part of our provision of advanced study. The trouble is that what we might learn today about the effectiveness of current forms of instruction over current technologies may just not apply tomorrow when band width is essentially free, software more sophisticated, and when teaching over interactive video connections will be guided more by what has been learned through trial and error from previous experience than by systematic research. Essentially our research in this area today – and there is little enough of it -- is about current experiments with primitive technologies establishing base-lines for comparison with later experiments with better technologies employing better and maybe quite different forms of instruction. But that is a modest kind of research, and not a base on which we can confidently advise decision-makers, either in government or in our own institutions.

Everywhere we turn we see major commitments by big institutions coming to naught, foundering on unforeseen shoals in uncharted waters. California created a Virtual University a few years ago, and gave it up a few months later. The Western Governors University, begun with much high level support, has scaled down its ambitions sharply. And even the consortia of great research universities which are entering the competition for what they believe to be potentially large sums for training people for work on line are redesigning themselves and taking on private business firms as partners - both as sources of start-up funds and of needed experience.

If we consider many of the other major technological transformations around us, we are struck by how many of them are nineteenth century inventions: the telegraph and telephone; the railroad and automobile, electric lights and grids, with the airplane coming early in the twentieth century, radio in the 20s and television in the 30s and 40s. In each case, private institutions and public agencies had time to

reflect and consider and make general policies for the new technologies, policies which, whether wise or not, were at least relevant to the technologies to which they were addressed. With respect to the ICTSs, I suggest that the speed of change does not give policy making bodies the time horizons that they need for those policies to be rationally related to the situations to which they are addressed even a few years down the road.

One example: last year, 2000, the US Congress became concerned about the impact of the new technologies on the ownership of intellectual property that was being distributed through it in ways that made it available to many users without payment or even acknowledgement of the authors and creators of the new knowledge. The Congress asked the National Academy of Science/National Research Council to do an expert study which would advise the Congress on what legislation it should pass to deal with the conflicting claims of users and creators of knowledge, and that would bear on art of all kinds – writing, music etc.. as well as information and knowledge. The highly qualified committee, including engineers, lawyers and other specialists, wrote a long report in which essentially they advised the Congress to do nothing – do not write any legislation in an area so little understood, legislation which was likely to do more harm than good given our ignorance about what best to do.[2] The subsequent total confusion in our courts and legislatures about what to do about Napster is a case in point.

The Tendency of ICTS to Blur and Weaken Institutional and Intellectual Boundaries of All Kinds.

To take an example familiar to us all, ICTS blur or destroy the distinction between pure and applied research, as the private sector finds use quickly for many discoveries, including those thought to be the products of pure research in math, science and engineering, and even in economics and the social and behavioral sciences.[3] In their fierce search for competitive advantage, private businesses reach directly into university laboratories, and pay well for even modest advantages in their access to new findings and technologies. The easy movement of people, information and ideas between universities and the private sector, and in both directions, is a characteristic of the new economy and its relation to universities.

The new technologies also undermine the distinction between non-profit and for-profit institutions, as their employees and scientists mingle in the same laboratories, work on common research problems, and profit from discoveries in similar ways, stimulated by similar or identical motives.

ICTSs blur the distinction between teaching and research, as more and more research perspectives are introduced into the classroom, and even into the undergraduate curriculum, where the net makes genuine research possible for the first time to undergraduates without easy access to big libraries or other good sources of information. The computer and web have an inherent bias toward research rather than scholarship, toward analysis and the testing of ideas against evidence, rather than the search for meaning in a text. We are already seeing the effects of that in our classrooms, as teachers take their abler undergraduate students into their labs and to the frontiers of research. Where that happens it really does change the climate of undergraduate education, often for the better. But again, it links undergraduate education even more closely to the discovery of new knowledge, rather than to a renewed appreciation of the art, literature and wisdom of the old, as in earlier conceptions of liberal education.

