The Web of Technology and People: Challenges for Economic and Social Research[1]

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ABSTRACT *The study of technology and people has gained acceptance as a field for social inquiry, but it has remained outside the mainstream of the major disciplines and is dealt with as an interdisciplinary area of specialization across the social and economic sciences. In addition, this field has been fragmented further by particular technologies and issues, creating journals focused on privacy issues, others focused on education, for example, with a gulf remaining between social scientists on the one hand, and engineers and computer scientists on the other. There are also major regional divides, with academics in one part of the world often knowing little about work underway elsewhere. The world-wide push for technological innovation, therefore, demands that the social sciences build a more intensive and internationally networked effort to sustain research on the social aspects of technology, and bring it to bear on policy and practice.*

Enthusiasm over the Internet and other emerging technologies should not lull the social science research community into complacency. Ironically, unbridled optimism in the coming digital age, or biotech century, and trends in technological innovation and related research and development (R&D) could undermine the vitality of social and economic research. Any agenda for future social science research needs to place a higher priority on the study of technology, to better integrate work on a wider range of technologies, and to attend to a broad array of issues concerning how people produce, utilize, consume, and govern technologies. Otherwise, technical and social choices are likely to escape critical analysis in a wave of next generation enthusiasm.

Keywords: innovation, Internet, policy, research, social impact, technology society, trends.

Introduction: A Revolutionary Time to Study Technology

The approach of the new millennium has generated a flood of speculation about technological change and its impact on society. Biological and computer metaphors have inspired an increasing number of popular and scientific accounts of social and technological change. One example is Kevin Kelly's[2] depiction of the convergence of people and machines toward a 'neo-biological civilization' driven by a 'hive' mentality. Early portrayals of a 'high-tech society'[3] as well as more recent characterizations of a developing 'cybersociety' fall within this tradition.[4]

This heightened futures' agenda has coincided with a widespread acceptance of a revolution in information and communication technologies (ICTs), most recently associated with the Internet and World Wide Web.[5] One broad overview of technology and the future argues that the Web has become the 'icon' for technology in the late 1990s,[6] adding that the Web is also 'an apt metaphor for the pervasiveness and interconnectedness of technology and human life.' Understanding these ecologies of social and technical

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choices across all areas of science and technology presents a tremendous challenge for the social sciences in the coming decades.

The Internet and Web have contributed to making the end of the nineties an exciting time not only for those interested in ICTs, but also for those in nearly every field of science and technology—all of whom have found ways to exploit ICTs in their work as researchers, teachers and administrators. Despite some misgivings about specific developments, there is a remarkable level of support at all levels of society for the prospects of scientific and technological innovation to enhance social and economic well being. This is indicated by widespread support for many public and private initiatives that see the encouragement of scientific and technological progress as central to industrial and economic development, such as efforts to encourage more students to pursue the study of science and engineering.

Public acceptance of technology can facilitate changes in policy and practice that are necessary to effectively exploit technical advances. At the same time, uncritical support can undermine positive change if it stifles research that takes a skeptical as well as empirical approach to the social aspects of technological change. Social and economic perspectives on the role of science and technology in society might well face even greater obstacles than in times when the public and its leadership were more divided about the promise of new technologies. For instance, it was during a period of anti-technology sentiment in the wake of the Vietnam War and the height of environmental concerns that the study of technology and society began to flourish. There have been major shocks to this optimistic mood, such as the Challenger disaster, Chernobyl, and renewed testing of nuclear weapons in India and Pakistan, and cause for concern over the future of technological progress, such as with experiments on cloning and the Year 2000 (Y2K) problem. However, past experience, such as with the Challenger disaster, has shown that the public's diffuse support for technology has a surprising level of resilience to specific problems. Surely the public can weather and benefit from a greater awareness of the issues raised by social and economic research.

This review provides a personal perspective on trends in technology, and how they will influence research on technology and people. It is based on my experience teaching and conducting research on the social dynamics of ICTs for over two decades, including being director of the last years of the UK's Programme on Information and Communication Technologies (PICT), and editing international journals devoted to issues of technology and people.

