NHA Congressional Briefing
by
Maud Chaplin
Ruth Schwartz Cowan
Alex Rowland

Implications of Technological Innovation at the End of the 20th Century

With Introductory Remarks by
Dr. Bruce Seely

National Humanities Alliance
Washington, DC

With Support from the Rockefeller Foundation

1997

NHA

The National Humanities Alliance

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Implications of Technological Innovation at the end of the 20th Century is the second Congressional briefing session of the National Humanities Alliance (NHA). This is a new educational activity that the NHA hopes will demonstrate the value of scholarly research in the humanities to members of Congress and Congressional staff.

The National Humanities Alliance is a not-for-profit 501 (c) (4) organization that was created in 1981 to unify public interest in support of federal programs in the humanities. The NHA is comprised of scholarly and professional associations; organizations of museums, libraries, historical societies, higher education, and state humanities councils; university and independent centers of scholarship; and other organizations concerned with national humanities policies. (A list of NHA members appears in the inside back cover.)

Most members of Congress recognize the importance of humanities in school and college curricula; fewer however, are aware of the potential role that humanistic scholarship could play in informing public policy. From the NHA perspective, a significant amount of scholarly work in the humanities is of immediate value in addressing both domestic and international policy alternatives of many kinds. The humanities offer in- sights that contextualize and identify sources of conflict—whether they are economic, social, religious or cultural; focus on moral and ethical questions upon which all public policy is based; and illuminate the practical consequences of various strategic policy choices. The state humanities councils have demonstrated the value of the humanities through a wide variety of programs. No comparable effort, however, has been under- taken with respect to policymaking at the national level.

Recognizing the need for a broader understanding of the usefulness of the humani-ties for some time, the NHA launched the Congressional Briefing Program in 1992. A generous grant from the Rockefeller Foundation has made this program possible.

John Hammer
Director

Congressional Breakfast Briefing
National Humanities Alliance
May 10, 1996

Introductory Remarks:
Dr. Bruce Seely, Professor of Hustory,
Michigan Technological University.

We are here to demonstrate what historians and philosophers can offer when analyzing the role of technology in society and its implications for contemporary life. These issues are very much at the forefront of our fields.

Three of our panel members have been officers of the Society for the History of Technology. The title of our journal, "Technology and Culture," conveys our interest in situating those two broad areas of history and philosophy at an interesting intersection. Despite our interest in contemporary issues, it may seem unusual to have historians and philosophers talking about policy questions. In recent times, natural scientists, physicists, and engineers have often taken the lead in providing guidance or background on policy questions. But just a little over one hundred years ago, during the Progressive Era, the notion of putting academic expertise at the service of better social policy was formulated. The architects of that concept were primarily people with an economics background, political economists for the most part. Their premise was that people with a university education that stressed science as the core of their learning were neutral, unbiased, perfectly logical problem-solvers for society.

These economists in fact had a historical orientation toward their work. They grounded their arguments about the problems of society and its solutions, not only on a clear understanding of current issues and reality, but, on an historical perspective as well to help find solutions to societal problems. In fact, the use of history in public policy is as old as public policy itself.

The value of history for the formulation of public policy has been argued convincingly by historian Ernest May and political scientist Richard Neustadt, both at Harvard University's John F. Kennedy School of Government, in their influential book, *Thinking in Time: The Uses of History by Decision Makers* (1986). The book shows that history has always been used in policy making. Policymakers have frequently drawn on history through analogy or metaphor, sometimes doing so unconsciously. They may have asked themselves how their predecessors acted or reacted in situations that seemed similar; but they probably did not analyze whether the current situation is really analogous or question the validity of their comparisons. Or they may simply have used bad or incorrect history. May and Neustadt conclude that good policy is best served by drawing on historical analysis that is as accurate as possible.

With that in mind, we have assembled a panel of two historians and a philosopher to discuss a few policy implications of technological innovation at the end of the 20th century. Ruth Schwartz Cowan, professor of history at the State University of New York at Stony Brook, will talk about some ramifications of the distinction between science and technology for public policy. Alex Roland, chair of the History Department at Duke University, will discuss the importance of determining, for public policy considerations, whether we are indeed in the midst of a computer revolution. Maud Chaplin, chair of the Philosophy Department at Wellesley College, will bring the two strands together by focusing on the threat that technology poses to privacy.

PRESENTATIONS

DR. RUTH SCHWARTZ COWAN:

For this presentation, I will discuss some distinctions between science and technology. This may strike you as an academic exercise, but I will argue that it has important ramifications for science and technology policy. Like many historians, I will make my argument by telling stories, but do not be fooled: historians generally choose to tell the stories that make analytic points they regard as significant.

The first story is a social history story, not about individuals but about groups of people. In the early part of the 19th century, say roughly between 1800 and 1850, most people could easily tell the difference between what "science" was and "technology" was. Indeed, it would have been immediately obvious, upon walking into a room, whether the people inside were scientists or technologists: the two groups of people (most of whom were men) spoke differently, dressed differently, and even smelled different from each other. In that era science was taught and practiced by college-educated or professional people; that is, people who had jobs in colleges and universities and museums. Technology, on the other hand, was done by artisans, people who were trained in workshops and who continued to work in those settings.

