ITFRU Project
Technology Subcommittee Meeting
May 5, 2000
Sloan Foundation, New York

Attendance:

Ralph Gomory, Sloan
Paul Horn, IBM
Dan Atkins, U. Michigan
Bill Wulf, NAE
Gerry Butters, Lucent
Mike Smith, Stanford
Lee Sproull, NYU
Ray Fornes, NCSU
Frank Mayadas, Sloan
(Doug Van Houweling, via e-mail)
(John Seely Brown, via e-mail)

Opening Remarks (Jim Duderstadt)

The ITFRU Project is beginning as a dialog among technologists, higher education leaders, and people experienced in public policy (primarily at the federal and research level).

The *premise* is that rapidly evolving information technology poses great challenges and opportunities to higher education in general and the research university in particular. Yet many of the key issues do not yet seem to be on the radar scope of either university leaders or federal research agencies.

The early approach is to envision a three stage *process* involving the Steering Committee:

> Technology Scenarios: What technologies are likely (possible) in the future (perhaps a 10 year planning horizon). The technology subcommittee consists of this group plus Doug Van Houweling (Internet2) and John Seely Brown (Xerox PARC) who were unable to participate at this first meeting.
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> Implications for Research Universities: What are the implications of this evolving technology for the activities (e.g., teaching and research), organization (e.g., disciplines, leadership, funding), and enterprise (e.g., markets, competitors) of the research university? The subcommittee focusing on these issues will consist of Frank Rhodes, Nils Hasselmo, Joe Wyatt, Shirley Jackson, Marye Anne Fox, Bob Weisbuch.
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> Policies, Programs, and Investments: What is the role, if any, for the federal government in protecting the valuable role of the research university in the fact of these challenges? This topic will be addressed both by the Steering Committee as well as by guest participants (e.g., Eamon Kelly, Rita Colwell).

Of course, these three stages are interactive and will proceed in parallel. Furthermore, any and all members of the Steering Committee will be invited to participate in any of the subcommittee discussions.

The *products* of this study require some further thought. Since we are dealing with a very rapidly evolving technology, the usual NRC product of a report is likely to be out-of-date before it is even written, reviewed, and released. Rather we might consider a more sophisticated sustained product such as a "knowledge environment" or a sustained dialog such as a roundtable that would track these issues for some time. Furthermore, we need to consider a variety of ways to extend the interactions and propagate the conclusions of the Steering Committee.

A side comment: Note here we are focusing on the research university, not all of higher education (and certainly not all of the American research enterprise). In this sense, our study will assume that the knowledge production roles of the research university are of comparable importance to its human resources development roles (i.e., research is comparable to teaching). Yet, if we look at the research university as part of a global "knowledge industry", it may be just as important to consider the evolution of this industry as the technology that drives it. For example, the research university might be seen as a producer of people and knowledge, but also as a provider and gatherer of content. But in these roles, it may be increasingly challenged not only by other providers of learning (e.g., for-profit universities and distance learning) but also providers of content (e.g., AOL-Time Warner and Disney).

Bill Wulf:

The issue before our group is not to preserve the research university in its present form, but rather to protect its contributions. He has concern about the reluctance in higher education to even discuss these issues, much less to consider them strategically.

Ralph Gomory:

His remarks focused primarily on the impact of information technology on education. The Sloan Foundation will have sponsored over 100,000 course units using Asynchronous Learning Networks (ALN). What they have learned from roughly $30 million of experiments are:

i) This stuff works. You can reproduce the classroom over the Internet. For comparable student-to-faculty ratios, ALN education works as well as classrooms, as measured by test scores (and other more sophisticated selected measurements).

ii) It is not expensive to convert a course into ALN format (about $10,000 per course) if teaching is interactive rather than automated. (They have seen this in thousands of courses.)

iii) The question is not whether ALN works, but rather how universities participate. You cannot just leave nontraditional students to the for-profits.

Yet, as you go up the learning curve, from community colleges to regional universities to research universities, there is less and less activity, particularly at the level of research universities. While there are experiments such as Unext.com, these are "hands off", without strong participation by the research university faculty. As a result, the research universities are not learning how to do implement this technology like others in the enterprise.

Gomory made a final comment on the "digital divide": Sloan believes that IT will narrow rather than widen social stratification. The real divide is not access to technology but rather between those who have access to educational opportunity and those who do not (because of economic ability, family responsibilities, or job constraints). IT lowers the cost of education (in terms of dollars, geographical constraints, time constraints). In this sense IT may close the digital divide by opening up access to education.

