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FOREWORD

This report summarizes the proceedings of a conference on needed research to help government and industry identify issues and outline policy research related to current and future applications of computer-based information technology.

The conference was held August 14-18, 1978, at the National Academy of Sciences Summer Study Center in Woods Hole, Massachusetts, under the sponsorship of the National Research Council, the principal operating arm of the National Academy of Sciences and the National Academy of Engineering. Participants in the conference included some 50 representatives of the federal government, universities, industry, and research organizations. Funding was provided by the National Research Council and the Alfred P. Sloan Foundation.

The Woods Hole discussions were followed by an additional one-day session that some of the conferees attended in Washington, D.C., May 15, 1979. The purpose of that meeting was to review the draft conference report for consistency with the conferees' conclusions, and also to fill some gaps in its treatment of the subject matter. Even in five days of intense work, however, the steering committee and participants could not expect to cover fully all of the important issues related to computer-based information technology and its policy implications. For example, artificial intelligence and software standardization and development were among the important topics noted by the conferees but not analyzed in any depth. Similarly, the relationship between computer-based information technology and education was discussed, but in view of the large amount of work on the subject that has already been done, and the lack of expert agreement as to conclusions that may be drawn from it, the conferees felt that little they might say would be of special value. In the conferees' opinion, in short, both the

Woods Hole Conference and the May 1979 follow-up meeting must be seen as but one milestone in a necessarily continuing effort to identify and analyze the many research needs related to information technology policy.

The Woods Hole Conference was conceived at a meeting that the National Research Council called in the spring of 1978 to explore key economic and social issues relating to the development and use of computers in the U.S. and other countries. Those discussions followed the creation a year earlier of a Board on Computer Science and Technology within the Research Council's Assembly of Mathematical and Physical Sciences. The Board had been charged with three main tasks: (1) promoting the health of computer science as a discipline; (2) linking computer science to other fields of scientific and technological inquiry; and (3) responding to requests from government agencies and other parts of the Research Council for advice on questions of a scientific or technical nature. Because of the Board's strongly disciplinary focus, the National Research Council has established another group, notably the Board on Telecommunications-Computer Applications in the Assembly of Engineering, to develop expertise in the pertinent economic, social, and system application areas.

Neither the participants in the original exploratory discussions, nor the participants in the Woods Hole Conference have seen the initiative as exclusively, or even primarily, of interest to program planners at the National Research Council. The development of public policy for computer-based information technology has become a proper concern of both government and the private sector, and the ideas presented in this report consequently aim to stimulate research and analysis under the widest possible array of competent auspices.

A word should also be said about the report's consistent stress on "computer-based information technology" as the organizing concept for current and future thinking about the gathering, processing, storing, and transmission of information electronically. The Woods Hole Conference quickly concluded that treating computing and telecommunications as functions that depend on different technologies makes little sense today. The two have been converging on common digital techniques for almost a decade. In the 1980's, as the nation's telecommunications systems become increasingly digital, one can expect all but the most arbitrary distinctions between computing and telecommunications to disappear. Thus, readers of the report should understand the term "computer-based information technology" as

connoting any combination of the tools of computing and telecommunications which, when deployed and operated in association with one another, allow information to be captured, retrieved, transmitted, stored, or otherwise manipulated electronically.

Much of the Woods Hole discussion was concerned with the benefits that will accrue to Americans if, as a society, we apply computer-based information technology wisely and efficiently. Some discussion also took place regarding the negative aspects of the technology if it were not used with wisdom and concern for its potentially adverse social implications. Indeed, as Chapter IV emphasizes, the participants were convinced that actions by the U.S. government and industry that affect the technology's development and use at home must necessarily reflect a full and sensitive appreciation of other countries' needs and aspirations.

Effective use of the technology requires global sharing of such resources as the electromagnetic spectrum. Computer-based information technology has become both an essential ingredient and facilitator of international trade and, for the technologically advanced countries, a key element in their national security. Accordingly, while the report argues strongly for research to shed light on the issues that currently permeate national discussions of computer-based information technology, it also assumes that any government policy aiming to encourage wise and efficient use of the technology must consider its foreign as well as its domestic policy implications.

Louis T. Rader
Conference Chairman

1 INTRODUCTION

During the last two decades, Americans have made a strong, if often unwitting, commitment to computer-based information technology.[1] Combining computing and telecommunications so as to allow information to be captured, retrieved, transmitted, stored, or otherwise manipulated electronically has become commonplace in business, science, and government. Countless experiments and demonstrations aimed at making new and increasingly complex applications of the technology are now under way in fields as diverse as medicine, mining, manufacturing, banking, and transportation. Predicting how particular applications of the technology will develop, or even which ones seem likely to become widely and firmly established, is still speculative. Technological feasibility does not by itself assure extensive use. Nonetheless, for many applications the prospects for broad adoption are being much enhanced by the growing demand for cost-saving innovations in nearly all sectors of the society.

Unlike the cost of most other types of capital goods, to say nothing of the cost of energy, raw materials, and workers, the cost of computer-based information technology has been steadily declining for more than three decades. This has been due mainly to the sharply declining cost of the computer's electronic components. In part, however, it is also a result of technological advances that enlarge the carrying capacity of the several telecommunications modalities (i.e., telephony, telegraphy, microwave, cable television, and satellites). These two developments--the ever widening availability of low-cost computing capacity and the expanding breadth and density of the communications channels that permit large-scale, efficient, and flexible use of that capacity--are creating opportunities to use computer-based information technology in ways that can be

expected to change significantly the country's economic and social life.

This report is about some of the changes computer-based information technology has already prompted and, more importantly, about contributions it might be able to make if its future application took place in the context of well-chosen public policies.[2] The central thesis of the report is that while applications of the technology are becoming a source of rapid and far-reaching change in American economic and social life, they are also raising a variety of new and difficult issues, both domestically and internationally. Thus, systematic research must be initiated to help public policy makers identify and resolve those issues not only in a timely manner but also in ways that allow both the technology's promise to be fulfilled and its untoward side effects to be neutralized.

The conference from which the report emanates had two objectives: (1) to identify areas in which competent, multi-disciplinary research and analysis could help to illuminate opportunities to use computer-based information technology more extensively than has been achieved to date; and (2) to identify areas in which such research and analysis could expose ways of maximizing the benefits the technology offers while, at the same time, avoiding, or at least minimizing, the undesirable consequences that thoughtless exploitation of it might entail.

Many arguments can be marshalled to support making sizeable investments in research and analysis aimed at achieving those two objectives. Several, however, stand out. One is the pace at which the technology itself is advancing. Another is the technology's potentially far-reaching economic and social implications. And the third is the harmful effects that poorly conceived decisions about the technology could have on the nation's economy, even in the short term.

As to the first, there seems to be little doubt that the pace of technological advance is now so rapid that many of the conventional statutory and regulatory approaches to deciding how computer-based information technology can or should be used are increasingly unreliable. As described more fully in Chapters II and III, what were once rightly considered two technologies have now become intimately intertwined. Yet, most of the formal processes by which policy decisions about the technology are being made do not recognize the change or, if they do, are unable to take account of it. The Federal Communications Commission, for example, has been trying for more than a decade to draw

manageable distinctions between telecommunications and data processing.[3] Yet, until quite recently it has been unable to propose any practical means of doing so short of case-by-case Commission examination.

Today, much of the research on which government policy makers rely is performed by private parties that have sizeable stakes in the choices to be made on the basis of it. When the work is of high quality, its origins can be largely disregarded. Often, however, deciding what is and is not of high quality is itself a problem. Those who contribute such empirical and analytical support usually have a strong interest in holding the recipient policy-making body to its own initial definition of what constitutes a pertinent consideration. Rightly or wrongly, many of the interested parties seem to prefer decision making based on familiar concepts and criteria to decision making that attempts to accommodate or develop new ones. Thus, they often try to avoid introducing any novel perspective or line of analysis whose exploration might shift the terms of a legislative or regulatory debate, or, worse still from their point of view, imbue its outcome with additional uncertainty.

This situation can and should evoke concern. Looking to the future, however, one foresees it becoming a major impediment to sound public decision making. Indeed, if policy makers are to be freed from the confines of today's narrow approaches to the challenges computer-based information technology is raising, one doubts that they can avoid supplementing the adversary process with other sources of knowledge and expertise.

Much the same can also be said when one turns to the set of questions and issues that are commonly referred to as the technology's "social implications"--i.e., the benefits and costs to individuals and institutions that stem from the objectives and values that are served by specific applications or application strategies.

One can think of many socially useful purposes to which the technology might be harnessed--purposes such as training unskilled adults for productive employment; assuring that public assistance beneficiaries are fairly treated; making affordable door-to-door transportation available to people who need it; and making it possible for handicapped persons and women with young children to work at home. Nonetheless, many responsible people worry that even some of these seemingly benign applications may have consequences which, over time, could undermine the American people's commitment to certain basic social and political values. Many, for example, believe that extensive use of the

technology in managing large-scale public and private enterprises can affect the way power in the society is distributed, altering not only the relationships between individuals and public and private institutions, but also the relationships among those institutions themselves. Concern is being expressed about the technology's impact on the relative autonomy of each of the three branches of government, on the balance of power between the federal government and the states, and on the future distribution of wealth among private organizations and social groups.