Late in the 19th century, however, this easily discernible social and intellectual difference between science and technology began to erode. Some people argued that artisans ought to know science; that we'd get more progress faster—and better progress faster—if we taught the subjects that were being taught in colleges and universities to the men who were in workshops. The earliest engineering colleges were created with precisely that intention: they were to be places in which the knowledge of intellectuals, the scientists, would be integrated into practical education for a certain group of people, people who would be called, not artisans, but engineers. Engineering education, its founders believed, had to be grounded in science. The faculties of engineering colleges had to be trained in the sciences; the students in engineering colleges had to learn to make use of the scientific method.

In the latter part of the 19th century, in addition to believing that knowledge should flow from scientists to technologists, many college-educated people also had a notion that being a scientist was somehow better than being a technologist; that the head was better than the hand; and that being rational was preferable, in a social and intellectual hierarchy, to being practical. Henry Rowland made the distinction very clearly in a speech that he gave to the American Association for the Advancement of Science in 1883. Rowland was a professor of physics at John Hopkins University, the first university in this country to grant the Ph.D., and the leading American physicist of his age.

> I refuse to call telegraphs, electric lights, and such conveniences by the name of science. I do not wish to underrate the value of all these things. The progress of the world depends on them. And he is to be honored who cultivates them successfully. But so also is the cook who invents a new and palatable dish for the table. That person ben efits the world to a certain degree. But we do not dignify him by the name of chemist.

From Rowland's perspective, scientists were better than inventors; while inventors were better, although not very much better, than cooks.

As a consequence of the growth of engineering education at the turn of the 20th century, it became harder to distinguish between scientists and technologists. Scientists and technologists both belonged to the same social class. Many engineers were as well-educated as scientists; many had white-collar jobs, and those who worked for corporations may have even dressed the same way as scientists. However, until the second half of the 20th century, scientists and engineers could still generally be distinguished from each other on the basis of their place of employment. Scientists were employed in non-profit institutions, primarily colleges and universities; while engineers were employed in industry, motivated by profit, attentive to the bottom line.

Thus, ironically, just as the class distinctions between scientists and engineers were disappearing, Rowland's conviction that science was intellectually superior to technology—*science discovers, technology applies; discovering is better and harder than applying*—became embedded in our culture. Additionally, although historians of technology and science have recently begun to argue that the distinction between science and technology no longer corresponds in any meaningful way to reality, many people still believe in it.

> ***"As a consequence of the growth of engineering education at the turn of the 20th century, it became harder to distinguish between scientists and technologists."***

My second story demonstrates why historians of science and technology no longer believe that the late 19th century distinction between science and technology makes any sene today. This is a story about individuals, not groups; and it brings into relief the reasons why we make serious policy errors if we continue to look at the world through Henry Rowland's glasses.

The story of recombinant insulin begins in 1953 when James Watson and Francis Crick published their discovery that the molecular structure of DNA was a double helix—a classic masterpiece of scientific work. It is basic research in that it tell us something crucial about one of the basic building blocks of a natural phenomenon: genetic replication. Socially, Watson and Crick were scientists: their salaries were paid by not-for-profit institutions. In very short order after 1953, other scientists made additional discoveries that increased our understanding of DNA: that genes are sequences of bases lying along a double helical molecule; that base sequences make proteins; and that there are certain proteins, called enzymes, that can chop DNA into specificiable pieces called—*restriction* enzymes.

Much of the work that led to these discoveries (including Watson and Crick's work) was funded by governments, philanthropic organizations, or universities. That funding was donated because of the practical benefits that the research promised. Scientists were not in the least bit hesitant to advertise those potential benefits when they asked for money: namely that the more we knew about what DNA was and how it functioned, the better able we would be to cure disease and, possibly, improve the foods we eat. The scientists and the people who decided to fund this scientific work believed that what they were doing would, ultimately, benefit society through progress in medicine and agriculture, two important underpinnings of our social and economic welfare. Thus, scientific research was paid for by people who were hoping to sponsor technological progress. Government and foundation funding for basic research was crucial to science in the postwar years, and it was predicated on an intimacy between science and technology.

Much of what we know today as the biotechnology industry is based on two discoveries in 1969. Herbert Boyer, a bacteriologist employed at the University of California's Medical Center in San Francisco, identified a particular restriction enzyme in a common, harmless bacterium, e. coli. That had the very particular property that when it cut DNA into pieces, it left a sticky end onto which something else could potentially be grafted. Stanley Cohen, a microbiologist employed at Stanford University Medical School, developed a micro-surgical technique for removing and inserting bacterial plasmids, pieces of DNA that float around inside bacterial cells. Cohen quickly realized that if his technique for removing plasmids was combined with Boyer's restriction enzyme, the two men could create bacterial hybrids; that is, they could take a plasmid out of a bacterial cell, graft onto it a stretch of DNA from another organism, and then reinsert the new plasmid back into the original bacterium.

Bacteria multiply very rapidly and bacterial DNA, like all DNA, creates proteins out of raw materials in the bacterial environment. Bacterial hybrids could, potentially, produce any protein made by any other organism in the world if the DNA sequence that codes for that protein had been identified. For example, if the base sequence that produces the ingredients in human milk were grafted onto a bacterial plasmid, and that plasmid were reinserted into one e coli, and that bacterium was allowed to reproduce, within a few days you would have a bacterial assembly line potentially ready, given the right raw materials, to produce large quantities of recombinant human milk.