The Study of Technology and People

An interdisciplinary collection of engineers and scientists formed a loose field of study around technology and society in the 1960s. This area of study waned in the 1980s, but gained fresh momentum in the 1990s. Over these years, several overlapping approaches to economic and social research on technology have become distinguishable.

The Philosophy of Technology

One of the earliest critical approaches to discourse on technology and society entailed broad efforts to understand the logical foundation and inter-relationships between technology and society, such as is implied by the idea of a technological society.[7] This literature helped to refine the discussion of technology in order to encompass far more than just equipment; to include the techniques and knowledge essential to its design and use.[8] Thoughtful assessments of discourse about technology have helped to identify the

degree to which technology is often viewed in misleading ways as a deterministic force that is somehow independent of human agency.[9]

Impacts of Technology

A stream of work, based more on historical and field research, has been concerned with the social impacts of technological change. Historical accounts of the social role of technological change fall into this category, such as the work by Harold Innis[10] and Marshall McLuhan[11] on the impact of communication technologies on society.

Technology assessments (TA) and evaluation research also fall into this category. TAs are broad, multidisciplinary approaches to understanding the full range of impacts—intended and unintended—that might follow from the use of a particular technology over the near- and long-term. TAs have been carried out on developments ranging from surface mining of coal to the video phone,[12] and have provided the rationale for institutionalizing the study of technology, such as in the former US Office of Technology Assessment (OTA).

However, the problematic nature of technological forecasting and the impracticality of conducting full-scale technology assessments has led to a decline in their use. Instead, researchers have shifted to studies that target the actual impact of technology implementations in specific social settings, such as studies of the social impact of the telephone in households, or the impact of computers in local governments. Many studies of social impacts have shown how the role of technologies has been driven by those who shape their design, and manage their use in various settings.[13] However, they have also found many examples of unanticipated impacts, such as in technological disasters that were intended by no one.[14]

Social Shaping of Technology and its Consequences

One of the more recent approaches has focused on the social shaping of technology (SST). This approach has extended social studies of science, which have looked critically at how scientists make discoveries and otherwise do their work, to examine how scientists and engineers—as part of a network of other actors—invent, design and diffuse technologies.[15] Textbook treatments of the scientific process are often at odds with how scientists actually work. Likewise, technological processes of invention and development often differ significantly from formal prescriptive treatments, for example, in the degree to which they are shaped by economics, public policy, the networking of scientists and engineers, and other social factors.

Many SST researchers focus their attention on the early stages in the design of technologies to show the role of economic, political, and other social processes in shaping technical choices and their eventual social implications.[16] SST research has established a basis for the social and economic sciences to play a more central role in the design and development of technology as well as in their more conventional study of social impacts, such as in the evaluation of technologies. SST perspectives have also led to a greater emphasis on describing the underlying 'processes' of technical and social change, rather than predicting their long-term impacts.[17]

Theories of Society Shaped by Technology

The most recent turn in the social sciences has been a reinvigoration of grand, macro-level theorizing about society, based on conceptions tied to technological change.

Daniel Bell's[18] framework for an information society is a seminal contribution in this area.[19] After more than two decades of debate, Bell's ideas have influenced the way many policy makers and practitioners think about ICTs and society.[20] In addition, new theoretical perspectives, linked to such emerging ICT developments as networking, have been built from critiques of these macro-level conceptions of a post-industrial information society. Manuel Castells'[21] work on the information age is the most influential in this tradition, having regenerated widespread interest in theoretical perspectives on social changes tied to technological change.