Paul Horn:

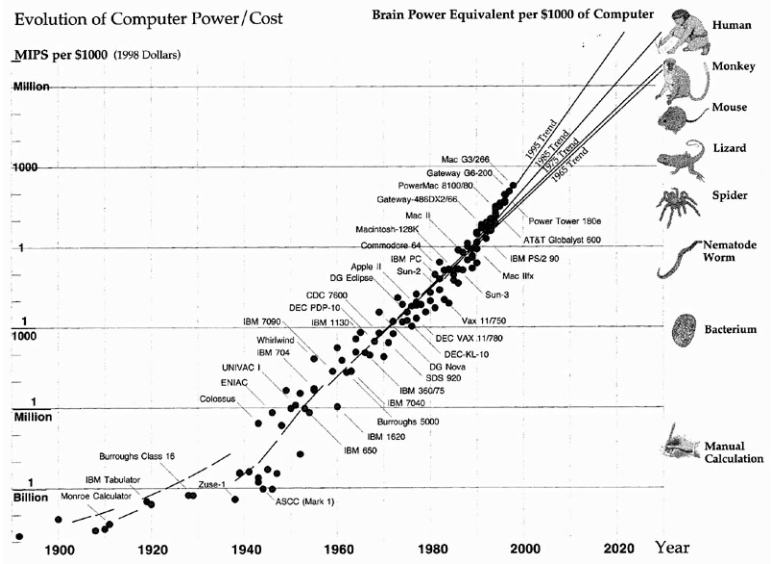
IBM has long conducted a "10 year outlook" to understand where technology is headed (now called its "global technology outlook"). The key issue here is when certain thresholds get crossed, e.g., when does the cost of digital storage become cheaper than paper storage.

Some conclusions from their efforts:

ii) There is no evidence of slowdown in the pace of evolution of information technology in any characteristic. In fact, it is increasing superexponentially, showing a 60 to 70% improvement per year, with an improvement of 100 per decade or faster across all areas of technology. Notes the comparison of computer operations per second:

- 500 Mhz PC comparable to a lizard
- In 5 years, supercomputers will be at this speed
- In 20 years, PC faster than human brain (10^{15} ops/s)

This will clearly trigger phenomenal changes.



(After Moravec)

iii) IT creates enormous incentives to re-engineering activities. For example, IBM saved over $300 M last year on $14 B of purchases on the Internet. There are staggering increases in efficiency, if you can reengineer work. Note the implications for the university, which has largely avoided re-engineering the academic enterprise. Significant implications for competition from those learning organizations capable of reengineering to take advantage of IT.

iv) A growing number of channels and approaches for learning, poses both threats and opportunities. (He expects Sloan's estimate of $10,000 to put a course on the Net as coming down very fast.)

v) Very significant intellectual property issues, involving research, data, course content. U.S. universities are becoming increasingly difficult to work with on IP issues.

What about the nature of the human interface? Wireless evolution will be incredible. Expect 1 Mb/s on cellular phones at $20 per month within a few years (implying universal access of wireless video).

Today there is already more computer power in Personal Digital Appliances that in all the PCs and enterprise servers. The number of data capable cell phones will cross over PCs within 3 years.

Gerry Butters:

The technology learning curve for photonics is evolving at twice the rate of information technology. Miniaturization is moving even faster, doubling every 9-10 months. The rate of growth of network appliances is incredible.

These technology learning curves are clearly superexponential, and show no sign of letting up.

It is important to look at all of this on a global level—the cybersphere. For example, the Sony Playstation 2 is really a platform for net appliances. Microsoft's X-box will have a speed of 300 M polygons per second, comparable to HDTV.

The logical web will require an avatar habitat. Agents in the network will be always on, always aware, and always atuned to one's needs. The logical part of the cybersphere will be a personal agent or avatar…or an agent for a workgroup. This will be a photonixa-based terastructure. (Mentions free-space optics.)

Some implications:

iii) The Age of Access implies than everything begins to disaggregate. This is already under.

iv) An example is Lucent's activities in China. One-third of Lucent facilities are research related, encouraged by the government. This is where intellectual capital gets created, integrating research facilities where there are likeminded industries. It is much easier to work on intellectual property issues in China than in the U.S. Easiest to work where the default is joint ownership, joint investment. (Note that Lucent will only do contract work in India because of laws, not the type of joint research they do in China.)

v) Research universities will face formidable competition from disaggregation on a global scale. Information technology provides nations with opportunities to leapfrog. Notes the expansion of wireless technology in Europe. Of course, many American research universities have global brandnames, so this may also be an opportunity.

vi) The quality of IT infrastructure is the key. Ideally, one seeks "fiber to the forehead". You cannot support the emerging hardware and software environments without big pipes.

Lee Sproull:

She applauds the Sloan Foundation work because they have actually tried to do something with today's systems. We can only learn how to use this stuff by trying it out.

Research universities are lagging far behind community colleges and 4-year institutions in efforts to learn about how to use IT. Perhaps research universities should begin by first understanding how to teach the plug-and-play generation.

Science is a social enterprise. There are serious aggregation issues, how to work together and socialize the next generation of scholars; at the next level are conferences competition, markets; and at the highest levels are institutions such as NAS/NAE. We need to pay particular attention to the middle level since this is changing very rapidly.