A third, equally crucial, development in the evolution of the biotechnology industry was the invention of machines that could sequence the bases in strands of DNA very quickly. Such a machine was invented at Harvard by two scientists, Allan M. Maxam and Walter Gilbert. Their work was supported by federal grants, but the patents on the machinery were assigned to Harvard University.

"A third, equally crucial, development in the evolution of the biotechnology industry was the invention of machines that could sequence the bases in strands of DNA very quickly."

Shortly after Cohen and Boyer realized the commercial potential of what they had discovered, they began looking for a product with significant demand, but short supply. They decided that insulin filled the bill and approached Arthur Riggs, a biochemist who worked for the City of Hope Hospital in Los Angeles to ask if he would join them and synthesize the base sequence, the gene, that produces insulin. Just at that moment, Riggs was preparing a grant proposal to submit to NIH for research that would allow him to synthesize a slightly simpler gene which he thought would be an essential first step in learning how to synthesize the insulin gene.

Cohen and Boyer convinced Riggs not to send the proposal to NIH. Instead they approached venture capitalists to raise money and created Genentech, the first biotechnology company. Genentech then wrote contracts with Riggs's laboratory to synthesize the genes, first the simple one and then the one for insulin. Thus, Riggs's laboratory became a social hybrid: a lab which had been financed with public and charitable funds that was used to develop a product that would be owned by a profit-making corporation.

In addition to grafting together pieces of DNA, the biotechnology industry combines government funding, philanthropic donations, and profit-centered entrepreneurship. It creates biological hybrids at the same time that it is a social hybrid, producing neither technology nor science, but something else altogether: technoscience. In the technoscientific world, scientists employed by government and philanthropic organizations now sit on the advisory boards of corporations. In return, they get substantial compensation in the form of fees and stock options. Universities strongly encourage their faculty to do more, rather than less, of such consulting work. Scientists leave academia altogether to create start-up companies of their own, taking all the training that was paid for by government and charitable funds. Young people whose training was similarly financed are moving into industry as fast as they possibly can. My colleagues in biology departments have an interesting way of expressing the transformation they have observed in their profession since the 1950s: the biologists, they sometimes say, "have known sin."

If biologists have known "sin"—and if "sin" is what it is—then they have had, as so many sinners have, some prominent predecessors. The biotechnology industry was not the first technoscientific hybrid in the 20th century. The history of the aerospace industry reveals that it too is a social and economic hybrid. So too are the pharmaceutical, computer, and nuclear industries.

Why then do biologists and others, including some policymakers, continue to think of these hybrids, these matings, as "sinful"? I would argue that they have not yet dispensed with the distinction between science and technology which was so popular in Henry Rowland's time, namely the notion that science discovers and technology applies—and that there is something better, purer, nobler about the former when compared with the latter.

However, since the end of World War II, if not before, neither science nor technology has been pure. Instead we have had technoscience, an enterprise in which it is impossible to separate the person who discovers from the person who applies, in which the time between discovering and applying may be less than a microsecond, and in which the funding for discovery is forthcoming, not because of the inherent interest of the discovery, but, because of the potential usefulness of its applications.

The sooner policymakers realize this reality and stop thinking of it as sinful, the sooner will better science and technology policy emerge. We might, for example, want to rethink the current division between scientific and engineering education and eradicate it. In considering the implications of the growth of technoscience, we might decide that it is not wise to separate science policy from industrial policy, as if they were two quite different undertakings. We might want to acknowledge in policy what has been happening in fact in the so-called science-based industries since at least the 1920s: namely that government funding and philanthropic donations have been undergirding industrial growth. We might further want to consider making public funds available for engineering research at the same rate that we make them available for basic, or scientific research, on the grounds that they may be inseparable from each other and, at the very least, that both are essential for economic growth. Finally we might want to consider abolishing the distinction between copyrights and patents, the distinction our legal system has traditionally made between intellectual property and artifactual property. Such traditional distinctions may have made sense in the 19th century when both systems initially developed; but, as I hope my two stories have made clear, they do not make very much sense today.

DR. ALEX ROLAND:

I will address a very different area which, nonetheless, shares some of the same characteristics. My focus is also on the intersection between history and public policy; however I will be looking at computers. Examples of public policy responses to computers abound in the political world and in the press. A candidate running against Jesse Helms in the recent primary campaign in my home state, North Carolina, maintained that we were in the midst of a computer revolution. The proper public policy response to this, he argued, was to put a computer in every classroom. A front page article in a recent *Washington Post* noted that Fairfax County now advocates that every sixth-grader should have an $1800 lap-top computer to keep up with the rapidly evolving world. I find this notion staggering on several levels, not the least pertains to safety. We read repeatedly of kids robbing each other for their shoes and coats. Imagine sixth graders carrying around these $1800 computers!

My major concern is that people formulating public policy in both cases believe that they are in the middle of a revolution. Furthermore, they have concluded that children who don't get computer education in their schools now will be unprepared for the future because computers are the future. I want to explore the accuracy of that perception and its implications for public policy.