Technological Trends: The Pursuit of Major Technical Breakthroughs

The approach of the 21st Century has fueled many technological forecasts, generating much evidence about what scientists and engineers believe to be the future of technology and its impact on people. These scenarios are overwhelmingly optimistic about the accelerating course of technology along its present trajectory and its impact on society,[22] as typified in the book *What Will Be* by the head of MIT's Laboratory for Computer Science, who states: 'all the music, film, and text ever produced will be available on-demand in our own homes' and 'your "bodynet" will let you make phone calls, check e-mail, and pay bills as you walk down the street'.[23] This highlights a major theme of most futures' speculation: that the major enabling innovations are ICTs and they will continue to deliver much, much more that is instantaneously available, affordable—and as easy to access as walking into a room or touching a screen.

Forecasts of technological change are notorious for their lack of foresight, usually erring on the side of predicting the extremes of transformation or continuity.[24] While it is prudent to be skeptical of any forecast, almost all discussions of the social and economic implications of technological change are necessarily built upon more or less explicit expectations about the future of technology and people.[25]

Digital Age Forecasts: The Social Shaping of Technological Forecasts

There are several dominant themes cross-cutting forecasts of technological change in the early 21st Century.

First, rapid technological advances are expected in nearly every arena of application. The UK's Technology Foresight programme, launched in 1994, brought experts together across 15 different sectors of technology.[26] The range of applications across these categories—many in constant states of innovation—presents one of the most significant empirical challenges to social and economic research. Research within any of these categories can be widely applicable. For instance, some of the most seminal research on the diffusion of technical innovations was not focused on high technology, but on technical innovations in agriculture, specifically the use of hybrid seed corn among Iowa farmers.[27]

A second theme is that ICTs are pivotal to developments in technology as a whole because they are tied to advances across the full range of technologies. As the Foresight exercise found: the 'pervasiveness of information management across every area of innovative opportunity' makes ICTs particularly key to the economy and society more generally.[28] Advances in biomedical technology, for example, are often centered on the role that innovations in ICTs are playing in such areas as genetic engineering, medical diagnosis and treatment, and the delivery of health care.[29] New developments in transportation often focus on ICTs embedded in smart cars and intelligent roadways.

Advances in molecular engineering, like the development of 'nanotechnologies', are dependent on digital information processing to precisely manipulate and build molecular structures.[30] This increasingly central role of ICTs is echoed in many general forecasts of technological change, which see the world entering an information, or digital, age.[31]

A third theme is that ICTs are themselves in the process of revolutionary change, often captured by the concept of convergence. This is the idea that all forms of electronic ICTs that underpin sectors such as broadcasting, telecommunications, cable, satellite and computer-based communication systems, are converging around common digital standards,[32] which are likely to converge eventually around a single 'network of networks' that integrates all these once separate information infrastructures to form the so-called 'information superhighway'. Moreover, this vision of convergence is being increasingly anchored in models of the Internet and Web, which have created a new way of thinking about the future of ICTs—the super-Internet.

There are many barriers to the convergence of media, since they are rooted in historically different ICTs, industries, markets, business cultures and legal–administrative traditions.[33] Nevertheless, the potential for change has been given weight through concrete innovations in the ease of use and power of ICTs, which have enabled ICTs like personal computers, cellular phones, pagers and direct broadcast satellite systems to diffuse across households as well as businesses. The use of electronic mail and the Web, for example, has exploded since the mid-1990s at a rate few had forecast even in the early part of the decade. Similarly, after decades of gradual growth, satellite-based services have exploded. Fleets of new satellites (as many as 1700) are expected to be launched over the next decade,[34] bringing worldwide personal communications over miniature handsets to a mass market.[35] As these technologies continue to diffuse, and industry prepares to introduce new ICTs, such as digital TV, revolutionary images of a digital age have become increasingly credible.

The model of globally networked ICTs is reflected in trends across other technologies, which are integrally tied not just to advances in equipment, but to techniques and know-how—that is, the diffusion of knowledge that is directly linked to advances in ICTs. The Internet's proven potential for supporting collaboration and the diffusion of knowledge across every field of science and technology has helped bring ICTs to the center of attention.