ICTS undermine the boundaries of disciplines, and make all study inherently interdisciplinary. We see this dramatically in the biological sciences, where in the nineties the boundaries between the historical subdisciplines of biology broke down under the impact of new discoveries in molecular and genetic biology. In this decade the boundaries of biology are yielding to common interests with engineers, with chemists, with physicists, with physical anthropologists, among others. In my own university, these penetrations across old disciplinary lines have already resulted in new kinds of physical arrangements, with people establishing offices and joining research groups and labs as governed by their

[2] The Digital Dilemma: Intellectual Property in the Information Age, The National Academy of Science Press, Washington, D.C. 2000.

[3] M. Gibbons, C. Limoges, H. Nowotny, S. Schwartzman, P. Scott, M. Trow, The New Production of Knowledge: The dynamics of science and research in contemporary societies, Sage Publications, London, 1994. The recent sequencing of the human genome is an example of what we were discussing in that book.

scientific interests rather than their departmental appointments.[4] We are seeing clearly that academic departments may still be useful for administrative purposes, but that they are increasingly irrelevant, and even a hindrance, to the creation of new knowledge. That is all in part a function of the increasing division and recombination of scientific specialties – but the work across specialist lines is in large part made possible by the new ICTSs.

The new technologies weaken the boundaries of the university and college itself. Students now may be living anywhere, and lecturers also may be on line from Australia or America or Denmark. Many academics are also working part-time for private industry which can be anywhere - and the efforts of governments and universities to limit those connections run the risk of their losing their best scientists to the private sector altogether, or to other countries more tolerant of those dual loyalties.

ICTSs have also clearly weakened the role of the library as a major centripetal force. Information comes on line from everywhere, and liberates scholars from dependence on their own libraries. In addition we have competing forms of online publication:

- Ebooks, with whole libraries in their massive storage capacities;
- Books on demand – printed out and bound as you drink your coffee, and sold to you for less than the price of a book in a book store;
- On-line publishing – where articles and whole journals now arrive via the net, and at much lower cost than the published journals, whose publishers raise their prices as their subscriptions decline. There are now some thousands of scientific journals published exclusively on line – with cheaper and faster access to knowledge. Moreover, many are peer reviewed and continue to serve that important function for the academic career.
- The American firm Questia is preparing a world-class online research library, initially with "More than 250,000 books and journals … available online for university students within three years …." [5]

All of these forms of online publishing and others compete with one another, but all together they undermine the old functions of the university library – and with it the historical core of the traditional research university. University libraries are seeking new functions, and may find some, but whatever they may be it is likely they will be less in integrating the university than in adapting to the centrifugal tendencies of the new technologies.

ICTS also are tending to blur the distinction between research universities and other kinds of postsecondary institutions. On one hand, research becomes easier in many fields through access to the net – even to people in what were formerly colleges offering chiefly professional and semi-professional training. On the other hand, the research universities are also doing more teaching in applied fields as the distinction between what is pure and what is applied breaks down. Commercial firms are indifferent to the status of the university or college where research of interest to them can be done. And with broader access to all institutions, the students in different kinds of institutions begin to look more alike. Students even in research universities are working more during term time and are more varied than formerly in age and social origins. The class links between different forms of higher education are still present, but breaking down.

The Democratization of Higher Education

The blurring of distinctions between elite, mass and universal access forms of higher education – the institutions as well as their students -- is a joint product of the development of ICTSs and also of the democratization of all forms of higher education. This pattern of democratization presses toward an equality of status and funding between different kinds of institutions. Of course these trends are still in their early stages, but the direction of change is clear enough, and unlikely to be reversed. If we look to the UK, we can see that in 1992 a Government decision was made to transform all the then polytechnics into universities. It is clear a decade later that what happened was much closer to the transformation of the universities into polytechnics – most clearly in their loss of autonomy to increasing control and micromanagement by government agencies, and the decline of the prestige that formerly attached to

[4] M. Trow, "Leadership and Academic Reform: Biology at Berkeley," in Rogers Hollingsworth, ed., Organizations and Innovation Performance in Biomedical Science, forthcoming 2001.

[5] The Times Higher Education Supplement, 6 November 2000.

those elite institutions and their members that accompanied that autonomy. All institutions are pressed to justify themselves by their contributions to national economies -- and look more alike in trying to meet that common expectation.

