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"National Knowledge Strategies, the Intelligence Community, and the Library of the Future"

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Good afternoon. I want to thank the organizers of this conference for the opportunity to discuss creative uses of new communication technologies.

[Overhead: New Technology & Economic Growth]

New Technology & Economic Growth

- 100,000+ increase in available bandwidth in the 1990s
- Revolutionary opportunities for scientific innovation and economic growth
  - Hard sciences
  - Social sciences

There is more in the works, as you know, than the dreams of 500 home entertainment and shopping channels discussed so prominently in the newspapers. Bandwidth

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availability actually will increase by over 100,000 times by the end of this decade, and with steep reductions in cost.

These numbers are difficult to translate into the hard surfaces of everyday life. But we are living into the beginning of a logarithmic rate of change, in a key technology of the world's economy, which will be more rapid than any other period of history. This means that, with foresight, we can begin to organize major benefits to almost every kind of institution in every community, and to explore the possibility of new relationships among all sorts of institutions, worldwide.[2]

I'm speaking this afternoon wearing two hats. The first, as the Director of a project to organize new uses for these technologies to increase the rate of scientific, medical, and industrial innovation with a focus on the natural sciences. The second, as a member of a long-term planning committee of the International Studies Association that is addressing similar strategic questions for the social sciences.

Let me begin with the hard sciences.

I. HARD SCIENCES

In the hard sciences, print publications are no longer the keys to the creative process. The leading edge of science is in the state-of-the-art discussions at the research colloquia at major universities, the new ideas and preliminary results presented at scientific meetings, and the informal face-to-face discussions in the world's invisible colleges. When scientists, companies, or nations rely primarily upon the journals for new ideas, they are assured to be 1-2 years behind.

[Overhead - Trend: From Public Broadcasting to Private Multicasting]

Starting this fall, we can create 10 global videoconference and videobroadcast channels, to cover all areas of science, which can stimulate scientific, medical, and industrial innovation by allowing scientists in all countries to communicate at an earlier stage in the creative process. The best and latest ideas worldwide can arrive, as soon as possible, on

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[2] For thoughtful analysis of the changes of telecommunications technology on society and politics, see the pioneering work of Ithiel de Sola Pool, e.g., Technologies of Freedom (Cambridge, MA: Harvard University Press, 1983) and his Technologies Without Boundaries: On Telecommunications in a Global Age (Cambridge, MA: Harvard University Press, 1990), Eli M. Noam (Ed.).

the desktops of a nation's academic scientists and corporate engineers. Non-geographic research colloquia and seminars for creative discussion can begin to meet on a continuing basis, without the current limitations of money and distance.

These channels will begin with a low cost, low bandwidth system that furthers a historical shift from public broadcasting to private multicasting. Let me give you a brief technical overview.

Trend: From Public Broadcasting to Private Multicasting

- Step 1. Internet Multicasting
  - Internet Radio upgrade
  - Cu-SeeMe
  - PictureWindow
- Step 2: PC-Based Telephone Multicasting

The first stage of global science channels will build on the proven technology of Internet Radio, that now multicasts to 100,000 people worldwide. The new improvement, this fall, adds a clear picture or slide, every 1-2 minutes, to the audio signal: it can be a speaker's slides or images sampled from a videotape. The effect will be similar to listening to a speaker and watching his or her slides in a darkened auditorium. It is a system that can run on a desktop PC in the back of a lab, or provide you with files that you can view on fast-forward. It is transmitted by a smart hub-and-spoke system, called multicasting, which knows to send only one copy of a message to Paris, then create 17 clones of itself, and so forth.

I emphasize the <u>private</u> multicasting change, because the Channels will use private data channels that, like telephones, are governed by a different legal regime than public broadcast television. No government regulatory review or delay is involved.

The Internet multicasting technology will be the basic level for global scientific channels because the programs can be sent in real time or as reasonably-sized files to all (including all low bandwidth) locations. It works across a full range of platforms, without any additional investment at the receiving end. The programming can be there on the desktop, almost everywhere in the world, with exceptions of some locations of sub-Sahara Africa and locations in China and elsewhere where the government does not allow the new technologies and the free exchange of ideas.