The phenomenal success of the Internet and Web has spurred efforts to push ICT research, development and use across many sectors of government, business and industry. In the US, for instance, one of the many major ICT initiatives underway covers basic and applied R&D on the next generation of media, which is being funded by the US National Science Foundation at the federal level, but also by states, business and many universities. An illustration of this is the new $50 million multimedia engineering facility within the Integrated Media Systems Center in the School of Engineering at the University of Southern California. State and federal support, such as through the NSF, for Internet2 and the Next Generation Internet (NGI) extends beyond the US, and is reflected in initiatives in the UK, Europe, and international bodies such as the EU and the Group of Seven (G7) nations.

Technology research initiatives are being driven by these larger technological trends and visions, but in ways that could undermine the role of social and economic research. The over-riding issues are the ways in which technological advances can be strategically leveraged to support the competitive advantage of individuals, firms and nations in an increasingly global economy. Social issues often derive from the pursuit of these economic strategies. The social sciences can illuminate how to more effectively exploit technologies, but also challenge the underlying assumptions of critics and promoters of

technologies, and thereby inform debate about the role of technological change in society.

Next Generation Research: Emerging Trends

Undoubtedly, many forecasts of the coming digital age exaggerate the development, convergence and centrality of ICTs. That said, it is difficult to overstate the impact these visions of the future of ICTs will have on technological—and social—research and development. In area after area of society, Web-oriented visions of the future of ICTs are shaping technological and organizational initiatives.

The field of communication is perhaps most obviously influenced as newspapers, broadcasters, telephone companies, and cable and satellite operators attempt to respond to the explosion of interest in the Internet and Web. Developments in online newspapers, digital radio and TV, Internet telephony and cable modems are a few examples of these responses. For example, the producers of cinema and television are investing more in the use of ICTs for animation, new production processes, interactive content, and worldwide distribution systems. At many universities, funding has poured into interactive video productions for the Internet and Web. Likewise, many studios and distributors are also exploring the potential of the Internet for new types of entertainment as well as for the marketing and distribution of content.

The public sector is making major efforts to catch up with business and industry in the application of advanced technologies. For example, many providers and public interest groups are emphasizing the application of ICTs to the processes of governance and politics. A major US effort under the heading of Digital Government is focused on moving governmental data and applications off old standalone computers and onto the Internet.

Educational institutions at all levels are reconsidering the role of ICTs in learning and education that move beyond distance education to include visions of a virtual classroom and university. Universities are engaged in efforts to create their version of the next generation Internet, such as the Internet2 project in the USA and SuperJANET in the UK, that will permit linkages among researchers and educators at far higher speeds to foster further innovations in science, engineering and teaching across all fields. This is an effort to more purposively replicate the success of the ARPANET in creating an infrastructure in support of research and education.

The health and medical sciences are also strongly influenced by the potential of ICTs like the Internet to support biomedical applications. For example, the US National Library of Medicine (NLM) has supported major efforts to extend access to electronic health and medical information over the Internet. It has also sought to encourage the development of 'revolutionary' medical applications over Internet2 in targeted areas, like heart disease to enable advances in medical diagnosis, treatment and care. Even cultural institutions such as major museums, art exhibits and rare book collections are responding to the Internet in creating their own presence on the Web, as in the Los Angeles Culture Net of the Getty Museum in California.[36] The Getty hoped this would spur similar developments throughout the world as a means for linking information about cultural artifacts to create a resource that complements each of the participating institutions and permits greater access to their resources.

The status of social and economic research in this technologically driven rush to development is uncertain. For example, the interim report of the US President's Information Technology Advisory Committee (PITAC) argued that one of four key areas of research in the coming years would be the socio-economic and workforce impacts of

information technology.[37] Yet, social scientists are not well represented on PITAC and the President, in thanking the committee chairmen, seems to miss the social sciences in saying he is: '... hopeful that the Congress and my Administration can work together to advance the leading edges of computational science to help us discover new technologies that can make this a better world.'[38]

Problems and Opportunities for the Social Sciences

Trends in advanced technologies and the push to apply them across all sectors of the economy create unprecedented opportunities for social scientists to examine technology and its implications. These initiatives create an opportunity for raising the priority of research that has a social science component. At times this is merely an acknowledgment of the role of social research in the evaluation of technological innovations, but it could be a fuller partnership with social and economic sciences in the design, implementation and assessment of technologies.