> ***"My major concern is that people formulating public policy... believe that they are in the middle of a (computer) revolution."***

The topic interests me because it is similar to my research on the Strategic Computing Initiative. This program that the Advanced Research Projects Agency (ARPA) funded from 1983 to 1993 was predicated on a similar perception about computers. SCI was established quickly after the Japanese announced that they were embarking on a so-called fifth generation of computers that threatened United States leadership in the field. The Japanese declared that they had the capacity to leapfrog from the third-generation computers that everyone was using to fifth-generation computers. In other words, they would jump from microprocessors to supercomputers that had the capacity to run artificial intelligence, or, as one scholar put it, to "machines who think."

Given the Japanese track record in automobiles and consumer electronics, their announcement caused great alarm in the United States. ARPA was one of many agencies and constituencies that decided to invest significant resources to stay ahead of the Japanese.

I see my study of the Strategic Computing Initiative as a history of recent technological development and public policy. I created an undergraduate course on the computer revolution to educate myself about the topic. I hoped also to educate my students about computer development in the United States and throughout the world. I've taught that course three times now. Most of the students in my class last spring were not history majors, but computer jocks who thought this would be a cool course as well as a way to fulfill their history requirement. They came in bubbling with enthusiasm, firmly convinced of the existence of a computer revolution. By the end of the course, only one student still maintained that belief; the others had become quite skeptical. I'd like to show you how they arrived at their new point of view.

It's very obvious that there are important developments in computer technology today. The evidence includes the sheer number of computers out there, the size of the computer manufacturing industry, the importance of the computer research establishment now, the intense competition between the United States and other countries, and the rivalry among companies in the United States. In addition, today's computers are doing things that were out of the question before. The most sophisticated supercomputers can do mathematical computations that were physically impossible before they came along.

As a result, we have many new services that we take for granted now; but my favorite example is airline reservations. We all managed to make our reservations and get on the right planes before we had these computers. Now we have enormous flexibility to change times, flights, and airlines. As a result, airlines can provide more efficient service because computers allow them to track and adjust to changing demand.

The military has also been transformed by computers. The Gulf War was almost a wizard war of computers and other sophisticated modern electronic equipment. It might be argued that the war was essentially won before the shooting started; we had the technological capability virtually to disarm the enemy before we started firing.

Clearly something big is happening in the world of computers, but what kind of development is it and what are its implications for public policy? It's important to know whether it represents a real technological revolution because a different set of public policies follow from this conclusion. To analyze this question, I always ask my students the following two related questions: are we witnessing a revolution and, if so, is it a computer revolution?

> ***"Clearly something big is happening in the world of computers, but what kind of development is it and what are its implications for public policy?"***

Historians have at their disposal a range of tools and techniques for dealing with both questions. I should perhaps caution that the discipline is somewhat proprietary about revolutions. We like to think that we alone can certify historical change as a revolution. For the last quarter of a century, historians of technology have been studying the nature of technological change. In the process, we have developed models to describe not only what goes on in such transformations, but also why. We have also accumulated a certain amount of corporate wisdom about how to understand the process.

We have learned, for instance, that "revolution" is a freighted term. It carries rhetorical baggage that impedes its usefulness and explanatory power. In recent years, it has been invoked more often to sell an idea than to describe a phenomenon historically. Indeed, I have come to believe that you should hold onto your wallet whenever you hear the term invoked, as it has been recently, to claim that there is a "revolution in military affairs" or a "spaceflight revolution."

In order to resolve these questions—are we witnessing a revolution and, if so, is it a computer revolution—we had better understand the meaning of the term "revolution." As I see it, there are two kinds of revolutions. The distinction between these two is particularly useful for our analysis. The first type of revolution is the directed or political revolution. The Glorious Revolution of 1688 that ended decades of political turmoil in England is the first modern instance of a political revolution. Indeed, that's when the word "revolution" was first applied to a political phenomenon. The Glorious Revolution was followed by the American Revolution, and then the French Revolution which served as a model for the Russian and Chinese revolutions in the 20th century. These were all self-conscious efforts to overthrow the existing political order in a short period of time.

The other kind of revolution, the kind we have in mind when we talk about a computer revolution, is the autonomous or systemic revolution. Examples are the agricultural revolution or Neolithic revolution of the 8th millennium B.C. and the urban revolution of the 4th millennium. More familiar still in modern times is the scientific revolution of the 17th century and the industrial revolution of the 18th and 19th centuries.

Although these transformations were produced by human agency, no one consciously directed the effort or orchestrated a transformation of science in the same way that French revolutionaries tried to overthrow the ancien regime. Instead many people made scientific discoveries that changed the nature of science and the way we think about the physical universe, but they didn't say, "Let's have a scientific revolution." They did not invite their colleagues to collaborate with them in a cooperative enterprise to overturn the existing order.

When trying to determine a public policy response to a revolution, it is important to determine what kind of revolution it is. Is it a natural revolution emerging out of human agency, but not consciously directed? This is the juggernaut coming down the road that will run over you unless you climb on board. Or is it a manufactured revolution, a concept in somebody's mind? In other words, is somebody appropriating this terminology to sell you a bill of goods? In the Western world, the term "revolution" has taken on a positive connotation, though we now prefer revolutions without violence. We tend to think that technological revolutions are good; and don't want to be left behind if one is coming our way.