Open Discussion:

What is the ebb and flow of the best people? Still movement from big companies to research universities, primarily because of the freedom to follow the opportunity (and the money from startups). But this may be very field independent.

Intellectual property issues are driven both by institutions and faculty. But we have to be careful here, since tech transfer is quite different than intellectual property development. Need to keep in mind there are different business models, e.g., technology acquirers vs. technology developers.

Will there be major surprises? Certainly. The PC in 1980 and the Internet browser in 1994 demonstrate how difficult it is to predict the future. But we should say what we can say about today, and then move on.

Gomory stressed the importance of remaining rooted in the present. Technology really doesn't tell us what will happen, what to do next year. The more distant the future, the more exciting and distracting it can become. We should pose the following questions:
i) What should we do about things we can see today?
ii) What should we do to examine or influence possibilities over the longer term?

At the top of the research university pyramid, the power is in the hands of the retrograde faculty. You need to give them something to do that is purposeful.

Perhaps we need to better relate technology-economics to opportunity-threat.

Gerry Butters noted surveys of why people choose to work certain places:
i) quality of leadership
ii) quality of work
iii) quality of environment
Concern that in many large institutions, leadership is boring, work is not exciting, and the environment uses old tools.

"One good fright is worth 20 business plans!"

Humanity is faced with a temporal dilemma. Because of technology, event horizons are much closer than we think they are.

Getting people to think about implications of accelerating technology learning curves as well as technology cost-performance curves is very important. Industrial experience suggests that IT generates great benefits which can cover the costs of installing it. But most research universities will look at IT as a cost, and will not see the cost-benefit. Yet if you are not going to invest in IT, you may as well get out of the game.

Information technology represents the table stakes for survival.

Might consider the following sequence in driving change:

i) Need the right proportion of fright
ii) Importance of 1, 2, 3 above
iii) Here is what you do tomorrow when you get back to campus…
iv) Here is what you need to think about for the longer term…

Suggestion that we might use some place like Bell Labs or IBM Labs for such a discussion.

In separate communications, Doug Van Houweling and John Seely Brown provided their own comments for consideration:

Doug Van Houweling:

DEVH's comments focus on the challenge universities will have retaining instructional mindshare among their best-known faculty. We have long since adapted to the reality of those faculty getting released time and very substantial freedom with regard to their research activities. But he doubts that we have much considered the impact of their ability to do the same with their instructional activities. A number of institutions are responding to the new opportunities available to their most famous faculty by enacting and/or enforcing various policies directed at restricting the faculty's ability to contract with outside organizations in the instructional arena. While these policies may be one part of the solution, he believes universities will also have to generate opportunity comparable to what those same faculty have on the outside.

DEVH doubts that any one institution can do that independently, so he suggests we would need to organize to respond to the challenge. Can a small group of prestigious institutions so organize? We don't have a very good track record. Yet if we don't, he believes other organizational forms will develop to support learning communities, and that they will become serious competition for our professional education programs.

John Seely Brown

He believes that the next 10 years could see an unprecedented growth in SCIENTIFIC findings if research were funded correctly. The last 15 years has led to revolutionary new technologies which enable fundamentally new approaches to probing nature and pushing the boundaries of science, IT being just one example, mems probes for biomedical research another, biochips being yet another, and so on.

We need to think about the research enterprise being more than just a research university. First we need to find better ways to engage multiple disciplines, no matter wwhere they are and no matter if they are in industry or universities to team up for attacking certain problem areas. Creating an AIDS vaccine is just one example of this. As we move into nano systems, we will see another, and so on.-

How can we do a better job of funding whitespace research, that is, pioneering research that lies between well-trodden parhs and disciplines. Are we nearing the end of the standard paradigm of research, and should we consider trying to explore some other ones, especially if we take seriously the creation of "human sciences" that truly bridge the two cultures?

Should we think more about how to support and tap the creativity of the community mind a la open source? Are there ways to bootstrap the community mind, such as the MOSIS project. To him, MOSIS transformed the learning scape of VLSI design on our university campuses in an amazingly short period of time.

How do we better train researchers to be willing to pick up fundamentally new tools and ways to look at problems. In the old days, we had to wait for a generation of full professors to die before a department or field could move to a new plateau. In today's world, this won't work. Likewise, how do we take seriously lifelong learning/reskilling of our research community. Should there be special funding me3chanisms that encourage new explorations and skill acquisition for senior researchers? Should we consider ways to fund graduate students directly and have them choose who they want to work with and on what problems rather than have them funded by the large scale research projects of the establishment professors? Should we look for new criteria for tenure such as a stint in industry or some other field?

JSB believes we are at an inflection point in recasting the social contract for scientific research and in finding new tools and methods for tackling some major problems. We need to move beyond the implicit and explicit contracts of the cold war era. Once we figure out why we deserve funding, we need to engage in a better and more comprehensive dialogue with the public in order to regain support for our endeavors.

JJD
5/23/00