However, as the social and commercial use of the Internet and Web expands, there are new and enduring risks to the vitality of social and economic research. If these are not addressed adequately, the social science community could very well see their role in research on technology diminish.

Some risks stem from the very same factors responsible for the push to apply technologies, like ICTs. The lion's share of the huge sums of money being invested in technical developments will support scientists and engineers who are leading innovators, promoters and stakeholders in their continued development. For example, the Digital Government initiative in the US is dominated by engineers and others with an expertise in computing and communications, rather than government and politics. Therefore, the thrust of research on ICTs and other technologies is likely to become increasingly promotional, and anchored in models that are more technologically deterministic and optimistic about the potential for technological solutions to social problems.

At an even broader level, society as a whole is less likely to question the social role of technologies embedded in everyday life. People can become accustomed to technology, and not even think about its social role, until they miss it. The fact that technological innovations often redefine the way people do things leads people to take technologies for granted as the normal state of affairs. For example, the telephone is perhaps one of the most significant ICTs used today, but little social research has been focused on this technology compared to that completed on new ICTs like the Internet.[39] Also some of the best research on the telephone has been done in the aftermath of blackouts, when people who had integrated the phone into their everyday life suddenly had to cope with its loss.[40]

For example, in the wake of the Galaxy IV satellite outage, which blacked out up to 90% of pagers across the US in May 1998, my colleagues and I at USC researched the social role of missing the pager. In the process, we found that virtually no social science research had targeted this technology even though it was used by over one-third of households in the Greater Los Angeles area, and played a central role in organizing their everyday life and work. The diffusion of technologies can actually undermine critical perspectives on their role in society as they become more ubiquitous and increasingly taken for granted—like the proverbial fish that do not recognize they live in water.[41]

Another major risk lies within the social sciences. It is easy to forget that social scientists are very much a part of the 'high tech' cyberculture. A very small proportion of social scientists are engaged in critical research on technology and people, while growing ranks of social scientists use ICTs and other technologies in support of their

research and teaching. A journal entitled the *Social Science Computer Review* has been quite successful in reviewing and assessing various computer-based tools for social scientists, like the Internet. It has become more devoted over time to articles about how to use ICTs in research and teaching, while the proportion of articles that look critically at the social impact of ICTs has declined.[42] Many promoters of the virtual university are academics from the social sciences and humanities who see ICTs like the Internet as a technology to exploit in their own teaching, research and outreach to the media and user communities. For example, so many social scientists have become enamored with computer simulations of social processes that it has been labeled a fad.[43] Reflecting this cast, when critics of ICTs in education speak out at universities, they can be overwhelmed by other academic users of ICTs, who view the critics as threats to the more widespread use and development of ICTs for teaching and research.

A set of risks is also rooted in the politics of information, a long-term problem facing social research on technology and people. The promoters of technology are distrustful of social and economic accounts because they threaten to delay technological innovation by exposing failures, identifying unanticipated negative consequences, and questioning whether the promise of technological innovation has been fulfilled in practice. From the other end of the spectrum, critics of technology often view any social research on technology as inherently supportive of innovation. Social research raises the visibility of an innovation and presents the potentially misleading expectation that any problems can be identified and corrected by appropriate management or policy responses. To many critics, ends like enlightenment and democracy, rather than the means (technology), should be the focus of research. In practice, the pursuit of topics ranging from democracy to healthcare brings new researchers into the study of technology on a regular basis, but they often fail to build on what has been learned about technology and people, thereby making many of the same conceptual and empirical mistakes common to early social research on technology. For instance, many new entrants to the study of the Internet and Web make overly deterministic and optimistic comments about the role of technology in fostering such social outcomes as community and democracy.