A clear picture every 1-2 minutes is a crude system by commercial standards. But it's okay for working scientists who care about the ideas, the data, and the discussion. The channels can increase the productive use of time everywhere, but the biggest impact of the channels may be outside the top 20 American research universities - elsewhere in the country and the world. The channels can extend the cultures of our best research institutions, and the excitement of the discussions, globally. A research scientist or talented student in China, or West Virginia, or the former Soviet Union or Eastern Europe also can have an immediate and direct engagement and relationship with the best scientists. An engineer in the former Soviet Union, who may lack the hard currency for foreign travel, can have the best and latest ideas on his or her desktop, with opportunities for E-mail to make requests for papers, ask questions, and use computer bulletin boards for further discussion.

The attraction of this technology includes current Internet policy that prices at wholesale rates by the capacity for putting material into the Internet, not by the number of multicasting addresses. Yale's T1 Internet port, like that of many other universities, can readily accommodate one, and perhaps more, global multicast channels without additional charge. It's free . . . At least for now.

On the Internet, more advanced systems can come quickly. Before this group meets next year there will be Internet systems of multimedia multicasting and small group videoconferencing that will deliver combined audio and video channels at 3-5 frames/second to advanced PC's across a full range of platforms. It probably will cost about $1500 for a plug-in board and package on the transmission end, and require software-only, which will be free, at the hundreds of thousands of reception sites. Cu-SeeMe at Cornell and PictureWindow from Bolt Beranek and Newman in Cambridge are two of the leading candidates. They allow ordinary VCRs to be used for input and storage, rather than requiring expensive hard disks. Both systems like larger bandwidth, especially because they have capabilities for 5-7 windows to be open at once, but they degrade gracefully and can still provide usable signals to low bandwidth users.

The next stage, perhaps surprisingly, probably will come from using the phone systems in the world, because new technology is about to allow anyone in the world to become a television broadcaster on a local, national or global scale without requiring

licensing.

The keys are two independent developments. New PC-based videoconferencing packages are coming from Intel (with 20 products announced in the next nine months) and others.[3] These plug-in compression boards and software will transmit audio, 10-12 frames/second of video with clear pictures and, we have been told, good eye contact. They will be equipped for ISDN and operate directly over telephone lines without going through the Internet.

The second development that marries with this is advanced switching on national and international telephone systems that allows people to dial the same local or 800 number and be connected immediately into an ad hoc hub-and-spoke telephone network. It's known technology. Add the new Intel products and you now have the technology you need to be a do-it-yourself private global television multicaster. While private telephone circuits are still relatively costly, and a scientific society would have to pay $1.50/minute for a line to Paris, it only will need one, and the cost of the long-distance segments can be spread over many viewers. Charges can be added to a telephone bill. It's not just 500 channels that face us on the road ahead, but any number that we need, with any scope, to help get serious work done.

[Overhead: Financing International Scientific Networks]

Financing International Scientific Networks

- Donated Programming
- Fees from R&D-oriented corporations
- Advertising
- Government, Foundation & University support

[3] Frank J. Derfler, Jr., "Videoconferencing the Desktop," PC Magazine (Network Edition), September 14, 1993, p. NE17.

I might say something about financing this next revolution in the world of science. The new channels for working scientists are inherently lowcost. Every university just takes $x thousand from its speakers' budget, videotapes current material of wider interest as its contribution to the Channel, and receives back many times this value from the Channel itself.

You could run them as cottage industries, as part of the budget of a lab or government agency.

But there has been enough preliminary study to think money could be made, and sufficient income generated, to pay for new programming, to cross-subsidize among scientific fields, and underwrite full participation by scientists in the Third World. The experience of both the MIT Industrial Liaison Program and the Japan Technology Transfer Association suggests that corporate fees for specialized science channels could be substantial. Best estimates are that $5,000/year fees would be easy; $50,000/year would be possible but would depend on the new ideas and savings in travel a company found itself realizing; $500,000/year probably is dreaming. But even $25,000/year from 250 of the world's 500 largest R&D-oriented multinationals is a substantial income, especially if your programming and multicasting costs are close to zero.