The term "revolution" is used all the time in public policy and in my other areas of research. Generally it's a term of art. The Pentagon has talked about a "revolution in military affairs" for decades to sell a sophisticated arsenal to the American public. The implication is that we risk our national security if we don't keep up with the latest changes in weaponry. What one scholar has called the "space-flight revolution" was also used to sell the space program. This doesn't mean that somebody's

trying to sell something every time we hear the term "revolution," but we would be wise to be wary. So revolution may not be the correct term, but we now we are witnessing dramatic change.

> ***"Perhaps what we are seeing is a micro-electronics "revolution" that has been responsible for everything—wizard weaponry, the ATM card, the space program, and micro-processors."***

This brings me to my second question: how should people who are involved in public policy think about the nature of change? I think it's fruitful to get away from the notion of revolution. By analyzing the change itself, focusing on what's changing and how it's changing, we can think more constructively about an appropriate response to it.

The so-called computer revolution is actually the result of several areas of technological change that are related to each other. From my perspective as a historian, I cannot say which of these may prove truly revolutionary, or if, in fact, any of them are. One innovation that may have been truly revolutionary is in the field of micro-electronics. It is possible to go back to the beginning of solid-state devices in the late 1940s and follow a trajectory that leads to all the developments that we often label as the computer revolution. Perhaps what we are seeing is a micro-electronics "revolution" that has been responsible for everything-wizard weaponry, the ATM card, the space program, and micro-processors. These advances would have been impossible in the form that we know them now were it not for the new micro-electronics technology.

Alternately, we might conceivably view the entire phenomenon as a digital "revolution." Since World War II when we went from analog machines to digital machines, we have been working toward computation, signal processing, and communication in digital form. As a result, we can store, retrieve, and manipulate information on the computer, and even transmit it in the same digital form. In fact, our society and much of the world is now engaged in head-long pursuit of changing virtually everything we know into digital form so that information can be transmitted at an ever-faster rate.

We should stop to consider whether this is an appropriate choice. Some researchers investigating "life-based artificial intelligence" maintain that computers of the future are likely to be designed on an organic model. These life-based computers are not digital machines, but are more like analog computers. It will be disastrous if computer development follows a life-based model while everything else is digital because the two technologies won't be able to talk to each other. Should there be such a disjuncture between the trajectory of computer development and the trajectory of all other technologies, we will have to choose between them. In order to choose which one to pursue, policymakers should now decide which technology is really revolutionary.

Another interpretation would be to view this whole phenomenon as an "information revolution." From this perspective, micro-electronics, computers and communication, and digitalization are all new technologies designed to store, retrieve, and manipulate information at a greater rate and with greater sophistication.

Each conclusion has enormous implications for public policy because each one leads to a different public policy. The internet is a solution for a communication revolution; while life-based computers and less digitalization are appropriate responses for a computer revolution. However, if digitalization were the cornerstone of the revolution, life-based computers do not mesh with the infrastructure that is being developed.

> ***"We came to suspect that one hundred years from now historians will probably call what we're living through an information revolution."***

It's critical, then, to determine where the phenomenon is really going. In the end, my students concluded that there's no computer revolution because they could not discern which revolutionary technological change was fundamental and determinant. We came to suspect that one hundred years from now historians will probably call what we're living through an information revolution in which many related technologies were brought together to make information easier to store, retrieve, and distribute.

A few cautionary tales should suffice to illustrate how difficult it is to recognize a revolution while it is going on, let alone to predict how it will turn out. In his book *The Trouble with Computers*, Thomas Landauer has dubbed the first example a "productivity paradox." The widespread introduction of the computer in the United States should have led to a great increase in worker productivity, but in fact individual worker productivity has gone down since the early 1970s when computers entered widespread use in American industry. Landauer can find no evidence that computers help us do our work better than other tools do. The capital that American business has invested in computers has generated 14% less in output and productivity than the average of all other capital investments. In other words, we would have done better spending that money on more typists and typewriters, accountants and adding machines. Computers may one day increase the productivity of American business, but they have not yet done so. One reason becomes clear in the next cautionary tale which I call the "hardware fallacy."

We are obsessed with a computer in every classroom and a "notebook" for every sixth grader. Yet nobody knows what kind of software will be used on that notebook, what it will do for students, or how to train teachers and students to use it. We seem to believe that if students carry such enormously powerful hardware around, they will be prepared for the future. We're infatuated with the technology, the hardware, the machinery itself, and its enormous power; but we have not evaluated how productive or useful that power is.

In addition, we must take into account a third cautionary tale. This phenomenon, which I call the "sovereignty of the user," leads to unanticipated consequences. E-mail is the best example of this. Not only is it a user-developed phenomenon; it has probably also had a greater impact on the way people do business now than any other computer development. In this case, hardware that was developed to share research data came to be used more frequently and more productively for e-mail. Though users pursued the intended purpose of the machine, they also started using it for informal communications with colleagues and friends. Soon the demand for e-mail swamped the network. What began as a linking of computer resources to facilitate research turned into a system that linked users. The users developed the information superhighway.

The fourth cautionary tale is a phenomenon that I call the tyranny of rhetoric. Artificial intelligence, the field that seeks to create software that will make machines think the way humans do, has fallen into some disrepute in recent years. It has produced significant results—from the Automatic Teller Machine that gives us cash to the devices on the latest generation of personal computers that allow us to speak to our machines. But its advocates promised more than they could deliver. The revolution failed, not because it produced no change, but because it was supposed to transform the world by producing "machines who think."