The democratization of higher education, the growth of access, and the efforts of governments to control costs has led in many countries to a marked growth in the numbers of temporary and part-time teachers – some happy to be working part-time, others unhappily chasing from one lecture room to another in two or even three different universities. But democratization has much more powerful and direct effects on higher education than through the growth of part-time teachers. The new technologies have a democratizing effect by transforming knowledge into a commodity to be bought from scientists and scholars and sold over the internet world-wide -- the teaching itself, and not just the books that are instruments of teaching. Democracy in the realm of culture and ideas always has a dual character. On one hand, it becomes increasingly possible through the new technologies to give access to more and more people to information and ideas, especially to the idea that they can gain and use new information and knowledge all their lives. Distance learning simply makes possible as never before the expansion of mass higher education to universal access, to people in their homes and workplaces and not just in seminar and lecture rooms. We educators cannot but applaud the extension to more and more people of the chance to gain knowledge, skills and learning, and of the application of that knowledge and those skills to the problems of living.

On the other hand, the transformation of knowledge into a commodity reduces the authority of knowledge, of the great books and the wisdom in them, and of the academic profession itself under the steady pressure, from states and consumers alike, to justify ourselves always against the pragmatic test: of what use are you and of what you teach. Here the old concerns are not irrelevant: a superabundance of information may be the enemy of knowledge, and a superabundance of knowledge the enemy of understanding and wisdom. This is too large a subject for a short paper, but I cannot visit this important subject without acknowledging, even so elliptically, the danger to humanistic studies inherent in technological advances which have led so directly to the commercialization of research, and now to the commercialization of teaching.

The deep penetration of market forces into the institutions of higher education implicates them ever more deeply in the life of other institutions. And that makes it more difficult for universities to retain their own unique identity, their institutional autonomy. A basic conception of institutional autonomy is the answer to the question: to what extent does the institution define its own ends, as compared with the extent to which it is a means to the ends of other institutions and answers to their needs. Universities have always balanced these two conceptions; ICTSs and the commercialization of research and teaching that they accelerate shift the balance away from university autonomy toward their being a means – a very important means, but a means nonetheless – to the achievement of ends and policies defined by the market and by government.

I made reference to five defining characteristics of the new ICTSs. I have spoken about three of them: the speed of change, the weakening of academic boundaries and distinctions, both institutional and intellectual, and the role of the new technologies in accelerating the democratization of knowledge, and its ambiguous outcomes. Two other fundamental characteristics of ICTSs are that they have enormously different significance and utility for different kinds of subjects, and for different kinds of students.

Differences Among Subjects

With respect to academic subjects and disciplines, it is pretty clear that the new technologies have a less ambiguous role to play in the straightforward transmission of skills and knowledge than in the search for meaning. So the earliest online courses have been in basic pre-research level mathematics, in the teaching of foreign languages, and in introductory courses in business, engineering and the sciences. They are less immediately useful for courses which involve the search for insight and understanding in art and ideas, where a teacher wanted to be in the company of one or a few students, each with a copy of a book in his or her hand, exploring the significance and meaning of a passage or character or event or poem or philosophical idea. But what we are experiencing now, in the childhood of ICTS, may not carry into their adolescence or maturity – where interactive video connections among the members of a small

widely dispersed seminar may prove the technology to be as fruitful for humanistic studies as in the transmission of technical information at a distance.[6]

I have seen such a seminar made up of advanced students of medieval history studying an illuminated manuscript more closely and effectively through an interactive video connection than would have been possible without the magnification of the manuscript together with the discusssion among the scholars made possible by an electronic link between Berkeley and Columbia University, each of which owns half of that manuscript. Still, at the moment and for awhile ahead, humanistic studies of the kind currently organized in small seminars will be lagging in their applications of the new technologies. And of course that is partly because the teachers of those subjects tend to be less enthusiastic about the new technologies, and also on average less skillful in their use.