Social scientists who are engaged in the study of technology and people are among those most directly affected by the problematic status of the social sciences as a whole. Social scientists can collaborate effectively with computer scientists and engineers, for example, when they respect each other's expertise. However, multidisciplinary teams often entail an A-team of scientists and engineers, linked to a B-team of social scientists, as illustrated above by PITAC's report. Moreover, social scientists have put some obstacles in their own path.

By and large, social research studies of technology are richly descriptive and historical. This emphasis is both a significant strength and contribution to knowledge, but also often deflects attention from the need to grapple with emerging technologies. Social and economic research will be dismissed by the policy and practitioner communities if they are too limited in their ambitions for shaping technology, policy and practice, and too far removed from present developments. For such reasons, SST and other approaches to social research on technologies remain in a position of proving their value to policy makers and practitioners. In contrast, the sciences and engineering are unquestioned authorities on technology (and often its social implications!), with policy increasingly focused on increasing their ranks as a strategy for competitive advantage in a global high tech economy. For example, some of the more widely read books dealing with ICTs and people have been written by the developers of telecommunications and computing, such as former Bell Labs' scientists Robert Lucky[44] and Arno Penzias,[45] and computer scientist Michael Dertouzos,[46] rather than by those in the social sciences.

Despite these risks to the status of the social sciences, technological initiatives are creating major social issues, such as regional and social disparities in access to emerging technologies, which are likely to buttress support for social and economic research in the near-future. What can the social sciences do to play a more significant role in this research?

Expanding the Agenda for Research on Technology and People

The following subsections highlight strategies that the social and economic sciences should pursue over the coming decades to enhance their significance in shaping technology, policy and practice.

Prioritizing Research on Technology and People

Social and economic research on technology and people will need to be scaled up in significant ways in order to inform debate about technology. The optimism and growth of high technology will not automatically fuel social and economic research. As argued above, the opposite is more likely unless the social sciences take unprecedented steps to increase support for research on technology and people. Social and economic research cannot thrive on the crumbs left by engineers and scientists engaged in technological research and development. This is not a time for complacency, but a period for re-establishing the legitimate role that social science research needs to play in shaping technology, policy and practice to support the progress of society.

Facilitating Convergence in the Study of Technology

Research on technology and people is scattered across dozens of specialized sectors. There are indications that this fragmentation is likely to become more institutionalized, with more specialized journals, and a greater recognition of technology studies within every field of the social and economic sciences. There is potentially great value in creating incentives and mechanisms for connecting social science research across all technological sectors. First, theoretical insights gained from the study of one technology can inform the study of other technologies, as suggested by the many fields that have contributed to research on the diffusion of innovations. Secondly, there are many technologies, like ICTs, that cut across many formerly more separate technological sectors. In such ways, technological convergence might be reflected in a greater convergence across the social sciences in the study of technology. There is indeed an increasingly complex and interconnected global web of technologies and people.

Another dimension of convergence is geographical. Technological producers and users are global. Multinational entities are being developed and promoted to negotiate bilateral and multilateral agreements on technology-related issues.[47] Yet social scientists remain relatively national and regional in their outlooks and networks. Building stronger global networks of collaboration in the social and economic sciences could go far to overcoming some problems with the fragmentation and size of this field. This could be pursued by:

- internationalizing ties across university and industry researchers, such as in creating joint degree programs and courses abroad;
- supporting cooperative research across nations and regions; and
- building more genuinely global networks by supporting the use of ICTs, like the

Internet and Web, to support international collaborative research and to create stronger international journals within the field.