- Will certain applications of the technology make it more or less easy for legislatures to oversee the administration of executive branch programs?
- Will the courts be able to handle the case loads generated by more efficient and effective law-enforcement operations?
- Will the technology make it more or less difficult for small businesses to compete with large ones?
- Will certain taken-for-granted conveniences, such as bank accounts and retail credit privileges, become more or less costly for some segments of the population?
- Will some individuals be permanently relegated to second-class citizenship by virtue of the information the technology could allow organizations to bring to bear on decisions affecting their rights, benefits, or opportunities?

These types of questions are being asked more and more frequently today, and yet remarkably little is being done to answer them. A few years ago, more than a dozen independent study commissions were working on some of them, but now only two or three sources of leadership or funding remain, and of those none is in a position to carry the needed work forward at a level of effort commensurate with its importance.

Finally, it is essential to recognize the extent to which partially informed or narrowly framed decisions about the technology could harm the nation's economy even in the short term. As shown in Table I, the U.S. "information industry," in 1978, contributed more than $80 billion to the Gross National Product. That figure, however, is based on the narrowest possible definition of the industry (i.e., one limited to commercial producers of computer and telecommunications equipment and services.)[4] If, as some economists now urge, one broadens the industry definition to include government users and certain large businesses that could not operate without computer-based information technology

TABLE I. 1978 Estimates for Selected Information Related Industries (in billions of dollars)

INDUSTRY (SIC+ Code(s))	U.S. PRODUCTION	EXPORTS	IMPORTS
Telephone and Telegraph Services (4811, 4821), revenues	50.1[a]	*	*
Telephone and Telegraph Equipment (3661), shipments	7.3[a]	0.3[b]	0.2[c]
Computers and Related Equipment (3573), shipments	13.2[a]	3.6[b]	0.3[c]
Computer Services and Software revenues	6.9[d]	1.3[e]	*

+Standard Industrial Classification.
*negligible

[a]U.S. Department of Commerce *1978 U.S. Industrial Outlook*, (Washington, D.C.: U.S. Government Printing Office), January 1978.

[b]Projected from 1977 amounts of 0.3 and 3.3 respectively, in U.S. Department of Commerce (Bureau of the Census), *Exports, Commodity by Country*, Publication FT 410, Schedule B, Current Industrial Report Series (Washington, D.C.: U.S. Department of Commerce), December 1977.

[c]Projected from 1977 amounts of 0.1 and 0.3 respectively, in U.S. Department of Commerce (Bureau of the Census), *Imports, Commodity by Country*, Publication FT 246, TSUSA, Current Industrial Report Series (Washington, D.C.: U.S. Department of Commerce), December 1977.

[d]Projected from 1977 amount of 5.9 in International Data Corporation, "Review and Forecast," *EDP Industry Report*, vol. 13, nos. 21 & 22 (Waltham, MA: International Data Corporation), May 19, 1978, p. 8.

[e]Derived from 1976 ratio of exports to U.S. production as given in Philip S. Nyborg, Pender M. McCarter, and William Erickson, *Information Processing in the United States, a Quantitative Summary* (Montvale, N.J.: AFIPS Press), October 1977, p. 11.

(businesses such as banking and insurance, for example), the industry's annual GNP contribution grows to 25 percent of the nation's total output[5] (or almost $500 billion in 1978). Add to that another 21 percent that might be attributed to the products of manufacturing operations and other enterprises in which the technology plays merely an important role[6] and one begins to see how high even the short-term economic stakes can be.[7]

Furthermore, one must remember that the United States has historically been the leading producer of information technologies and services for the rest of the world. Referring again to Table I, the nation's computer equipment manufacturers alone contributed more than $3 billion to the 1978 balance of payments. The figures for the telecommunications industry are sharply lower, but may soon grow, since several industry giants, including AT&T, are currently bidding for a share of the rapidly expanding markets for telephone systems in developing countries.[8]

Such a sizeable balance-of-payments contribution is one of the reasons why many industry spokesmen have begun to voice concern about the way public policy decisions, or nondecisions, may constrain innovative uses of computer-based information technology, both in this country and abroad. As they point out, the U.S. lead in developing and applying the technology has not been a gift of nature. The initial seeds were planted by government research and development investments during and immediately after the Second World War, but the government's role has since receded to a shadow of what it once was. Indeed, the industry for many years has financed its own research and development programs and has done so on a substantial scale. Computer equipment manufacturers, for example, invest from their own, private, resources about $2 billion a year, or 11 percent of all industrial research and development funded by U.S. firms.[9] Presumably that level of investment could be shouldered indefinitely if the industry's markets remained strong. Today, however, many contend that policy making bodies both in the U.S. and other countries are about to curtail the freedom to innovate that nourishes the U.S. industry's market lead and thus, indirectly, its ability to finance its research and development programs.[10]

Whether that contention is well founded may itself be a candidate for extensive study. Nonetheless, it points to a problem of potentially great magnitude, since it involves other countries' efforts to develop and control their own indigenous information industries, as well as regulatory

and antitrust obstacles to innovative exploitation of the technology here at home. Most observers agree, moreover, that the U.S. government today is neither institutionally nor programmatically equipped to deal with such a problem in ways that take account of the interplay between its domestic and international dimensions.

A PROPOSED AGENDA FOR POLICY RESEARCH

To recapitulate, then, there are at least three compelling arguments for making sizeable investments in policy research and analysis at this time. One is the pace of technological change itself--a pace so rapid that the issues it poses challenge virtually all of the premises, perspectives, and expectations that heretofore have guided decision making about how the technology can or should be used. The second is the technology's potentially profound economic and social consequences, and the third is the effects that poorly conceived decisions about the technology could have on the nation's economic health, even in the short term.

These three arguments provide the rationale for much of what follows in this report. As indicated earlier, the report is an agenda for research rather than an argument on one side or the other of any issue currently in controversy. Thus, the topics it addresses and the order in which it addresses them reflect a judgment as to what may be usefully researchable rather than a view about the priority that should be given to each of the broad areas in which research recommendations are made.

The report's discussion is divided into five parts. Chapter II, provides a general frame of reference by delineating some key concepts and outlining recent trends in the development of computing and telecommunications technology. For the lay reader, in particular, this chapter should be helpful in understanding Chapter III, which examines some of the regulatory issues that technological change has already posed and suggests why problems of even greater complexity should be anticipated in the future.

In Chapter IV, the discussion moves from domestic issues to international ones. Among other aspects, Chapter IV explores possible relationships between "media" regulation in the developing countries and computer and communications regulation in the industrialized nations.

Finally, Chapter V examines the U.S. government's own use of computer-based information technology for domestic program purposes, with particular stress on identifying

ways the technology can be used to improve the efficiency and effectiveness of the executive and legislative branches.

The report is at best a start toward strengthening our society's ability to handle the challenges that computer-based information technology poses. One hopes, however, that even this modest effort will demonstrate why strengthening that ability is essential. Depending on the policies that govern its application, computer-based information technology will bring about changes for the better or worse; there is nothing inevitable or foreordained about its effects. On the other hand, only deliberate policy, with specific objectives and well conceived instruments, can assure that the technology's potential for economic and social betterment will be fully realized.

NOTES AND REFERENCES

1. The term "computer-based information technology" connotes, for the purposes of this report, any combination of the tools of computing and telecommunications that, when deployed and operated in association with one another, allows information to be captured, stored, compared, retrieved, or otherwise manipulated electronically.

2. The term "public policy" as used here refers either to the *deliberate action* or the *conscious inaction* of public authorities. Conscious inaction is included because, if public authorities are aware of issues and consequences and either choose not to take or are unable to take new policy actions, they are, in effect, allowing the existing structure of public rules or private policies, or both, to continue operating.

   Increasingly, and especially where major technologies such as computing and communications are involved, public policy on significant issues has these characteristics:

   (1) It requires and is executed through a combination of actions taken by public authorities at different levels of government (federal, state, and local), and, at each level, by a mixture of executive, legislative, regulatory, and judicial agencies. Overlap and competition among public authorities is therefore commonplace.

   (2) It takes a variety of directive forms, from legal prohibition or regulatory plan to relaxation of controls (e.g., suspension of anti-trust rules or enforcement), as well as stimulative actions (subsidies, research contracts, tax-benefits, and so on).

   (3) Public policy can also be made by investigative oversight, publicity, and exhortation by government leaders, in which a combination of official requests and warnings of potential regulatory measures amounts to a statement of public policy.

   (4) Public policy also involves a complex interplay of public authority and private (industry and consumer) decisions. Predicting the costs and direction of private responses to public action is crucial.

   (5) Finally, while the public policy-making process has its rational aspects and empirical

foundations, it inevitably also involves matters of personality, political party, and organizational self-interest. This makes the identification and clarification of values, interests, and options for public policy a "political" matter in the larger sense of that term.