A final warning about the dangers of predicting the course of technological revolutions comes from what I call "the phoenix syndrome." Not many years ago, the most informed observers of computer development firmly believed that the large mainframes of the 1960s and 1970s were a thing of the past. The new microcomputers put unprecedented power on everyone's desk, making it unnecessary to work on the big muscle machines. But now another development, networking, has forced a reconsideration of that judgment. When it is so easy to gain remote access to distant machines, why not export large, computationally-intensive problems to a machine that can do the problem easily instead of burdening desktops or workstations. Had observers been able to see how rapidly the Internet would expand in capacity or speed, they might have been slower to predict the demise of the mainframe.

So too with most revolutions. Like all historical phenomena, they are contingent on contextual events that are themselves difficult to predict. Nothing is inevitable; nothing is deterministic.

> ***"Like all historical phenomena, they (revolutions) are contingent on contextual events that are themselves difficult to predict. Nothing is inevitable; nothing is deterministic."***

In conclusion, I will make both a modest disclaimer and a modest argument for the power of the study of history and historians. We cannot predict the direction of technological change or tell you what policy to adopt in order to adapt to it. But we can often tell you what is not happening. As a result, we can eliminate many public policy options. This is not as significant as predicting the future, but it is better than facing the future with unwarranted assumptions about where it will all lead.

DR. MAUD CHAPLIN:

As the outsider of the group, a philosopher amidst historians, my task is to find common issues in the technologies we have heard about and to look at some of the social problems they imply. These innovative technologies—biotechnology and the computer—have far-reaching implications for our society because, aside from their potential to ameliorate the human condition, they also have the power to threaten some of our cherished human rights. They intrude upon our individual and private selves in very unexpected ways, although they appear to expand and to increase our capabilities. Accordingly, I would like to focus on how these two technologies affect and invade our privacy.

My interest in this topic was sparked by the 1973 landmark decision of the Supreme Court, Roe vs. Wade, in which Justice Blackmun declared that there was a constitutional right to privacy. In that opinion, he cited an 1890 *Harvard Law Review* article by Samuel Warren and the not-yetJjustice Brandeis that described privacy as the "right to be left alone." Blackmun quoted Brandeis as asserting that privacy was the "most comprehensive right of man."

"...Biotechnology and the computer—have far-reaching implications for our society because, aside from their potential to ameliorate the human condition, they also have the power to threaten some of our cherished human rights."

I was stunned by the citation because I could not recall such paramount emphasis on privacy in all the schooling that I had received in this country. Americans hear a lot about our rights to life, liberty, and the pursuit of happiness; but few would think of privacy when queried about their fundamental rights. We tend to take privacy for granted.

When I went back to look at this foundational article in the Harvard Law Review, I was disappointed to find no discussion of "the right to be left alone," although one could certainly argue that it could be inferred from the text. Blackmun argued that Warren and Brandeis had contended that privacy was the "right to be left alone," freedom from the unwelcome intrusion of the press, in the context of their article; but more generally, freedom from the invasion of others into what we might now describe as one's personal space.

Much later I discovered that Justice Brandeis had made his most eloquent statement about the nature of privacy and its centrality to a free society in a 1928 dissenting opinion, *Olmstead v. United States*. Here Brandeis made explicit reference to the "right to be left alone," and he specifically designated it as a constitutional right:

> The makers of our Constitution undertook to secure conditions favorable to the pursuit of happiness. They recognized the significance of man's spiritual nature, of his feelings and of his intellect. They knew that only a part of the pain, pleasure and satisfactions of life were to be found in material things. They sought to protect Americans in their beliefs, their thoughts, their emotions and their sensations. They conferred as against the Government the right to be left alone, the most comprehensive of rights and the right most valued by civilized men.

I found this statement fascinating because it listed no sources, made reference to no authorities, nor presented a compelling argument. Brandeis simply asserted that privacy was the most comprehensive of rights, that it was the right most valued by civilized man, and he expected the reader to believe it. I had been looking for quotations from John Locke, Immanual Kant, and John Stuart Mill, among others, the philosophers who shaped our concepts of rights, liberty, and autonomy, as well as guides to the conditions most favorable to the pursuit of moral behavior and of happiness.

Furthermore, "the right to be left alone" was too vague and colloquial to be useful. I had sought a clear-cut, precise definition of privacy, but found a fairly murky concept instead. Brandeis had handled the problem of definition by relying upon the Fourth Amendment which asserted our right to be free of unreasonable searches and seizures and had its roots in protecting colonists' homes from unwelcome intrusion by British soldiers. But there is no specific reference to the right to privacy in the Fourth Amendment. Indeed there is no mention of privacy in the entire Constitution. Instead it can be traced to a 1776 address to the English Parliament by William Pitt, who vividly declared:

> The poorest man may, in his cottage, bid defiance to all the forces of the Crown. It may be frail; its roof may shake; the wind may blow through it; the storm may enter; the rain may enter; but the King of England may not enter; all his force dares not cross the threshold of the ruined tenement.

Eloquent and forceful as this statement is, it still leaves us with an unclear notion of what privacy actually entails. If we are to depend on the Fourth Amendment for our definition of privacy as a constitutional right, we will have to rely on its implicit claim that there are certain areas of our lives which are nobody else's business unless we choose, freely and intelligently, to disclose them.