Choosing a Strategic Focus

Given the range of technologies and social issues, it is critical that the social science community target some areas in which limited resources might be best concentrated. The study of ICTs is one obvious focus because of its continuing innovativeness, and its diffusion and significance across nearly all other sectors. Biotechnology is another because of the major social and ethical choices opened up by advances in such areas as genetic engineering.[48]

In targeting research in one or another area, it is important that the target is not too narrowly defined. A major mistake at present has been a tendency for social research on ICTs to study the Internet and Web almost to the exclusion of other ICTs. Fascination with the Internet and Web has deflected attention from other ICTs, and other technologies, making it valuable to encourage research on a broader array of ICTs, and technologies beyond ICTs. This might be encouraged by targeting research on key processes, rather than on specific technologies.

Targeting Processes

I have described the various approaches to research on technology that have evolved over the decades. Despite the importance of refining approaches, such as SST studies, there is a danger that too much attention will be given to nurturing particular schools of thought, rather than the processes that should be the focus of inquiry. One way to do this is by moving away from categories of research that are too wedded to particular groups of scholars, or specific technologies, and adopting categories that are anchored in the objects of research. This has the added advantage of directing attention to understanding the underlying processes of technological and social change, and away from forecasting impacts.

Research on the web of technology and people should focus on one of four general technological processes: production, utilization, consumption or governance, as well as the relationships among them (see Figure 1).[49] An effort to attend to each of these four areas concerning technology and people could expand the role that the social sciences play in technological change, and increase the likelihood that social issues are taken into account in all aspects of technological innovation—not just in latter stages of use. This approach will also encourage more debate across various approaches to theory and research.

1. *Production*: social, cultural, and political processes that shape innovations in products, services, and industries
2. *Utilization* of technologies in organizations, management, and work: reinforcing and transforming the structure, processes, and geography of organizational forms
3. *Consumption*: living in a technological society, focusing on technologies in the household, community, education, and democratic processes
4. *Governance*: public policy and regulation, exploring actors, goals, and strategies in local, regional, and global arenas

Figure 1. Foci for research on technology and people.[50]

The involvement of social scientists in the study of how technologies are invented and produced should be among the highest priorities for those who wish the social sciences to play a more significant role in policy and practice. Participation by social scientists in the early development of biotechnology, for example, can better identify alternative paths of development and the social and ethical choices facing the developers.

The structure of industry is also an issue for the management of innovation and creativity. Concentration within the ICT industry is one case in point. This issue has been most evident in the US Justice Department's concerns over the competitive practices of Microsoft in the manufacturing and sale of computer software. However, growing concentration across a wide array of high tech companies suggests that this is a more general issue that will become increasingly central to policy and practice in the coming years.

Utilization entails the ways in which technologies are used in organizations, management, and work to reinforce or transform their structure, geography and organizational processes. Research on the role of technological change in the productivity of business and industry has highlighted the degree to which social and organizational change are inseparable from technological change.[51] In the case of ICTs, for example, firms and governments alike have considered ways to redesign organizational processes to take advantage of ICTs in manufacturing, marketing, sales and other activities. ICTs have enabled organizations to strategically relocate functions and jobs, such as with the creation or outsourcing of call centers, in ways that have changed the geography of many firms.[52]

A focus on consumption is concerned with the many ways households, citizens, consumers and the public at large actively consume and otherwise adapt technologies to fit into their everyday lives, such as examined in research that critically assesses notions of social access and exclusion. The linkages between technologies and economic development have generated great concerns over access.

In the area of ICTs, for example, critical perspectives on the impact of ICTs have focused on understanding the ways households 'domesticate' technologies[53] and they have drawn attention to the increasing divide between information haves and have nots.[54] In my own view, the role of social and technical choices shaping access is far broader, potentially encompassing the full-range of issues tied to ICTs and other technologies as they influence what people know, who they communicate with, what services they obtain, and what other technologies—skills and know-how—they require.[55] All technologies pose the potential for redrawing the boundaries between those with and without access to the knowledge, techniques and artifacts of an advanced technological society in ways that can improve as well as erode the quality of people's lives. Consumption is also taking place in an increasingly global marketplace, raising questions about the maintenance and enhancement of local values in the face of global access to products and services.[56] The Internet has made electronic commerce (e-commerce) among the most burgeoning topics in business, and its social implications have not been systematically examined.