3. For further discussion of the FCC's "Computer Inquiry I" and "Computer Inquiry II," see below, pp. 27-35.

4. The conventional definition of the "information industry" includes all manufacturers and suppliers of computing equipment; all commercial data processing service bureaus; AT&T; the nation's 1,590 independent telephone companies; Western Union; the "international record carriers"--Western Union International, RCA Global Communications, ITT World Communications, TRT Telecommunications, and French Telegraph; the Communications Satellite Corporation; the Microwave Carriers--primarily MCI Communications and Southern Pacific Communications; Telenet, Tymnet, and Graphnet--the so-called "value-added" carriers, which lease their communications lines from others; the several domestic satellite carriers--Western Union, RCA, American Satellite, Southern Satellite, and the fledgling Satellite Business Systems Corporation; mobile radio carriers and suppliers; retailers of acoustical couplers, computerized switchboards, and the like; cable television companies; and all local radio and television stations plus the national networks. To this list, moreover, the Xerox Corporation and other manufacturers of facsimile equipment should probably be added.

5. Marc Uri Porat, *The Information Economy: Definition and Measurement*, OT Special Publication 77-12(1), Office of Telecommunications, U.S. Department of Commerce. Washington, D.C.: U.S. Government Printing Office, May 1977, pp. 6-8. In his expanded "industry" definition, Porat includes advertising agencies, printers and publishers, broadcasters, film producers, manufacturers of office supplies, banks, insurance companies, the U.S. Postal Service, government agencies generally, and research institutions.

6. *Ibid*.

7. These figures are only the roughest measures of industry performance. The economists responsible for them have had to glean them from GNP statistics that do not recognize the "information industry" as a discrete category for national accounting. The precision of the numbers, however, and the adequacy of the methods used to develop them, are less important than the relative size of the industry's contribution, no matter how it is calculated.

8. Paul Sturm, "Cairo Calling," *Forbes*, December 11, 1978, pp. 64-69; and Peter J. Schuyten, "Blanketing the Globe with Phones," *The New York Times International Economic Survey*, February 3, 1980, pp. 18, 21.

9. Willis H. Shapley and Don I. Phillips, *Research and Development*, AAAS Report IV. Washington, D.C., 1979 pp. 122-123, Table C-1. The 11 percent figure cited is for 1977.

10. Examples of public-policy action or inaction inhibiting innovation would include the seven-year delay that occurred in the commercial application of domestic satellites--while industry structure was being proposed, analyzed, debated, and challenged; a similar delay in the application of mobile telephone technology at 800 MHZ--while an analysis of spectrum utilization was being made and disputes between dispatch-type and mobile telephone-type services were being contested; the delays that have occurred in the introduction of cable television due to effective political opposition by broadcasting interests; and the attenuated controversy over government regulation of data communications, the so-called "hybrid services," discussed below, pp. 30-35.

2 TECHNOLOGICAL TRENDS AND IMPLICATIONS*

To appreciate why computer-based information technology presents unusual opportunities and challenges affecting wide sectors of American society, one needs to appreciate the capabilities of the computer, both as an information-processing device and as a facilitator of modern-day communications. The appreciation of those capabilities can, in turn, be helped by delineating carefully a handful of simple but often only hazily grasped concepts, one of the most important of which is the concept of *information representation*.

Consider information as an abstract entity that in some way reveals knowledge about the environment in which each of us lives--the planet Earth, the solar system, the cosmos, a community, an institution, or a series of events. To convey such information--i.e., to pass it from one person to another, or from one institution to another--it has to be represented in some form. For example, one item of information in a community is each inhabitant's name. An individual's name may be represented as a written signature, as a sequence of printed letters, as a series of spoken sounds, as a sequence of Morse code characters, or in surrogate form as a sequence of numbers on (say) a credit card, a mailing label, or a personal check. Each of these forms of representation fulfills the same function--that of conveying a given item of information--and each can be converted into the other without altering the item's basic information content.

*This chapter is included mainly for the lay reader. Thus, readers with a strong background in communications and computing may want to skip at least the first 7 or 8 pages.

Broadly speaking, there are two categories of ways in which information of any kind can be represented. One is called *digital*; the other *analog*. Digital representation is distinguished by its sequences of discrete symbols, usually letters or numbers, that have meaning when organized according to specified rules. English words, sentences, and paragraphs are a good example. The symbols they employ are the 26 letters of the Latin alphabet, plus a variety of special symbols called punctuation, which, when organized according to the rules of grammar and syntax, make it possible to convey information of almost any kind.

Analog representation, in contrast, relies not on the ordered sequencing of symbols, but rather on representation in terms of some continuously varying physical entity or attribute. The automobile speedometer, for example, shows a vehicle's rate of forward motion by the varying position of a needle mounted on a moving shaft. Change in the needle's position, while typically read against a numerical scale, does not require a scale to be comprehensible. Other commonplace examples of information conveying devices that rely on analog representation include the cassette recorder, which represents sound as continuously varying states of magnetism on a tape, and the analog portions of the telephone network, which use a continuously varying electrical signal to represent human speech.

That there are these two different categories of ways to represent information carries important practical implications. Within either category, for instance, there can be a variety of *representational forms*, any one of which may be interchangeable with others. Perhaps the best illustration of this in the digital category is the use of numerical symbols in lieu of letters to represent information that are not inherently numerical--e.g., letters, words, and sentences. By simply numbering the letters of the alphabet 1 through 26, the information conveyed by any letter can be made independent of whether the letter appears as a letter or as a number indicating its place in the alphabetical order, a through z. So also with numerically encoded words and sentences. As long as the encoding scheme is known, any numerical symbol, or combination of numerical symbols, can be "read" as efficiently as the combinations of corresponding alphabetical symbols.

Such interchangeability also exists, though to a lesser extent, in analog representation. For example, the sounds on a phonograph record can be transcribed onto a cassette

tape, and two measuring devices can be calibrated so that the position of the indicator on one conveys information about the position of the indicator on the other.

One should also note that because information can be represented by two fundamentally different methods, the representation of it in one will have an equivalent in the other. This is particularly true in the computing and telecommunications fields where techniques for *analog-to-digital conversion*, and vice versa, are necessarily well developed.

Finally, it is important to observe that information-conveying mechanisms often have both analog and digital aspects, and, when they do, it can be helpful, and sometimes essential, to appreciate the differences between them. As noted, the automobile speedometer has both a moving needle and a numerical scale--the one sufficient to observe acceleration; the other essential to staying below the posted speed limit. A clock has both circulating hands and a face engraved with sequences of symbols that conveniently refine the information conveyed by variation in the positioning of the hands. A musical instrument is a device for reproducing the discrete tones of the musical scale, which is digital in nature, while the actual playing of the instrument relies on a form of analog representation--i.e., sound created by continuously varying the pressure of the surrounding air.

For the present discussion, one need not examine in exquisite detail the analog or digital attributes of things that are not central to understanding computing and telecommunications capabilities. In what follows, however, it is important to bear in mind that information as a quantum of knowledge can be represented in many forms, some of which may be analog, others may be digital, and combinations of the two and conversions from one to the other also are possible.

CONTEMPORARY COMPUTING AND TELECOMMUNICATIONS TECHNOLOGY

There abound in the world today two broad classes of computing technology--not surprisingly, one called analog and the other called digital. In the analog device, information is typically represented as continuously varying electrical signals whose direct manipulation allows the performance of desired algebraic or mathematical operations. In the digital computer, on the other hand, information is in the form of sequences of (usually numerical) symbols whose

physical representation is an electrical voltage or signal that may have only discrete values or an element of magnetism that may have only particular positions. The basic computing operations consist of combining such electrical or other signals, according to appropriate rules, such as those of arithmetic, and, because all information is represented and manipulated digitally, encoded nonnumeric information, such as letters, words, and phrases, can be handled as readily as any other. The digital computer, in other words, is in principle capable of accepting and manipulating virtually any kind of information, and for that reason, in particular, it has become over the last 15 years the most common electronic computing device.

The digital computer's extraordinary versatility in regard to the forms of information it will accept also accounts for its wide use today in conjunction with other technologies and, most notably for present purposes, in conjunction with telecommunications technology. Any computer, be it analog or digital, has four main functions: to accept information of a variety of kinds; to represent and store it internally in appropriate fashion; to manipulate it as instructed; and to produce a desired information product. In performing those four functions, the computer may combine fragments of information with one another, discard other fragments, or create new information, such as by adding or multiplying a series of numbers. In short, the very essence of computing, or of data processing, as it is sometimes called, is *to change information* in desired ways.

The essential function of telecommunications, on the other hand, is *to transport information* from place to place with the understanding that what is delivered to the recipient will be the same as what the sender sent. Regardless of the form in which a telecommunications system accepts information from a sender, regardless of how the information is represented in transit, and regardless of the form in which it is delivered at its destination, the information content is not supposed to be altered. A telegraphic communication system, for example, may accept handwritten messages whose representation enroute changes repeatedly--from keystrokes to electrical signals, to radio signals to and from a satellite, to a printed telegram delivered to the recipient. Similarly, the voice conversation between two subscribers of the telephone system may at one time be represented as analog electrical signals and at another time as digital signals--each changing one to the other typically without affecting information content.