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Nonetheless and notwithstanding this lack of definition, Brandeis' opinion set off a whole series of state cases. A tradition of tort law developed that was dependent upon the "right of privacy" and referred specifically to this dissenting opinion and, of course, to the law review article of 1890. Between roughly 1930 and 1960, several hundred arguments developed to articulate violations of a right to privacy.

In 1960, William L. Prosser, Dean of the law school at the University of California at Berkeley and a well-known legal theorist, tried to make sense out of this multiplicity of definitions. He wrote a sustained and noteworthy article in the *California Law Review* in which he placed the definitions of privacy into four general categories: intrusion, the public disclosure of private facts, false light, and appropriation. All of these are implicated in the ways technology can reduce or threaten our privacy. In particular, the computer and biotechnological engineering have introduced intrusions of privacy that were simply inconceivable in the nineteenth and early twentieth century. What late 20th century technology has done is to threaten privacy in ways unforeseen and unanticipated when those early definitions were formulated.

In order to protect our privacy, we need to develop a comprehensive, coherent, and neutral definition of privacy. Secondly, we have to make the argument that privacy is important and valuable: it is not simply something that one can just take for granted. Third, if you grant that there is such a thing as privacy and that it is valuable and should be protected, we need to show why it is necessary for the law to protect it. There many things, after all, that are valuable and important that the law doesn't protect and doesn't guarantee. I would argue, however, that privacy does need to be protected by federal legislation and that that need is crucial to our constitutional rights.

A few examples related to Professor Roland's and Professor Cowan's presentations should give substance to these arguments. As Professor Roland made clear, one of the unintended consequences of the development of the Internet was the widespread use of e-mail—orginally for research purposes but now as a powerful and pervasive tool of communication regardless of what is communicated.

Very recently, the Supreme Court decided that it would review the constitutionality of the Communications Decency Act, a provision of the Telecommunications Reform Act of 1996 passed by Congress this year. A federal court in Philadelphia and in New York had blocked the provision from enforcement in June on the grounds that speech on the Internet deserved constitutional protection and that the language of the Communications Decency Act was both too vague and too broadly written to justify the government's interest in intervention on behalf of protecting children. Because so many suits were brought against it by such diverse groups as AIDS Educational Global Information System, Human Rights Watch, Planned Parenthood Federation of America, and the American Civil Liberties Union, among others, the Act has been put into abeyance. Should the Supreme Court reverse the lower courts decision, the possibilities of interglobal communication, the sharing of knowledge, and individual privacy would be severely curtailed.

"at the present time, not only is there no single authority controlling the Internet and its contents, but there is no way to do so."

A historical footnote is helpful here: the Internet was developed towards the end of World War II with the express purpose of making it invulnerable to enemy attack. It is, therefore, totally decentralized. This means that at the present time, not only is there no single authority controlling the Internet and its contents, but there is no way to do so. It is possible to contol information transmitted from specific sites, but only by the person or people who control that individual site. Thus, for example, if you were to say that no network site in the United States can put pornographic material on its site, there is nothing to stop people from simply transporting this material to a site in Finland and posting it there. People in this country could access it with no trouble whatsoever. The only way you can stop receiving or control what comes from a specific site is at the receiving end. Already, the major on-line services provide means to restrict access to data bases or even certain key words, an important feature for parents who wish to control the subject matter that their children see. But other than that, the Network is totally uncontrolled, except insofar as the people who use it exercise their own control. This has raised a lot of concern on the part of some individuals and groups.

A brief review of the main ACLU arguments against the Communications Decency Act suggests some of the reasons that the privacy of the Internet needs to be protected if the capabilities that the computer provides for the increase and dispersion of knowledge are to be realized fully. In its argument to the court, the ACLU pointed out that the network enabled the average citizen to gain access to a vast and literally worldwide range of information, while simultaneously protecting his or her privacy because it can be done in the sanctity of the home. In this connection, the American Civil Liberties Union noted the acknowledgment by Congress in the Communications Decency Act of 1996 that the Internet represented an extraordinary advance in the availability of educational informational resources to our citizens. Second, the ACLU contended that interactive computer services already offered the user a great degree of control over the information received. The Act, however, would prohibit communications that may be deemed "indecent" or "patently offensive." This language is troubling since indecent and offensive are vague and undefined. What is offensive to me may not be offensive to you, and what you find offensive may seem unobjectionable to me. What is offensive to some groups in this country is absolutely inoffensive to others.

The third argument made by the ACLU was that if the Internet were controlled, private communication between individuals, letters sent over e-mail, would be subject to government scrutiny. That would be a real invasion of privacy. Very few of us would agree that our love letters, our personal communications, even our expressions of intelligent and reasoned response which might be quite individual, should be the subject for government perusal.