Studies of governance focus on the criteria and processes by which public policy and regulation balances competing values and interests, such as those examined in studies of the inter-relationships between media economics and media culture. In this area, there are issues concerning the impact of technological change on processes of governance, as well as a growing normative debate over the political processes that should be created to govern technology. The social and political control of technology is bound up with issues of who has access to the skills, equipment and know-how essential to design, implement and employ technology.[57] Technology raises unique issues of control by

creating the potential for power shifts, such as: enhancing the influence of technological experts,[58] extending centralized bureaucratic control,[59] becoming a force for more decentralized and possibly more democratic control,[60] or reinforcing the prevailing structure of power, whether centralized or decentralized.[61] Big science raises concerns over control, just as new media generate hopes of more democratic control structures.

Debate over the implications of advances in technology on social and political control will continue to be a major issue in this field, particularly as developments in such areas as cloning are widely seen to have far reaching social implications, such as in genetically engineered human beings. This has fuelled a heightened interest in debates over the appropriate governance of technologies. For example, many advocates for more democratic control over technology have begun to campaign in old and new ways, using the Internet, for example, to inform a broader public about the social issues tied to technological change.[62]

In addition to general issues of political and democratic control, there are many enduring issues of governance across the range of technologies, such as those tied to regulation and industrial policy. A growing issue in this area is the management and governance of global technology and networks.

One force behind global concerns is the degree to which technology is becoming a major factor in national competitive advantage. Technology policy has become a central element of national industrial policy in the UK, US, and other advanced and rapidly developing industrial nations like Singapore. For example, an increasing body of social science research has supported the role of ICTs in economic development.[63] However, this issue remains far from being resolved. The spreading financial crisis in East Asia has raised demands to reassess lessons drawn from the spectacular rise of these economies. But this crisis underscores the degree to which the role of ICTs and other technologies in economic development is highly contingent on other factors, such as the degree to which a firm or nation adopts a set of beliefs and values—a new 'techno-economic paradigm'—and has basic transportation and other underlying resources that are necessary to take full advantage of technological innovations.[64]

Another force behind global governance issues has been the development of worldwide networks of communication that erode national boundaries and national regulatory mechanisms for such matters as copyright and privacy. The Internet and Web reflect more general issues of how to manage and govern technologies and networks of activities like film and software production that are both regionally concentrated and global in their reach and social consequences. Management issues are not simply a private matter to be handled by the marketplace, since large-scale technologies like global satellite and telecommunication systems have implications that move beyond the fate of individual companies and nation states.

The Galaxy IV communication satellite malfunction illustrated the potential social implications of systems that increasing proportions of the public organize their lives around. It is uncertain how well organizations have prepared to cope with the year 2000 problem, when the two digit dates used on computers will fail to distinguish the year 2000 from 1900, creating the potential for errors in systems critical to the functioning of social and economic life. ICTs have permitted firms and individuals to construct systems that stretch the capacity of humans to manage and control effectively, raising the specter of a future of technological failures, and disasters of greater consequence.[65]

Safety is related to a larger range of public issues tied to global industries and networks of technologies. With respect to ICTs, many believe that effective regulation of copyright, intellectual property rights, standards and security issues require more supranational policy responses. Experiments in cloning, and genetic engineering have created

global concerns over local projects with calls for more international regulation. India and Pakistan reminded the world of the risks tied to the proliferation of nuclear weapons systems, which elude effective international controls. This is only one example of a far more general potential for change in the nature of conflict in the information age, which calls for nations to rethink military and defense strategies and technologies anchored in large centrally controlled command structures to combat smaller networked forces, ranging from drug cartels to state-supported terrorists.[66]

Social science research has drawn many connections across these areas, such as the degree to which users are also involved in production as they reinvent and reconfigure technologies in the workplace and the household. Renewed efforts at more general social theories tied to technologies like ICTs and biotechnology also build on themes common across these areas.[67]

Notes and References

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