Notwithstanding these basic functional differences, however, computing and telecommunications, and particularly digital computing and telecommunications, are proving to be extraordinarily useful to one another. Telecommunications can extend the outreach of computing capability by connecting it to remotely located terminals, printers, and displays. By thus allowing the processing power of one or more computers to be delivered to places of choice in a flexible, economical, and appropriate manner, telecommunications technology encourages the development of new and often highly practical computer applications. For example, a merchant today can use a counter-top terminal to check the validity of credit cards presented as payment for purchases; a branch bank can verify that a customer's balance is sufficient to cover a proposed withdrawal; and employees of a government agency, such as the Social Security Administration, can assist clients by querying the agency's central records through terminals located in widely dispersed field offices.

Conversely, digital computing technology can greatly enhance the flexibility and efficiency of telecommunications capability. In the domestic and international telephone net, for example, digital computers are now used to perform such tasks as:

- Selecting routing paths and establishing circuits;
- Monitoring the utilization of equipment;
- Producing bills;
- Accepting information flowing in on one communications channel, storing it temporarily, and then routing it outward on another;
- Monitoring the reliability and overall performance of the network; and
- Allowing information represented in digital form to be broken up into easily transportable units that are then reassembled at their destination to recreate the original data stream.[1]

In sum, digital computing technology is playing an increasingly significant role in the management, operation, and control of telecommunications systems at the same time that telecommunications systems are facilitating the spread of digital computing capacity. Moreover, this growing synergism between the two technologies, sometimes referred to as the marriage or convergence of computing and telecommunications, is being continuously reinforced by technological advances in both areas.

Traditionally, computing and telecommunications have been considered to be based on distinct technologies, and in many respects they still are. Each has its own specialized equipment, for example. A telecommunications system uses microwave relays, satellite transmission facilities, modulating devices of various kinds, and, of course, all of the open-wire and coaxial cable technology. Likewise, a digital computing operation uses magnetic tapes, magnetic disks, various types of printing devices, and some special electronic technology such as magnetic cores. Increasingly common to both, however, and, in effect, encouraging them to move ever closer together, is the exploitation of modern-day solid-state integrated circuit technology.

TECHNOLOGICAL PROGRESS

The first truly electronic digital computer--ENIAC--exploited World War II vacuum-tube technology. The machine, completed in 1946, used some 20,000 vacuum tubes to execute 100,000 or so calculations per second. It had a memory capacity of only 20 words (of 10 decimal digits each), and amply filled a room of more than 1,200 square feet. Over the years vacuum-tube technology gave way to miniature vacuum-tube technology, which in turn yielded to the first transistor technology, and eventually to the contemporary densely-packed integrated circuit. As a consequence, a complete microcomputer today, including even memory capacity, can be contained on a silicon chip perhaps 1/4-inch square, and such a tiny electronic mechanism can outperform ENIAC hundreds of times over.

Furthermore, the density with which basic electronic entities can be placed on such a chip is steadily increasing, so rapidly, in fact, that by the mid-1980's a memory chip that can store a million binary digits--the equivalent of some 30,000 of the old ENIAC words--is expected to be commercially available. Not only has the packing density of such silicon-chip technology been increasing dramatically, but, importantly, the cost of manufacturing microchips has declined impressively. Thus, ever-larger computational capacity is becoming available in ever-smaller physical size at ever-decreasing cost. Computations that were done for tens of dollars three decades ago can now be done for pennies or fractions thereof. To illustrate how dramatic the advance of solid-state electronic circuit technology has been, one recent report noted that if the price-to-performance ratio of a Rolls Royce had evolved in comparable

fashion, today, the most luxurious model would cost slightly less than 25 cents.[2] (One might also note that it would go a million miles on a gallon of gas!)

In many respects, progress in the telecommunications field has been equally remarkable. The capacity of the original copper or iron open-wire line, subsequently enhanced by various carrier systems, has been supplemented by the broader bandwidth, or carrying capability, of coaxial cables and microwave relays. Today, enormous numbers of individual voice and other subscriber channels can be "multiplexed" together for satellite transmission, and just entering use is the glass optical fiber, which provides enormous capacity in a very small physical size. Furthermore, as the demand for communications links dedicated to data transmission has grown, along with the demand for so-called "dial-up" data communication, the telephone industry, in particular, has been responding with new ways to better use older facilities as well as by providing new capability with improved technology.

Historically, data communication--i.e., communication between central computers and remotely located terminals or other computers--has been constrained by the carrying capacity of the installed telephone network. That limitation has been due in part to the original design of the telephone system for the bandwidth of voice communication, and in part to the many subsequent improvements that have necessarily been shaped by the statistical properties of subscriber behavior--e.g., duration of call, frequency of calling, geographical distance between connected parties. For computer-related data transmissions, however, both the optimal bandwidth and the statistical properties of usage are quite different. For example, a particular circuit may sometimes be needed only for milliseconds but at other times continuously for hours. Thus, the designers of telecommunications facilities have had to make special efforts to understand the needs and behavior of data communication subscribers, and, as they have done so, some of the constraints arising from the past emphasis on voice communication have begun to disappear.

Some, in fact, have disappeared simply as a result of new digital techniques developed to make more efficient use of voice communication facilities. "Pulse code modulation," for instance, is now a well-established innovation that represents voice conversations in digital form, thereby enlarging the number of them that can be carried on simultaneously over a given communication link. (As should be clear from earlier discussion, each conversation, while

temporarily represented as a digital stream, is restored to its original analog form prior to its delivery to a receiving handset.) Because pulse code modulation is a digital technique, however, its use by the telephone industry inevitably facilitates the industry's ability to transport other types of digitally represented information and particularly the digital data streams generated by computers and computer terminals.

Advances in solid-state integrated circuitry are also having an impact on telecommunications, though to date a less direct impact than the one on computing. Modern-day telecommunications systems may have parts that are coaxial or microwave, parts that are satellite-based, and parts that rely on twisted copper wires. This, by itself, limits the opportunity to exploit microelectronics, but, in addition many system components appear to be ones to which the new chip technology may contribute little--satellite antennas, for example, and substantial portions of the transmitting and receiving devices. Still, one can confidently expect the impact of microelectronics to grow as the telecommunications industry learns how solid-state integrated circuitry can be used to improve the efficiency of existing operations, to develop substantially new and significantly different services, and, most importantly, to satisfy the burgeoning demand for data communications capacity.

NEW KINDS OF FACILITIES FOR DATA COMMUNICATIONS

Because the demand for data communications capacity is growing by leaps and bounds, virtually all segments of the telecommunications industry are now working on ways to transport information in digital form. Experiments with digital broadcasting, using transmission channels assigned to local television and FM radio stations have been underway for several years, and just over the horizon is large-scale exploitation of fiber-optic technology--sometimes called optical cable--which uses laser-generated signals instead of electrical ones to transmit digitally represented messages. Total capacity of such an optical cable is many times greater than that of conventional copper-wire cables, and thus can provide an enormously enhanced capability for information distribution, particularly in densely populated areas.

A handful of new business ventures have also sprung up, marketing specialized forms of telecommunications systems,

such as "packet-switching" networks or, more precisely, "packet data communications." This is a method of digital data transmission that divides data traffic into packets of fixed length, with no limitation on the number of packets that may be used. For example, if a transmission consists of 100,000 digital elements, it might be fractured into 100 packets of 1,000 elements each. Each such packet is then individually addressed so that enroute-switching and control centers know how to handle each one and direct it toward its intended recipient (typically a computer that performs data-processing operations). Because each packet travels through the network as an individual entity, not all will necessarily follow the same path, but all will arrive at their intended destination where they can be reassembled in proper sequence, thus recreating the original data stream.

The packet approach is one that exploits the statistical characteristics of data communication, but, in addition, it is a clear example of digital computing technology being innovatively exploited for a telecommunications purpose. Because all information flowing through such a system is represented digitally, digital computers are readily used to control packet routing, to detect and control errors, and to maintain the integrity of the network if trouble develops in some of its parts. In other words, the digital computers in a packet network act as control mechanisms that see to it that the transmission of information takes place as intended and that the network fulfills its basic obligation as a telecommunications system--namely, to deliver information from sender to recipient in a timely manner, without errors or other changes in the information content of the original message.

Packet switching, it should be noted, is also a good example of how an application of digital computing technology can have significant economic implications. Packet techniques were first implemented as the ARPANET, funded by the Department of Defense in the late 1960's. Conceived as a vehicle for sharing computing capabilities among a group of government-funded research centers, the ARPANET now contains some 60 "nodes," each of which is either a computer center providing services to the net or a research operation using services from the net. Such an arrangement makes it possible for the participating researchers to share one another's computing installations and also encourages the sharing of computer software, often at appreciable cost saving.

At present the packet concept is being commercially

exploited. Throughout the world a half dozen such networks are either in operation or under construction. From the commercial users' point of view, one of packet switching's strong advantages is that it allows the telecommunications carrier offering it to charge users for the amount of traffic they actually generate rather than for the amount of time that toll circuits are committed to them. In the past, because of the technological need to dedicate circuits to users, many paid for time they could not fully use. With the advent of packet switching, such dedication is no longer essential, and thus not only can price be brought into line with actual usage, but previously underutilized circuits can be operated more efficiently.