Now, I will just mention a few troublesome issues raised by the other technological revolution discussed here this morning—the emergence of biotechnology. In particular, I will look at the Human Genome Project, funded by NIH and the Department of Energy, which would, if successful, locate each one of the hundreds of thousands of genes in the cells of our bodies in the process called *Mapping*. Then it would learn the molecular structure of each gene in the process called *Sequencing*. And, finally, the Human Genome Project aspires to discover how genes function in the human organism to produce traits, behavior, and dysfunction. If this project indeed maps the full human genome, geneticists will be able to tell each of us about disorders they or their children may develop in the future, even though we may have no cure or ways of preventing these disorders. Given that situation, do people have the right to know about their genetic make-up? Who will decide what is a genetic trait that may be considered a disease (as, for example, most people would consider Huntington's) or a condition that might not be desired (sex, height, eye color) but is in no way lethal? The ethical problems raised by the Human Genome Project are many and varied, but I will only touch on one issue, that of privacy, here.

"...It takes an imagination beyond our present capabilities to think of the things that could be done with biotechnology and with computers—techniques and uses that we would see as potentially threatening to our autonomy, to our freedom and to a free and healthy society."

Once there is the possibility of being able to describe someone's genetic makeup, who would the right to this information: the individual in question, a child born to a couple in which one parent carries the gene for a lethal or severely dehabilitating disease, a prospective spouse, a present spouse, an employer, insurance companies? Not all of us would answer these questions in the same way, but they all touch upon the notion of privacy as well as the societal concern with public health. I can only suggest these issues here, but they bear thinking about and they call for policies which both protect the individual and the society in which that individual is a part.

By way of conclusion, I submit that these questions are pressing today and will be more pressing in the future. I think that it takes an imagination beyond our present capabilities to think of the things that could be done with biotechnology and with computers—techniques and uses that we would see as potentially threatening to our autonomy, to our freedom and to a free and healthy society. For that reason, as well as many others, we need to develop policies that protect our privacy and allow us to realize the potentialities of new technologies rather than suffer the consequences of unexpected results.

QUESTIONS & ANSWERS

DR. ROLAND:

Does anyone have any questions or need a little clarification. I also encourage reactions.

AUDIENCE:

One implication of the presentations seems to be that policymakers should focus on basic research over industrial applications. Is that correct?

DR. ROLAND:

I think both are feasible, but caution is in order. Basic research is always safer politically because there's no commitment to any outcome. When funding industrial policy, you're betting that you know where the revolution is going. I'd caution against doing that. Funding basic research can also be fraught with peril. For example, whatever emerges from life-based artificial intelligence will have enormous implications in the next five or ten years. Much will depend on the amount of funding awarded to that sort of basic research. So caution is necessary for both. As a general rule, however, the more applied the research, the more you ought to know where things are going.

DR. COWAN:

The dichotomy that you raised between science policy and industrial policy is exactly what needs rethinking. Dr. Roland's response confirms what I've been saying here. Initially, a decision to fund life-based computation looks like basic research, but it also turns out to be industrial policy.

DR. ROLAND:

Another example of the phenomenon we are addressing here is neural nets. These were being explored successfully in the 1960s, but federal funding dried up at the end of the decade. Not until the 1980s was the importance of this research once again appreciated. Federal funding resumed, but fifteen years had been lost. Decisions about funding basic research have consequences.

AUDIENCE:

What are the implications of patent law for copyright law and intellectual property?

DR. COWAN:

I was trying to suggest that people who worry about intellectual property rights ought to consult people who know something about the history of patent law. The two are not as separate as it seems on the surface. I am not personally familiar with the legal intricacies.

MR. SEELY

I will conclude by emphasizing that this has been an interesting opportunity for those of us who have participated. This is a conversation that we do not usually carry on. Within academia there are strong pressures to look inward rather than outward, but not everyone thinks in those terms.

We hope we've shown how a dialogue that brings humanists together with policymakers can be useful. We don't have any magic answers or a crystal ball, but history and philosophy bring into focus critical considerations and provide a crucial context for decisions that affect all of us.

SPEAKERS

Maud Chaplin is Professor of Philosophy at Wellesley College. She is a fellow at the Bunting Institute where she is working on technology and privacy. She has served as Dean of Wellesley College, acting president of the college, and interim director of the Stone Center. She has written widely on the philosophy of education; science, technology, and the liberal arts; aspects of Greek philosophy; and women's education.

Ruth Schwartz Cowan is Professor of History at the State University of New York at Stony Brook. She also served as Director of Women's Studies. Among her publications are *A Social History of American Technology* (1997), *Our Parents' Lives: Jewish Assimilation and Everyday Life* (1996); *Sir Francis Galton and the Study of Heredity in the Nineteenth Century* (1985) and *More Work for Mother: The Ironies of Household Technology from the Open Hearth to the Microwave* (1983). She has been an active member of the History of Science Society, the Society for the Social Study of Science, and the Society for the History of Technology where she served as president. She has received several fellowships including a Guggenheim Fellowship, an ACLS, and grants from NSF, HIH, and NEH.

Alex Roland is Professor of History at Duke University. He has directed Duke's program in science, technology, and human values and chaired its history department. He has been a visiting professor at the United States Army War College, a resident fellow at the Dibner Institute of the History of Science and Technology at MIT, and served as historian at NASA from 1973-81. He has written widely on the history of warfare; the space program; naval history; technological change in history; and secrecy, technology, and warfare. He has served as President of the Society for the History of Technology. His books include *Underwater Warfare in the Age of Sail* (1978); *Model Research: The National Advisory Committee for Aeronautics 1915-1958* (2 vols., 1985) and *Men in Arms: A History of War and its Interrelationships with Western Society*.

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