Differences Among Students

Of great significance for the impact of ICTS on higher studies are the characteristics of students, and among these are their motivations – essentially how seriously they are engaged in their studies. We already see, and hear from other teachers, that when students are serious students, they can use the web to enrich their lectures and reading, and develop their insights and understanding of a subject. But when students are rather passive -- and the number of such students grows with the expansion of access, students wanting mainly to gain the certificates needed to get a better job after they leave the university – those students are less likely to use the resources of the net to deepen or broaden their knowledge. Rather, they use it to find ways to make their written work look more sophisticated and professional, borrowing from sources all over the world, and often crossing the line to plagiarism, innocently or knowingly. The new technologies currently make it easier to fake getting an education for those less interested in actually getting one, one of the many ironies associated with these new forms of communication and information.

Disaggregation and Diverse Effects of ICTSs

What these defining characteristics of the new information and communication technologies suggest is that we cannot speak very usefully, or at least cannot go very far in our analysis of ICTS, as a single phenomenon, but must specify very soon what and where they are being used, for what and by whom. We must disaggregate the world in which ICTSs are used to get any sense of their diverse effects and consequences.

Two examples of diverse effects, from opposite points on an extended continuum of effects, make clear the necessity when speaking of ICTS in connection with higher education to specify who and where and when and what for. The first analysis of the decoded sequence of the three billion chemical bases making up the roughly 30,000 genes in the human genome is a triumph of computer science, without which these tremendous discoveries could not have been made in our lifetime.[7] But equally important, all this information is now online, available for further work by thousands of university-based scientists all over the world, for all the kinds of things they may be interested in exploring. The achievement by the scientists aided by their computers is just the first achievement; the net now empowers other scientists beyond their wildest dreams. One of the research team leaders said that he had spent ten years of his life searching for and studying the structure of one gene; now another scientist can find that information on the net in 15 seconds, but more than that, can see that gene in relation to all its neighbors and others with whom it interacts. The coming explosion of discovery in all branches of biology, not least in the health sciences, must transform the practice of medicine over the next few decades – a matter of personal as well as professional interest to all of us.

---

[6] A new application throws its shadow far ahead. It is called "the access grid;" it is a "a low cost interactive apparatus through which one network site can interact (in both audio and video) with up to 50 other sites. ..This has the potential to change the nature of remote education and the ultimate function of a school or university." The Times Higher, Feb. 9, 2001, pp. 22-23.

[7] See the issue on "The Human Genome", Science, 10 February 2001, vol. 291, no. 5507. While neither of the two organizations which sequenced the human genome is a university – one a commercial biology firm and the other a consortium of four publicly-supported American laboratories – their links to research universities are many and close.

At a far distance from that happy story of the central role of ICTS in contemporary scientific research is the rather more ambiguous impact of the same technologies on the academic profession. We are currently seeing widespread efforts to project teaching beyond the classroom, both to students in one's own institution in their homes and halls of residence, and beyond that to students outside the boundaries of the university, near and far, in other universities and in their homes or workplaces. Indeed, the energy and resources currently being poured into these efforts can hardly be chronicled. Almost every day we hear of consortia of great universities combining their resources to create possibilities for distance learning of various kinds.[8] Alongside and in sharp competition with them – so far rather more successfully -- we see for-profit bodies, like the University of Phoenix in the US or the quasi-universities being created by multinational corporations. The burgeoning universe of distance learning providers – still far more a potentiality than an achievement – nevertheless raises serious questions about the nature and survival of the universities that we know and love.

I mention in this connection only one facet of that development: if some kinds of teaching can be highly rationalized, employing brilliant lecturers at world renowned institutions equipped with all the resources of the net at their finger tips, there is at least a reasonable possibility that more modest institutions will choose to use those world-class resources, hitherto confined to a small number of leading research universities. They might be forced to use them by their competition for students looking for star teachers expounding the latest or deepest understanding of their subjects. But each of those institutions currently has its own instructors teaching most if not all of the subjects that are also taught on line by star lecturers from institutions with famous brand names. The transformation of college and university teachers, most of whom have earned a doctorate or other higher degrees themselves, many of them active researchers – into what amounts to teaching assistants in other people's courses, cannot be welcome to them. That must affect not only their autonomy, but also their tenure, pay and academic freedom. That fear, already alive in academia, is not unfounded, only a little premature.