TELECOMMUNICATIONS EFFICIENCY AND OTHER ISSUES

Packet services may be supplied by a specialized common carrier or as a specialized service within the framework of the classical telephone system. For the future, an important market for them will be record-keeping operations whose information comes from a variety of geographically dispersed locations. One illustration is the so-called "point-of-sale" electronic funds transfer system in which a purchase would be paid by using a terminal on the merchant's premises to debit the customer's bank account and credit the merchant's. In any such transaction, the amount of data generated is small and need only be transmitted each time a sales transaction occurs. Hence, while there might be thousands of merchants using such a system, the vast majority of them would not generate enough data traffic to warrant full-time use of a dedicated communication channel, whereas a system based on packet techniques would provide them with as little or as much transmission capacity as they might need.

There are, of course, other approaches to implementing a funds transfer system of the sort described. For example, one could aggregate data from many sources for transmission through a full-time communication channel that is collectively shared, and, in fact, such an approach is currently being taken by some transaction-oriented systems, such as the reservations systems the commercial airlines operate. One should also note that in order to make a packet system function properly, extra items, such as error control digits, address digits, and sequence numbers, must be added to the basic information being transmitted. Thus, there is a

form of overhead inherent in packet techniques that, for a user who does have a large quantity of steadily flowing data to transport, may make them less cost-effective than the more conventional dedicated circuits.

Indeed, the question of how best to provide telecommunications among geographically distributed terminals and one or more computing centers that service them is clearly an engineering design problem that involves much more than questions of technical feasibility. One would like to think that eventually conventional techniques for managing and using a telecommunications network, plus packet switching and other innovations that are yet to be made, will give telecommunications users all the options necessary to satisfy their requirements in whatever way is most cost-effective for them. To reach that point, though, many obstacles still need to be surmounted.

As explained in Chapter III, the influence of government regulation on the future of data communication services is of major importance. In the large, there is ample technology already available for much of the data-oriented telecommunications services that users will demand, and additional technology is constantly emerging from the research laboratories. From a purely technological point of view, that is, there seems to be no reason why today's telecommunications systems could not be augmented to the point where a user would be able to send and receive virtually any kind of information (i.e., print, data, speech, facsimile, full-motion television images) economically and whenever the user needs or wants to do so. As in many other high-technology areas, technical feasibility is only the first requirement.

The U.S. telephone and telegraph industry has long been a regulated monopoly, and in recent years regulation, for a variety of reasons, has tended to slow its technological evolution.[3] Furthermore, because the industry must depreciate its installed plant over a long period of time, and because the prices that may be charged for a regulated service are typically set with a view to making the service affordable by small users as well as large ones, there is a reluctance to allow new competitors to enter the telecommunications field if, in so doing, they might siphon off customers the established carriers consider necessary to maintaining their existing base of revenues.

In addition to these kinds of knotty regulatory problems, the need for widely agreed upon technical standards could turn out to be a major source of difficulty in some matters. If computers are to "converse" through

telecommunications networks easily, interface standards--generally called protocols--will have to be devised. The task of developing them, however, could turn out to be as contentious as it is complex, since few standards are wholly without competitive ramifications.

Finally, there is a formidable group of problems that arise from the applications of computer-based information technology that often stimulate, and occasionally require, changes in the way things have previously been done. Sometimes such change is accepted but often it is resisted by people, or institutions, or interests that, for one reason or another, prefer the status quo. Even today one can produce a long list of instructive examples that encompass a wide array of economic, psychological, and, on occasion, political concerns.

Consider, for instance, the amount of resistance that some price-conscious consumers showed to the introduction of computerized check-out stands in supermarkets. Quite apart from any consumer resistance, consider also the opposition to electronic funds transfer systems that has developed within segments of the financial industry on the grounds that the systems' remote terminals amount to branch banks and, therefore, threaten to upset the existing pattern of intra-industry competition. Consider the public concern that was voiced in the mid-1970's over the use of computer-based information technology to gather, maintain, and disseminate records pertaining to identifiable individuals, and note as well the uneven pace of office automation that appears to be due in part to concern that long-established interpersonal or hierarchical organizational relationships will be disrupted.[4] Lay these examples alongside the growing controversy over the future role of the U.S. Postal Service as a provider of electronic message services--a controversy that involves issues of public versus private initiative and ownership, conflicts among regulatory agencies with overlapping jurisdictions, and unsolved policy and technical issues relating to the confidential status of first-class mail--and one begins to see clearly why successfully extending the utilization of computer-based information technology requires a solid appreciation of matters far beyond the narrow question of technological feasibility.

Then, too, there are in no way farfetched applications of the technology that may contain latent problems of which few to date have even an inkling. For example, small microprocessor-based home computers for which an interface to the telephone system is readily available are growing

in popularity. In what ways might they pose new threats to personal privacy? In what ways might their widespread use facilitate subtle incursions by innovative people into public and private information systems that also use the common-carrier telecommunications networks?[5]

Questions of this sort are multiplying today, and unless they are forthrightly and responsibly examined, there seems to be little doubt that the pace at which computer-based information technology is applied will continue to be slower than its demonstrated usefulness throughout large sections of our society might lead one to expect. The joint applications of computing and telecommunications technology that have been made so far have been extraordinarily rich in services--financial and reservations services, public data bases, shareable computing power, command and control systems for the military, corporate audit and planning capability, stock and commodity price quotations, individualized education in grammar and arithmetic, traffic-control support for air, water, and rail transportation, weather reporting, scientific data banks, newspaper morgues, specialized services for medical professionals, remote printing capability for newspapers and magazines--and on and on. Nonetheless, the sum of what has been accomplished to date is less than what might have been accomplished if the technology had been recognized as the potentially powerful technological resource that it is. Further, if we are to begin now to recognize it as such, and also, and most importantly, to recognize it in a way that directs attention to the differences between desirable and undesirable applications of it, the amount of research and analytical effort in support of public and private decision making about the subject needs to be enlarged.

NOTES

1. For an explanation of packet-switching techniques and their utility, see below, pp. 20-21.

2. Simon Nora and Alain Minc, *L'Informatisation de la Société*, Rapport à M. le President de la République, La Documentation Française, Paris, 1978 (English translation prepared by Transmantics, Inc. of Washington, D.C. for the National Telecommunications and Information Administration, U.S. Department of Commerce), p. 20.

3. Regulatory delays of several years in each case were cited in note 10, Chapter 1, for domestic satellites, mobile telephone, cable television, and hybrid computer communications services. To this list may be added regulatory delay in authorizing various transatlantic telephone cables and "teletext," or alphanumeric information services for home television screen display. Such delays mean that new markets cannot be counted on with certainty, so that incentive lags to develop the innovative services and facilities to supply the markets. Another deterrent to innovation is long depreciation schedules set by regulation. For example, mechanical No. 5 crossbar switching equipment has been retained in the rate base well beyond the time that it was technologically surpassed by electronic switching. An example of innovation not held back by regulation is optical fiber transmission technology; the decision in this case could be made by the firm within existing regulatory policy.

4. See, for example, U.S. General Accounting Office, *Federal Productivity Suffers Because Word Processing is Not Being Well Managed*. Washington, D.C.: U.S. Government Printing Office, April 6, 1979; see also, *The Technical Office*. Cambridge, Massachusetts: The Yankee Group, March 1978, p. 138.

5. An alleged case of such an incursion involving a private school in New York City and 21 computer systems operated by organizations in Canada was the subject recently of an affidavit filed by the Federal Bureau of Investigation in support of a Bureau request for a search warrant. *New York Times*, May 6, 1980, p. 1.

3 REGULATORY ISSUES

As computer-based information technology has been adapted to an ever-widening array of economic and social pursuits, it has increasingly come within the purview of government regulation. This has occurred in part because many activities the technology supports are themselves regulated. Electronic funds transfer systems, for example, are being noticeably shaped by the statutes and regulations governing services that depository institutions and credit grantors provide to individuals. Equally important is the interaction between technological innovation and information policy generally--that is, between the processes by which technological advances are transformed into commercially available products and services and the bodies of law and interpretation that shape, directly, the way individuals and organizations in our society assemble, disseminate, and use information.

The United States has never had a coherent national policy for the development and use of information technology. Such information policy as we have had has been closely tied to the evolution of particular technologies, each conceptually distinct from the others, and each with its own special uses, markets, and associated interplay of political and economic interests. As a result, the mail, the telegraph, the telephone, print publishing, broadcasting, cable television, automated data-processing, and satellite communication, each in its own time and each in its own way, have given rise to a separate body of law and interpretation and in many cases to a separate structure of interpretative institutions. Each technology, moreover, has been approached from a somewhat different policy perspective. The conditions encouraging entry into the marketplace have varied greatly from one technology to another. Government approval has been required in some

instances, while free entry, subject only to antitrust constraints, has elsewhere been the norm. Accordingly, competition has been forbidden, permitted, or required. First Amendment rights, privacy protection, copyright, and freedom of information requirements have all been affirmed differently in different contexts.

This pervasive fragmentation of policy initiative and responsibility could be sustained so long as there were valid technological grounds for distinguishing a letter from a phone conversation, a television image from a wired birthday greeting, and a telephone switchboard from a computer. Today, however, computer-based information technology is calling all such distinctions into question and, with them, many of the premises, perspectives, and expectations on which our nation's information technology policy, and particularly its regulatory policy, have heretofore been based.