Advertising is another possibility for financing. A recent Sloan Foundation study notes that a full-page 4-color ad in Scientific American sells for $75,000 and estimates this to be an approximation for one minute on a C-SPAN-like science channel with an equivalent viewership.[4] Low cost advertising also could be organized by topic - new products of interest in photovoltaic research, next Tuesday evening from 8-8:30. Companies interested to employ scientists could be allocated 5-minute segments, organized by industry.

Finally, there are perennial sources of support: governments, foundations, and fees from universities themselves. The goals of economic growth and competitiveness rank highly in every country, and the intelligence agencies of leading countries are increasingly being asked to provide information about science in other countries. It's possible that money could be derived from these sources. Because the innovative edge of science is 1-2 years before print publication, government translations of foreign scientific literature are - today - too lagged to be the primary investment in scientific information. If governments are paying for analysts to read journals or even to attend international scientific meetings and presentations at foreign universities, hear speakers, and pick up papers - then it might

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[4] Gary Welz, Proposal for the First Year of Production and Broadcasting (NY: Association for Computing Machinery, 1993). Copies may be obtained from Mr. Welz at the ACM, 151 Broadway, 17th floor, New York, NY 10036-9998.

make even more sense for the G7 or OECD nations just to encourage scientific societies to put all the truly relevant material in common channels, available on analysts' and everyone else's desktops.

[Overhead: Operating International Scientific Channels]

Operating International Scientific Channels

- Cottage Industries
- International Corporation for Public Broadcasting
- Limited Partnerships

There are several options for organizing channels. They could begin, like 1,000 points of light, as cottage industries. An Ocean Dynamics group at Yale, for example, might just do an Ocean Dynamics Channel of 2-3 hours/week, worldwide, receiving videotapes and multicasting to everyone who wants to be on the list.

The ideal Open Source solution could be a kind of international Corporation for Public Broadcasting for science that could offer multicasting services to the entire international scientific community, and manage cash flows, advertising, user fees to corporations, and other elements that are the comparative advantage of the business community and managers rather than research scientists. It would take visionary people to create this.

It also might be reasonable, in some cases, to create limited partnerships among

scientific societies, interested industrial sponsors and private investors. We have helped to draft a proposal for colleagues at MIT, for example, for an environmental channel that might be supported by the international automobile industry. Industrial leaders would identify key technologies for the future of their industry - synthetic fuels, photovoltaic and fuel-cell technology, efficient manufacturing - and while the channel would be run by scientists themselves, all of the stakeholders in rapid scientific advance in these fields would be working together. Any new ideas would be available to everyone, but if a company is well-positioned to recognize and take advantage of new ideas, everyone should get their share and benefit.

[Overhead: Priorities for International Scientific Channels]

Priorities for International Scientific Channels

- Telecommunications & Computer Science
- High Quality Across all Fields
  - Former USSR, Economic Transition
- Environment
- Mathematics
- Human Rights & Conflict Resolution
- UN Science Channel

One design question is to select areas where these new technologies, and especially the video and interactive possibilities, could give a high yield. This overhead identifies a list of areas that have emerged where we've been seeing what can be organized. There are special opportunities to fashion channels that can build relationships throughout the former Soviet Union and help with the transition and upgrade of plant, equipment, and skills. They have a basic cadre of very capable scientists who lack ready access to foreign exchange, but it may be one of the wisest investments the world could make - with extraordinary returns - to use these technologies to connect them, on a daily basis, with

state-of-the-art discussions and have their talents fully on-line for the work ahead.

Mathematics, as you will see, is on the list - primarily because it's a good non-political startup. Biomedical and pharmaceutical channels should be on the list, but ideally NIH will take this on, or one of the two extraordinarily well-endowed foundations, the Howard Hughes Medical Institute with $7 billion in endowment, or (in Britain) Burroughs-Wellcome with $8 billion. A UN Scientific Channel might be a useful role for UN University or UNESCO, and be a step forward in the agenda in President Clinton's speech to the UN, encouraging it to reinvent itself using the technologies of the information age.