But even more serious than the slow loss of the cherished freedom and autonomy of the academic in his/her own subject is the inevitable loss of the status and rewards that accompany that professional freedom and autonomy. We already see signs of the deprofessionalization of the academic work force in some countries in the form of central governmental control over institutions through their external assessments and evaluations, and its intervention into the curriculum by the setting of minimal national standards of achievement, subject by subject. Here we see the blurring of the traditional distinction between secondary and higher education. But the rationalization of teaching through the new technologies must tend to reduce even further the professional status of the academic. That in turn will affect recruitment to the academic labor force, and not for the better.

A crucial question for academic life is whether higher education can recruit in each generation a fair share of its most able, creative and talented people, in competition with the interesting, challenging and materially rewarding work generated by the high tech and multinational industries outside the academy. Undermining the status and rewards of teaching must have negative effects on that ability to recreate the academic profession. But the quality of the teaching and learning in our colleges and universities depends far more on the quality of the academics in them than on any reviews or assessments generated by external reviewing bodies. And a decline in the quality of the recruits to academic life in the face of competition from interesting and well-paid work in the private sector would be a pattern very hard to reverse. It would be a classic vicious cycle. We have seen it happen in secondary school systems around the world, and not least in the United States, as our ablest teachers were drawn off over the past half century by the new and more rewarding opportunities created by the expansion of higher education. The irony here is that intrusive efforts by governments to make universities more responsive and rewarding to students may make the academic profession less rewarding to the ablest potential recruits to it.

8 One of these, The Global University Alliance, an online venture of 10 American and British universities, has decided to start offering courses of its own, in addition to courses offered by its member universities. SEE http://chronicle.com/free/2001/03/2001030201u.htm

Sources of Future Demand for Continuing Growth of Higher Education

Discussions of ICTS assume that there will be a growing demand for education that cannot be met through traditional forms and structures. Americans take growing demand for higher education so much for granted that we scarcely analyze its sources in history, cultural attitudes, changes in the economy and demographic change. Certainly growth is not taken as given in most other countries. Nevertheless, while growth is perhaps clearer in the US than elsewhere, some of the same forces are present in all advanced societies, in some of them even more strongly than in the US. Growth in demand for higher education rests on three fundamental developments in society – economic, cultural and demographic.

- One such development is the growing gap in income between those who have had some experience of higher education, and those who have gone no further than secondary school. The difference in income is found to be related to every year of additional higher education.

- This differential in income and wealth in turn is related to changes in the economy. It is a commonplace that wealth is increasingly based on information, on a rapidly changing technology, and almost equally rapid changes in the organization of economic activities. Part of the driving force behind the expansion of higher education lies in the globalization of our economies. In this world of rapid change rooted in knowledge and information the rewards for gaining education, and for continuing education, are increasingly visible as providing better life chances, not just at the beginning of a career but all through life.

- Rapid changes in the global market provide a long-range reward for more education, both liberal and vocational. But the impact is equally great in the short-term, by radically increasing the demand for training in the new technologies and organizational arrangements. Not so long ago workers at every level could count on functioning in jobs effectively for decades with little more than the skills with which they entered the job. That is no longer true, and the market for training of employees on the job has grown rapidly in recent decades. There is no reason to believe that this growth of demand for continuing training to keep up with the rapid changes of doing business will not continue.

- In addition, it is well documented that the more education that people have had, the more they want. The demand for continuing education arises first among those who have had considerable education. We are now seeing the effects of the growth of access over the past few decades; looked at another way, we are seeing that mass higher education is providing the demand base for the movement to universal access.[9]

- Rarely noticed in this connection, is the remarkable increase in life expectancy in advanced societies in the past half-century. Better health and longer life lead to more time and energy for education. We have scarcely begun to see the use of the Net for education of various kinds by retired people. In all advanced nations the numbers of retired people is growing, in some countries very rapidly. Moreover, those coming to retirement age in the future will be computer literate, in the way that current retirees are not. [10]

- While population growth has slowed or halted in the countries of the European Union, and dramatically reversed in Japan, there are still many countries experiencing high population growth. Even the richest societies, among them California in the US, cannot provide higher education for the projected numbers at the same cost levels as at present. California will almost certainly need to provide access to every kind of post-secondary institution, from community colleges to the University of California, through a mix of traditional and distance learning, and is already planning to do so.