DATA PROCESSING OR TELECOMMUNICATIONS: THE FCC DEBATE

The decade-long effort by the Federal Communications Commission to define a boundary between data processing and telecommunications provides a classic illustration of the regulatory challenges posed by computer-based information technology. As early as 1966, the Commission became aware that computing technology would play an increasingly central role in the operation of telephone and telegraph services, and that as a consequence many regulated common carriers would develop both a capacity and a desire to enter the growing market for commercially provided data-processing services. As the FCC repeatedly observed during its first formal inquiry into the subject:

> ... (C)ommon carriers "as part of the natural evolution of the developing communications art" were rapidly becoming equipped to enter into the data processing field, if not by design, by the fact that computers utilized for the provision of conventional communication services could be programmed additionally to perform data processing services.[1]

This technological convergence, moreover, was not occurring only within the telecommunications industry. Just as data-processing capability was becoming a basic tool of the telephone and telegraph industry, so also signal transmission capability was becoming increasingly

indispensable to data-processing operations. As the FCC noted at the conclusion of its "Computer Inquiry I":

> ... (D)ata-processing cannot survive, much less develop further, except through reliance upon and use of communication facilities and services.[2]

To the Commission and the industries involved, it was apparent that this blurring of technological boundaries could raise some difficult policy issues. At the time, however, the issue that stood out was whether the Communications Act of 1934 should be interpreted as requiring the FCC to regulate firms that provide communications-linked data-processing services on a commercial basis.

The Communications Act of 1934 constitutes a Congressional determination that the public interest requires government regulation of any common-carrier communications activity. That determination was long interpreted by the FCC as requiring it to protect interstate providers of telephone and telegraph services from unregulated competition. The rationale for such protection has been that without it the regulated carriers would be unable to generate the revenues necessary to keep high-quality telephone and telegraph services continuously available to the public at affordable rates. Thus, in attempting to decide how it would treat communications-linked data-processing, the FCC has had to deal with two intimately related (as well as highly charged) regulatory questions: should communications-linked data-processing services be defined as a common-carrier communications activity and therefore subject to the same general rules as telephone and telegraph services? should competition between data-processing firms and the established common carriers be encouraged, forbidden, or controlled?

The first question, it so happened, sparked the controversy, since it was apparent to the FCC that both data processors and carriers were increasingly using combinations of computing and telecommunications technology to perform information-handling tasks that, from a technological point of view, seemed virtually indistinguishable. The second question was equally important because no matter how the Commission classified communications-linked data processing (i.e., as regulatable or not regulatable) the success or failure of the firms offering it as a commercial service might hinge on whether the established carriers could compete with them. For example, if the Commission were to decide that all or part of the

data-processing industry fell within its regulatory jurisdiction, few other than the established carriers might have the financial resources necessary to obtain prior FCC approval of their service offerings. Conversely, if the Commission were to decide not to regulate data processing, it would, in effect, be releasing the carriers to enter the data-processing business without Commission supervision,[3] and in doing so perhaps tempting them to use their protected communications monopolies to secure formidable market advantage. The carriers, for instance, might use computer facilities or even revenues from their telephone and telegraph monopolies to subsidize, and thus artificially price, their commercial data-processing offerings. Or they might provide their data-processing competitors with inferior communications equipment or services, or refuse to provide service on the grounds that to do so would be inconsistent with the intent of FCC policy.[4]

At first glance, formally separating the carrier's regulated business enterprises from their unregulated ones might seem like a painless way to alleviate much of the concern about anticompetitive practices, and, in 1970, the FCC did adopt a regulatory policy based on a concept of "maximum separation." The carriers were precluded from otherwise disposing "of any capacity on computer systems utilized...for the provision of common carrier communications services," and, in addition, the Commission stipulated that they might enter the commercial data-processing market only through separately incorporated affiliates.[5] Nonetheless, as the Commission recognized, this was only a partial solution to a partially articulated policy dilemma.

In principle "maximum separation" did little more than require the carriers to maintain two sets of accounts, one for their regulated communications services and one for their independent, and thus unregulated, data-processing services. It did not provide anyone with the ability to say whether the communications or data-processing operations thus accounted for were the ones intended. Yet, unless the Commission could delineate what was intrinsically communications and what was not, unregulated data-processing services would always be vulnerable to competition from the regulated carriers' technologically similar communications ones. Likewise, in order to fulfill its obligation to protect the carriers from unsupervised competition in the telecommunications domain, the Commission would inevitably be called upon to decide whether services marketed as commercial data processing were in fact communications services in disguise and, thus, properly subject to regulation.

As an illustration of how difficult it can be to draw such distinctions, consider the case of message switching. Message switching is a form of information transmission in which signals, instead of going directly from the sender to the receiver, are passed through one or more routing facilities that determine the path they should take and the priority they should have in the queue at any given routing point. Historically, message switching has been the basic common carriage service provided by the telegraph industry. Today, however, it is also used in data-processing operations where the workload generated by one or more remote terminals is shared among several computers. To complicate matters further, the telegraph industry is itself in the course of shifting from conventional to computer-based message switching. Under such circumstances, how might the FCC decide, on technological grounds, that message switching in the telegraph context constitutes regulatable telecommunications, while elsewhere it may be properly classified as unregulated data-processing?

The method by which the FCC chose to extricate itself from such ambiguities was to begin defining services as either communication or data processing depending on the degree to which each exploits the capabilities of the computer. The Commission defined message switching as a communications service on the grounds that, in contrast to data processing, it does not involve any alteration of the information being transmitted. From the Commission's perspective, message switching was pure information transmission. This could mean, however, that any data-processing service that employed message switching could be regulated as a communications service, and, as indicated, the Commission, for a variety of reasons, was reluctant to reach that conclusion. Thus, the Commission distinguished a special class of "hybrid" services that it further divided into *hybrid communications services* (in which data processing plays only a minor role), and *hybrid data-processing services* (in which communications plays the minor role). Which was which, the Commission said, it would decide for itself after evaluating "the primary thrust of the service offered."[6]

THE WEAKNESSES OF THE HYBRID SERVICES APPROACH

It can be difficult to describe policy making processes and outcomes of this sort without appearing to criticize the regulatory agency responsible. The FCC, for its part,

was doing no more than interpreting general rules and objectives laid down in its statutory mandate. That mandate, in effect, enjoined it to differentiate among service offerings that historically had been distinguishable by the capabilities of the technologies they employed, while, as a practical matter, the direction of technological change was making distinctions among those capabilities harder and harder to draw. The problem in other words was not that the path the Commission chose was unreasonable, given the circumstances, but rather that it was beholden to an increasingly anachronistic conception of its regulatory functions.

By adopting the hybrid services concept, moreover, the Commission inadvertently inhibited some of the changes it had hoped to find a way of accommodating, since, as subsequent events have shown, one of the chief effects of the hybrid services approach has been to discourage innovation in the hybrid services area. The Commission's action created a situation in which a firm wishing to market a communications-linked data-processing service typically had two choices: to request prior FCC evaluation with all the delay and expense that could entail, or, alternatively, to venture into the unregulated marketplace and wait to see if anyone challenged its right to be there. The consequences of posing such a dilemma for potential service providers have never been systematically assessed, but there seems to be little doubt that they impeded the introduction of new services made possible in principle by cost efficiencies inherent in new generations of computers. One clear result is that much needed productivity gains are being foregone in areas ranging from manufacturing and banking to postal service and education, and the loss is being felt not only domestically, but also when U.S. firms offer their products and services for sale abroad.

Sensing this, and also being an early convert to the "regulatory reform" movement of the mid-1970's, the FCC, in 1976, launched a second inquiry into the technical and functional relationships between data processing and communications.[7] Known as "Computer Inquiry II," the investigation has resulted in a recent Commission decision to abandon the hybrid services approach in favor of one that distinguishes between "basic transmission services," which the FCC will continue to regulate, and "enhanced services," which it proposes not to regulate.[8]

In its Final Decision announcing this new policy, the Commission defines a "basic transmission service" as

> the offering of transmission capacity between two or more points suitable for a user's transmission needs and subject only to the technical parameters of fidelity or distortion criteria or other conditioning. Use internal to the carrier's facility of computing techniques, bandwidth compression techniques, circuit switching, message or packet switching, error control techniques, etc. that facilitate economical, reliable movement of information does not alter the nature of the basic service.[9]

Computer memory or storage, for example, may be used within the network to facilitate the transmission of information from origination to destination, provided that "the carrier's basic transmission network is not used as an information storage system."[10] A "basic transmission service," in short, is one in which the communications carrier

> essentially offers a pure transmission capability over a communications path that is virtually transparent in terms of its interaction with customer supplied information.[11]

An "enhanced service," by contrast, is defined as one that uses the telecommunications network to accomplish something more than pure transmission.[12] In the typical enhanced service,

> computer processing applications are used to act on the content, code, protocol, and other aspects of the subscriber's information. In these services additional, different, or restructured information may be provided the subscriber through various processing applications performed on the transmitted information, or other actions can be taken by either the vendor or the subscriber based on the content of the information transmitted.[13]