[Overhead: Problems for International Scientific Networks]

Problems for International Scientific Networks

- Strategic planning for global science
  - Urgent needs. former Soviet Union, Eastern Europe
  - Urgent needs: environment, sustainable development
- Quality control
- Discussions that get somewhere
- Open sharing and reciprocity

This next overhead identifies problems and pitfalls, and there probably are several that are not on this list that the pioneers will encounter. I will not go through a full discussion, but I do want to comment on two issues of open sharing and reciprocity.

First, there might be political issues raised about "giving away *our* ideas" - although as a scientist I should say that the people who talk this way - i.e., about "giving away *our* ideas" - aren't the people whose ideas are involved. But it may be wiser to have part of

this strategic vision for the future of global science developed at one-step removed from governments. We've had 500 years of an international politics with nation-state personae squaring-off against each other. We're in a special period and there is always a potential for restarting destructive and primitive dramas of national mercantilist competition. It may be better to let sleeping dogs lie. But I do want to emphasize that there are sound arguments to make (and that will be made straightforwardly) if this enters the political arena. Let me call to your attention what scientists call the 40% rule - American scientists may produce 40% of the breakthroughs, win (in many fields) 40% of the Nobel prizes. But the rest of the world produces 60%. We need each other, and if we shut them out, we're the net losers. *[Pause]* But with 40% we're also in a good bargaining position, in a unique historical period, to help build a global future with full reciprocity.

The second comment about openness I want to make is the question of whether scientists will share their best ideas? In some areas with high potential for profit - areas of biotechnology, for example, this may be a barrier and the best programming would be selected from areas like genome-mapping research, where people expect to make money eventually, but no one is sure (yet) how. In other areas, however - for example, environment-related research - scientists are eager to know the data and ideas of scientists in other locations.

In general, a new era of global scientific channels offers three incentives scientists care about. The channels offer a guarantee of scientific priority - being the first person to mention an idea, before a global audience of leaders in the field. They allow scientists to, in effect, advertise for consultantships or support for their labs before a worldwide audience of corporations and venture capitalists - hinting, and giving away, just enough of their work. And third, the possibility of the fast and free exchange of ideas, creative discussions with other stimulating and bright people, and serendipity is one of the genuine pleasures of science, and these occasions can be multiplied by the channels. The Channels need to be thoughtfully designed by good people - but I think we can create Tuesday brownbags that no scientist in his field would miss.

[Overhead: National Security Benefits]

I will not spend much time on the national security benefits. There is a good fit with the Neo-Wilsonian views of the Clinton Administration. These global channels are, I think, the most worthwhile idea I can imagine to expand our global scientific capability, stimulate economic growth, and bring our full resources to bear on the urgent problems of environment and sustainable development that will become worse, and where the world badly needs breakthroughs in the years just ahead.

[Slow] I might add, however, a word about a New World Order dimension. The best

investment of the British Empire to foster democratic values and long-term relationships probably was the role its educational institutions played in educating the best students of the Commonwealth. Acting now, the US and American institutions can bring values of technical excellence, openness, and common commitment to these channels that may be an equally farsighted investment.

National Security Benefits

- Economic Growth
- Improved Chance of Breakthroughs for Urgent Science-Related Global Problems
- Neo-Wilsonian Values
- Applying the Bntish Model

At this point, however, I must tell you that I am not sure anything is going to happen. The channels could start in many areas, supporting many different groups, develop as small-scale cottage industries, limited partnerships, or a global Corporation for Public Broadcasting. But any startup requires a bit of money and leadership, and no one seems to be getting past the first letter with any major foundation. In earlier cycles of technology, in earlier decades, we would just be receiving visionary Reports from a Sloan Commission or a Carnegie Commission, which would stimulate public discussion of creative uses for new technologies, such as the cable broadcast system and the Corporation for Public Broadcasting. At this point, however, no major foundation is writing checks. The Clinton Administration has been looking at a proposal for a global Environment Research Channel as an expression of its commitments, but no policy has emerged and it's unclear whether the Executive branch is fully organized to act in anticipation of events in this area and recognize and shape these extraordinary emerging global forces that can secure a better future for us all.

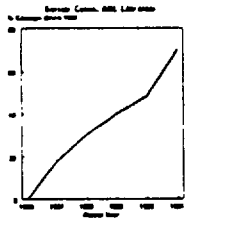
II. SOCIAL SCIENCES AND ECONOMIC GROWTH

Let me now shift hats and discuss briefly a strategy to improve information sources for the social sciences and economic growth.