- Finally, we need to address the force of the youth culture. The world young people are growing up in is tied to the electronic revolution in ways that those who grew up in a pre-Net world can hardly imagine. Those young people, and those yet to be born, will using the electronic media, for postsecondary education as for many other uses, casually and constantly, formally or informally.

[9] On the movement from mass to universal access, see M. Trow, op. cit., Spring 2000.
[10] On this see Science, 18 Feb. 2000, pp.

Of course the rate of growth of demand for higher education, some of it on line, will depend on many other factors besides those mentioned above. For example, use of the Net for any purpose is affected by the idiosyncratic policies of national telephone systems. The United States and Finland are among the few countries whose citizens are charged a fixed monthly fee for local phone service, which means that there is no additional charge for connecting to the Net through a local provider. And it is perhaps not an accident that those two countries lead in the proportions of their population who are connected to the Net. Moreover, the use of the Net for the education of a labor force at work will be affected, among other things, by state subsides for those activities where they are provided. Subsidies to students for the costs of part-time distance learning will vary between countries, as they do currently. And there are other factors not discussed will affect whether demand grows or not, and if so how fast. But my guess is that on balance, the factors in favor of growth, coupled with the development of the technologies and their decline in relative cost, will make for a growth in demand over time, an increasing proportion of which will be met at a distance on line.

The Mix of Traditional and Distance Learning

An important issue in the emergence of web-based higher education is the physical locus of learning: where is it experienced, and in what combinations of propinquity and synchronicity with traditional forms of instruction. We can locate existing and future forms of education involving ICTS along a continuum, from a) all of it provided in existing ways and situations, to b) traditional venues interspersed with distance learning, to
c) distance learning interspersed with direct contacts between students and teachers, to d) higher education provided all or nearly all at a distance.

Moreover, the middle of that continuum—types b) and c) -- is in some ways the most interesting, as most clearly involving traditional institutions of higher learning rather than the marginal institutions which have long relied on distance learning with little or no direct meeting of teachers and students. In what we will call “mixed provision,” we increasingly see such combinations of traditional and distance learning as these:

- Traditional courses on campus using ICTs in ways that allow students to take all or part of a specific course physically and temporally removed from the class or lecture room.

- Arrangements that allow students to take some courses on campus and some on line off campus within the same term or year.

- Arrangements that break the normal years to allow students to enroll in some fraction of their course in residence on campus and some part off campus on line – the issue there being what fraction of each. The nature of the experience will clearly be different if the students is asked or required to take one semester of eight on line off campus, as compared with taking half or three quarters of their course work off campus.

Each of these arrangements, of requiring students to take a portion of their traditional college or university education off campus, is already being discussed, not primarily for the learning or curricular advantages of these arrangements, but as potential responses to large and rapid increases in enrollments in higher education that challenge institutions and governments to find the money and physical facilities for on campus education in traditional forms. As is often the case, radical innovations in traditional forms of instruction will be driven less by intellectual than by financial and political forces – in this case the overwhelming costs associated with the growth of enrollments inherent in the demographics of twenty-first century America. While these demographic pressures are not present or as strong in Western Europe or in Japan, the growth of demand for higher education is not wholly dependent on demographics, as I suggest above. The need for a broadly educated society, and for continuing education both on the job and in the home, will tend to increase the demand for postsecondary and continuing education. And it is that growth of demand, especially for non-traditional forms of higher education, that will provide the stimulus for the expansion of the use of ICTSs in higher education. Where, for what ever reasons, as for example the steep demographic decline in Japan, growth of demand

is weak, both pressures and incentives to expand access through ICTSs at a distance will also be weaker as traditional institutions are hard pressed to maintain their existing enrollments.

Functions of Higher Education and the Differential Impact of ICTS

In the past century and a half, in addition to the creation of knowledge through research and scholarship, the two dominant purposeful functions of colleges and universities have been to shape mind and character of students – the elite function – and to provide skills and knowledge as preparation for a variety of jobs and careers – the vocational function. Of course the line between these is not absolute: in a sense, the qualities of mind that mark the liberally educated person are high recommendations themselves for a range of leadership roles in the society, and thus have a latent vocational function, while some vocational training and education does in fact shape mind and character beyond the narrow requirements of competence in the world of work. But still, the distinction between the two in visible in an institution's catalogue, in the curriculum leading to a degree, and in the syllabus of a course.