For a service to qualify as "enhanced," information need not be changed by either the vendor or the subscriber, since the enhanced category would encompass an "electronic mailbox" service that "simply involves subscriber interaction with stored information."[14] Typically, however, an enhanced service would involve considerably more than simple storage and retrieval capability. The Commission offers as its principal illustration of such a service a time-sharing network in which

> computer facilities are structured in a manner such that the customer or vendor can write its own customized programs and, in effect, use the...network for a variety of electronic message service operations.[15]

Key to the practicability of this twofold categorization of carrier services is the Commission's corollary decision to reduce the scope of its 1970 ruling on "maximum separation." As explained earlier, the FCC, at the close of Computer Inquiry I, required a regulated communications carrier wishing to enter the unregulated data processing market to do so through a separately incorporated subsidiary. Each such subsidiary was required to maintain its own books, to have its own officers and operating personnel, and to use computer equipment and facilities separate from those used in providing regulated communications services.[16] This degree of organizational separation was seen as a necessary safeguard if carriers were to be prevented from using revenues or other resources associated with their regulated communications operations to secure competitive advantages for their unregulated data processing ones. Now, however, the FCC has concluded that only carriers "under direct or common control of AT&T[17] or GTE[18] have the capacity to engage in such anticompetitive behavior."[19] In the Commission's opinion, only those corporations possess the requisite combination of financial resources and dominant market position. Thus, only AT&T and GTE will be subject to maximum separation rules. All other carriers will be allowed to offer whatever enhanced services they wish as direct adjuncts to their basic service operations.

This narrowing of the scope of the maximum separation requirement is thought to be crucial in at least two respects. First, by easing the requirements for entry into the enhanced services market, more, better, and more varied services are expected to become available to users. Second, the FCC will no longer have to decide on a case-by-case basis whether each new service offered by a communications carrier constitutes communications or computing, or, to use the terminology of the final decision, whether it constitutes a "basic transmission" service or an "enhanced" one. The FCC will not be wholly freed of the need to make such distinctions, since questions concerning the proper categorization of certain AT&T and GTE offerings may still arise. The Commission has noted that its definition of an enhanced service effectively precludes the use of code and protocol conversion[20] as part of a basic transmission

service, and that as a result, carriers subject to the maximum separation requirement may be deprived of opportunities to increase the utility of their communications channels.[21] If that proves true, one may expect the affected carriers to appeal to the Commission for relief. Nonetheless, the FCC appears to have found a way to simplify greatly its regulatory task. Indeed, it appears that the key issue for the Commission now is not whether it will be able to develop new regulatory policy suited to the growing convergence between computing and telecommunications technology, but rather whether it will be able to carry out that policy.

There is a possibility, for example, that aspects of the FCC's decision will be challenged on the grounds that they exceed the Commission's regulatory authority or, conversely, constitute an illegal exercise of discretion not to use that authority. One point of potential controversy is whether the Communications Act of 1934 allows the FCC to impose varying degrees of regulation on carriers providing the same type of service--i.e., whether the maximum separation requirement can be applied selectively.[22] Another is whether the Commission is statutorily required to regulate enhanced services--i.e., whether it has the authority to choose not to do so.[23] Questions have also been raised by the U.S. Department of Justice as to the effect of the FCC's new policy on a 1956 consent decree that forbids AT&T and its affiliates to engage in any commercial activity not regulated by the Commission,[24] and, in addition, there are numerous complications stemming from the FCC's decision on basic vs. enhanced services that is closely linked to an accompanying rulemaking on the sale and installation of so-called "customer premises equipment (CPE)."[25] The latter poses particularly difficult problems since its execution requires a major restructuring of the rates charged for interstate telephone service as well as extensive cooperation between federal and state regulators.[26]

Many of these hurdles may be overcome by timely Congressional action on proposed amendments to the Communications Act, while others may be settled through litigation. The point to be emphasized is that the issues addressed by the FCC's latest action are still far from settled, even though the Commission has been working to resolve them for more than 13 years. Furthermore, one can expect that in the future the Commission will be confronted with regulatory questions of even greater complexity as computer-based information technology becomes the essential underpinning of communications modalities such as broadcasting

and cable television. As the technology that is economically advantageous to each of these becomes more and more the same, and as new kinds of hybrid services become increasingly feasible and attractive, the inadequacy of conventional approaches to establishing and implementing regulatory objectives will be dramatically, and often painfully, revealed.

Efforts to rethink those objectives and to devise more predictable strategies for implementing them are currently afoot in the Congress. At the moment, however, primary attention is focused on modifying the internal structure of the several communications industries and on the future role of the FCC. Legislation recently before the Congress would replace the Commission with a weaker regulatory agency whose principal mandate would be to stimulate further competition within the telecommunications industry, while looking to the Executive branch for broad policy guidance. Whether such legislation will ever be enacted is currently hard to say, but however the matter is decided the effects will surely be felt in many areas.

Today, for example, there is confusion whether electronic funds transfer and electronic message service will be under FCC regulatory jurisdiction or will be assigned to or shared with other agencies, such as the bank regulatory authorities and the U.S. Postal Service. Making such collateral assignments of regulatory responsibility may prove to be a practical alternative. If technology no longer provides a reliable basis for bounding regulatory jurisdictions, a regulatory structure organized around primary application areas may be the sensible alternative. The difficulty is that today judgments of that type can be made more on the basis of habit or expediency than on the basis of carefully considered, independent evaluations of their implications.

THE ROLE FOR INDEPENDENT POLICY RESEARCH

Coping with the many regulatory issues that computer-based information technology raises is clearly a task for governmental decision making processes that give full voice and consideration to the interests of the potentially affected parties. Fact gathering and analysis outside of those processes can only play a supporting role. That role, however, need not be a small one, nor need it be confined to purely technical issues.

Although a technical consensus on matters such as definitions, feasibility, and costs is sorely needed, public policy decisions, or nondecisions, must also be based on a much heightened understanding of market peculiarities, financing conditions, and the propensity of public and private sector users to exploit the technology's capabilities. Just as each of these elements can expand or limit the future flow of resources to a service or market, so also can they expand or limit the variety of policy options to be considered.

In addition, because the pressure for timely government action is likely to grow rather than diminish, there will be corresponding pressure to keep the decision making process focused on issues that have already been identified. This, too, will tend to prevent questions that ought to be asked, and options that ought to be weighed, from being given the careful consideration they deserve.

In short, a fresh look that takes full advantage of previous efforts, but also ventures well beyond the current preoccupation with new or revised roles for existing institutions, seems to be very much in order. As a first step, technical, economic, legal, and sociological expertise should be jointly applied to the task of designing a program of independent research and analysis to support the public decision making process. Developing a capacity to articulate the implications of alternative policy proposals and to highlight and examine implicit policy assumptions should be particularly stressed.

For example, recent history seems to suggest that regulatory policy should have as its central objectives (1) giving full scope to innovation and (2) assuring that the public interest is adequately protected. Yet, because those objectives are not always compatible, and because there are more or less optimal ways to make and implement the choices and adjustments they demand, their interaction needs to be explored carefully within the context of alternative regulatory strategies.

Similarly, although many now seem to believe that regulated and unregulated markets can be effectively interwoven under circumstances of diminishing government supervision, the circumstances under which that assumption may or may not be valid need to be more thoroughly considered. Is it reasonable, for example, to believe that cross subsidization[27] and other predatory practices can be eliminated if a corporate family is still allowed to provide both regulated and unregulated services? Has the point been reached at which conscious policy decisions can create

highly competitive service markets, with little or no direct government involvement? Are there some countervailing economic or technological trends that, in the absence of government supervision, will tend to promote increasing concentration of control over the resources for innovation?

The prospect of interaction between regulatory objectives and other types of policy objectives might also be examined. If stimulating innovation is to be a central policy objective, are there, for instance, aspects of federal and state tax policy that will tend to keep the competitive marketplace from providing that stimulus? Are there dimensions of antitrust policy that need to be rethought in the light of their observable or projected impact on incentives to innovate? Thus, some contend that antitrust constraints now tend to keep the fruits of basic research from reaching the marketplace as rapidly as they should, while others maintain that removing those constraints would allow basic research knowledge to be used in predatory ways.

At this juncture, it is possible to do no more than illustrate the kinds of issues and questions that independent policy analysis might address. These should indicate, at the least, the scope of the program that is envisaged and also the importance of starting from a strong, multidisciplinary perspective.

NOTES AND REFERENCES

1. Regulatory & Policy Problems Presented by the Interdependence of Computer & Communications Services and Facilities, 28 FCC 2d 267 (1971) (Final Decision), 36 *Fed. Reg.* 5346.

2. *Ibid.*

3. All the carriers except AT&T, which, by the terms of a 1956 consent decree, has been prohibited from engaging in any commercial activity not regulated by the FCC.

4. For a thorough and lucid analysis of the many issues before the FCC in this area, see Paul J. Berman, "Computer or Communications? Allocation of Functions and the Role of the Federal Communications Commission," in Anthony G. Oettinger, Paul J. Berman, and William H. Read, *High and Low Politics: Information Resources for the '80s*. Cambridge, Mass.: Ballinger Publishing Company, 1977.