[Overhead: Escalating Costs of Serials for Research Libraries]

Escalating Costs of Serials for Research Libraries

- Total costs, $350 million/year for 107 ARL members
- Total costs with -2% change in # of titles



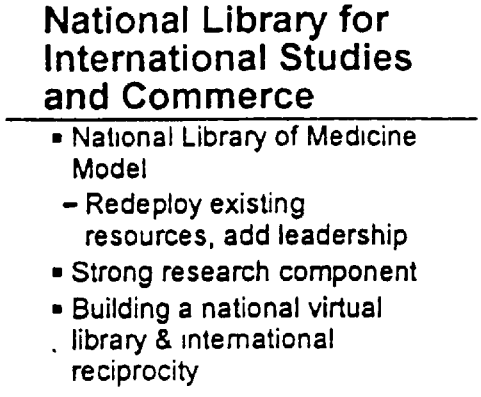
As a nation, one of our best ideas has been the National Library of Medicine and its creations such as the Index Medicus. Across several decades, it has supported America's global leadership in biomedical research. The omnibus Library of Congress is a fine institution, but it was not designed to serve a single clientele that is highly purposive about what it is doing. If we want real progress in an area, we need an institution with a focus, and that will invite - as the National Library of Medicine has done - some of the finest people to design the nation's basic information systems.

As everything becomes more international, the stark truth is that American universities and research libraries will not keep up. The number of publications is rapidly increasing everywhere, including in China and the former Soviet Union. But it's a fantasy to believe much additional information will be received, processed, and available in American university libraries. The overhead transparency tells the story: The 107 leading

North American university research libraries in the Association for Research Libraries now spend $350 million/year for periodical and journals. The total budget is going up - 72% in the past five years - while the total number of purchases actually is being cut - down 2% in the same period. Even Yale has drawn the line: there will be no net increase in periodicals purchased, in any field, or from any area of the world.[5]

[By the way, it might occur to you that 72% increase in the average cost of periodicals in the past five years is not justified by increases in the cost of producing the journals. And you would be right. Also, scientists do not receive a penny of royalties from publishing in scientific journals - the $350 million/year does not go to the pockets of scientists. The system is a house of cards. As a nation, if we decide to push it over and replace it with electronic publishing, I doubt there would be a scientist or University librarian in the country who would shed a tear for the publishers.]

[Overhead: National Library for International Studies and Commerce]



[Slow] I'd like to suggest a National Library for International Studies and Commerce, on the model of the National Library of Medicine. Physically just outside the CIA gates

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[5] Sarah M. Pritchard and Eileen Finer (compilers), ARL Statistics, 1990-1992 (Washington, DC: Association for Research Libraries, 1992), p. 8.

in Langley. The open collections of the Library of Congress, Foreign Broadcast Information Service, the CIA, and other members of the intelligence community can come together in one place. Hire a first-rate Director, add a bit of new money - but not much - and the opportunity to create the virtual library of the future could attract some of the most capable people in the world, serving jointly our government agencies, major research libraries, and business.

Obviously, a data warehouse isn't enough. The new National Library for International Studies and Commerce needs a first-rate and strong research component, and serious - sector by sector - attention to the international information needs of American business and other institutions. But I might mention that I've seldom seen tenured faculty colleagues bounce up and down in their seats in joy and enthusiasm. I see it, these days, among former colleagues and bright graduate students at MIT involved in computers and information science. If you build it, they will come. Just as the National Library of Medicine, its Index Medicus, and other services provide extraordinary support for American leadership in biomedical research, so a National Library of International Studies and Commerce could provide Washington-based opportunities for creative talent and an institutional vehicle to organize a similar, bright, future for many of the pioneering ideas we are hearing this week.

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I am chagrined, in a way, not to have any proposals for spending enormous sums of money to produce major results. But, in both of these areas, the gods of technology are smiling on us. The good news is that new money is needed, but not much. The cautionary news - and I hope it is temporary - is that a touch of high-level leadership, and a small amount of inspiration, are still required to launch the new era.

Thank you for your attention.

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