But the functions of higher educational institutions are not confined to the expressed purposes of these institutions. Like all institutions, colleges and universities have functions and consequences that are not necessarily intended, and some of them undesired. Thus, another perspective on the impact of ICTSs can be gained by reflecting on their potential effects on both the traditional and on the new and emerging functions of colleges and universities. Among these are the following:[11]

- the liberal education of youth: the shaping of mind and character
- the acquisition of useful skills and knowledge
- professional education and socialization
- research and scholarship: the creation of knowledge
- the provision of apprentice training for research: research assistants
- the education of adults for personal pleasure
- entertainment -- e.g. college sports
- status acquisition, both through gaining a degree and borrowing the status of the awarding institution
- friendship and mate search
- networking
- stockpiling of youth; keeping them out of the job market
- offloading late adolescents/young adults out of the home into a protected environment
- the preparation of low cost teachers: short-contract, not on tenure track, and teaching assistants

Some of these functions will be heavily affected by the expansion of distance learning made possible by the ICTSs, those that exist at this writing and those still to be created. The chief of these functions of universities responsive to the ICTSs is research. On the one hand, research in every academic subject is now heavily dependent on communications across the web. On the other, the recent decoding of the human genome is dramatic evidence if any more is needed of the capacity of public and private research labs outside of universities to do research of the highest levels.[12] But other functions will be less vulnerable to the new technologies, and provide continuing support and justification for traditional forms of higher education for the foreseeable future. Elite forms of undergraduate education, involving the shaping of mind and character and not just the transfer of skill and knowledge, will survive as an important though diminishing fraction of postsecondary education as a whole. Traditional forms of liberal education require conditions and relationships between students and teachers similar to those associated with the socialization of research scientists and scholars in graduate study. While research is increasingly independent of its traditional venues, research training is not. As far ahead as we can see, the physically close and extended relationship of student and mentor will be necessary for a student to

[11] Some functions are unique to particular countries. For example, in the United States, colleges and universities serve a central function in the acculturation of immigrants to American society. In addition, American colleges and universities collectively legitimate the social and political system by providing channels of mobility which are seen as guarantors of the American Dream. In other countries, university systems historically have played comparable roles in nation- building.

[12] See also Gibbons et al, op. cit.

become a scientist or scholar through a socialization into the norms and perspectives of science and its subdisciplines.

The acquisition of status – by gaining credentials and degrees, and borrowing the status of the awarding institution – can also be done at a distance, though not so successfully at this moment as through residency. But that may well change in the near future. What is not likely to change is the appeal of the traditional university to parents who are glad to hand their late adolescents/young adults off to another institution for help in transforming them into successful adults. Nor are we likely to see a loss of the parallel appeal to the youthful students themselves of the traditional university or college as a place to make friends of all kinds and degrees, some of whom become life partners and others business connections through forms of networking.

The point here is that the survival of the traditional university does not depend on its maintaining a near monopoly of advanced teaching and research – a monopoly which it has already lost. The traditional university performs a variety of other functions, some having little to do with education per se. And these, alongside the elite functions of character formation and socialization to science, scholarship and the professions will ensure the survival of the traditional institutions, though they will look different too.

Conclusion

It is a clouded crystal ball into which we peer to see the future of our universities and colleges, cloudy because of the uncertainties of the development of the new technologies of information and communication. The only thing we can be sure about is that these developments will have large and cumulative effects on our universities and colleges. I have tried to make my own crystal ball a little less cloudy by identifying some defining characteristics of these technologies and their effects. In addition, I have explored some of the sources of a continuing growth of demand for higher education in many if not all advanced societies that will accelerate the introduction of ICTSs. The future will see a combination of traditional and distance learning rather than the replacement of traditional forms. This perspective is supported by the differential effects of ICTS on the varied functions of higher education. But the short history of the computer and the net has provided us with many surprises, some of them even welcome. I suspect it will continue to do so.