5. FCC Final Decision, *op. cit.* 36 *Fed. Reg.* 5349. This ruling did not apply to AT&T, which by the terms of a 1956 Consent Decree has been permitted to engage only in those activities that involve the offering of a communications service or facility *and* are subject to public regulation.

6. Regulatory and Policy Problems Presented by the Interdependence of Computer and Communications Services and Facilities, 28 FCC 2d 291 (1970) (Tentative Decision), 35 *Fed. Reg.* 5822. For a more detailed analysis see Oettinger, *et al.*, *op. cit.*, p. 157-159.

7. Amendment of Section 64.702 of the Commission's Rules and Regulations, Notice of Inquiry and Proposed Rule-Making, 64 FCC 2d 103 (1976), 41 *Fed. Reg.* 33563; Supplemental Notice of Inquiry and Enlargement of Proposed Rulemaking, 64 FCC 2d 771 (1971), 42 *Fed. Reg.* 13029.

8. In the Matter of Amendment of Section 64.702 of the Commission's Rules and Regulations (Second Computer Inquiry), Docket No. 20828 (Final Decision), 45 *Fed. Reg.* 31319.

9. *Ibid.*, pp. 31333-31334.

10. *Ibid.*, p. 31334.

11. *Ibid.*

12. *Ibid.*

13. *Ibid.*

14. *Ibid.*

15. *Ibid.*

16. *Ibid.*, p. 31349.

17. I.e., The American Telephone & Telegraph Corporation.

18. I.e., the General Telephone & Electronics Corporation.

19. In the Matter of Amendment of Section 64.702 (Final Decision *op. cit.*, p. 31321.

20. As the Commission explains in a footnote:
> In this context, "code" means the binary representation of alphanumeric and control characters. Thus an enhanced service may modify the transmitted bit stream to change it from the ASCII code to the EBCDIC code, which a basic service may not. "Protocols" govern the methods used for packaging the transmitted data in quanta, the rules for controlling the flow of information, and the format of headers and trailers surrounding the transmitted information and of separate control messages. *Ibid.*, p. 31334.

21. *Ibid.*

22. *Ibid.*, p. 31327.

23. *Ibid.*, p. 31329.

24. *Ibid.*, pp. 31362-31363.

25. *Ibid.*, pp. 31340-31344.

26. *Ibid.*, pp. 31345-31346.

27. Cross subsidization is the practice of using the revenues or facilities of one enterprise to help pay the cost of offering the products or services of another enterprise for sale at less than their full market value. In the FCC context, cross subsidization would typically involve the transfer of such resources from a regulated monopoly to an unregulated business enterprise run by the monopoly or one of its subsidiaries.

4 INTERNATIONAL ISSUES

In most countries of the world today, an indigenous capacity to generate, process, store, disseminate, and use information is viewed increasingly as a necessary resource for economic and social progress. Indeed, many believe there are potentially large benefits to be derived from providing many more nations much greater access than they now have to information technologies and services. Even a modest increase in the capacity of individual countries and groups of countries to cope with the seemingly intractable economic and social problems that beset them could justify making sizeable investments in information resource development, both nationally and internationally. In fact, the paramount question today seems to be not *whether* such investments should be made, but *how* they should be made and, particularly, in what areas they should be made at a time when there appears to be disagreement over the specific objectives and priorities they should serve.

THE EMERGING INTERNATIONAL CONTROVERSY OVER INFORMATION RESOURCE DEVELOPMENT

Contrary to what might have been predicted even five years ago, conflicts are beginning to arise over who should benefit from developing and using the information resources*

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*The term "information resources" as used in this discussion connotes the broad mix of technologies, plant, skills, and products that individuals and organizations can use to originate, transform, and distribute facts and ideas. Thus, "information resources" include the techniques of computing and telecommunications as well as investments in

of both the industrialized countries and the developing ones and, also, as a central part of the debate, over how such resources should be controlled and managed. These conflicts, some of which could grow into bitter confrontations, are directly related to the world-wide wedding of information resource development to prospects for economic and social development.

Among the world's poorer countries, for example, many now seem to believe that their prospects for achieving full-fledged modernization may be adversely affected by the industrialized nation's superior ability to generate, process, store, use, and disseminate information of all kinds. Some countries, moreover, complain that the information products of Western news gathering and broadcasting organizations, and of Western-oriented information storage and retrieval services, create a distorted image of their developmental experience and aspirations. As a result, they argue, the industrialized world tends to be much more aware of their failures than of their successes, and, perhaps worse,

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communications satellites, printing presses, and data bases. They include specialized workers with ability to discover, assemble, manage, and apply knowledge to fields of science, engineering, economic development, and public administration. And they include all the goods and services thereby made possible--telephones, radio, television, newspapers, computer data banks, educational courseware, engineering advice, and so on.

The term "information industry," in contrast, refers to the set of economic institutions that supply "information machines" and "information content" for use in developing a country's information resources. Currently, those economic institutions may be either indigenous or foreign, although for most countries today they tend to be mainly foreign--the industrialized nations being the principal suppliers of information and information technology to the rest of the world. For the purposes of this analysis, moreover, one should note that the demand for information machines often reinforces the demand for information content and vice versa. While each has its own main complex of producers, methods, controls, users, and impacts, there is frequently a complex interplay between the two. New network facilities, for example, may enable the delivery of messages not previously possible and those messages, in turn, may create new demand for network facilities.

their ability to foster the robust sense of national pride and cultural identity on which successful modernization depends is being undermined.[1]

To date, only a minority seems to view the information activities of the industrialized nations in such a light. Many, however, are challenging the conventional Western view that complex information resources, to be exploited effectively, require complex forms of economic and social organization. In their eyes, the technology of satellite communications systems and computer-based information retrieval services could be as usefully transferred to nations in the early stages of modernization as during the later ones.[2] While they concede that the difficulty of effecting such transfers is due in part to economic and social impediments, they also believe that such impediments could be overcome were it not for the self-regarding and, some would argue, self-serving parochialism of the industrialized nations.

Historically, the development of each nation's indigenous information resources has been partially shaped by decisions made in international forums[3] that the industrialized countries, because of the weight of their interest, investment, and expertise, have dominated. Out of this a pattern of international resource distribution has emerged, which many developing countries now want to modify in ways that will reflect more directly their own special needs and concerns. Operating through various intergovernmental forums, they are urging the United States, Canada, Europe, and Japan to take significant steps to make the industrialized world's information resources more useful and accessible to them. The various activities and position papers leading up to the August 1979 U.N. Conference on Science and Technology for Development reveal not only the objectives and strategies of the developing countries in this regard, but also the magnitude of the effort they are asking the industrialized nations to undertake.

At the rhetorical level, there are calls for a "new world information order," and for "free" access and exchange of knowledge and experience--the latter a concept at odds with the U.S. preference, and that of most industrialized nations, for treating proprietary information as a marketable commodity. At a more pragmatic level, however, most developing countries recognize that their information resource needs are extensive and are seeking guidance and assistance in developing their own information policies, in educating and training their own cadres of information users and

professionals, and in obtaining access to the relevant information technologies and sources of developmentally useful information. Further, they recognize the need for regional and international cooperation in these endeavors and look to the industrialized world not only for more extensive development and deployment of international information systems and networks, but also for help in encouraging regional approaches and technical cooperation among the developing countries.[4]

Unfortunately, however, the pleas for help from the developing countries are coming at a time when the industrialized nations are struggling to adjust to new and potentially divisive conceptions of the role that information technology and services will play in their respective futures.[5]

Today, most of the world's industrialized nations have economies in which an unprecedentedly large and growing share of their Gross National Product is in some way dependent upon being able to generate or retrieve information electronically.[6] Many are also having to cope with unemployment and balance of trade problems exacerbated by the rising costs of energy and raw materials and by the inroads that some developing countries are making into the traditional markets for their manufactured goods. This combination of economic circumstances is challenging each of them to consider how its information resource policies can be used to increase productivity in a variety of established industries and also to stimulate the growth of new industries. At the moment, how any one country or group of countries will respond to this challenge is hard to predict, but many observers believe that more than a few of them may respond by lacing their information resource policies with subtle albeit powerful forms of economic protectionism.[7]

The prospects for economic friction among the industrialized nations could also be heightened by the attempts they make to resolve political or social problems they see created by the information sectors of their economies. Maintaining the revenue base for existing postal, telephone, and telegraph services, safeguarding personal privacy, and protecting data processing workers from occupational hazards are objectives that many are now pursuing. Yet, to achieve such goals in an orderly manner, and with due regard for the extent to which the information sectors of their economies are already closely linked, the industrialized nations may have to bridge differences among their

respective political systems and governmental priorities, and thus far those bridges have not been easy to construct.

Consider, for example, the difficulties that many have encountered in attempting to harmonize their domestic policies on the protection of personal privacy. The impetus for harmonization has come primarily because computer-based information technology has made it economically attractive for public and private organizations to process and store records about individuals in countries other than the ones in which the records were originally generated. Such "transborder flows" of data about identifiable individuals challenge national requirements to protect personal privacy, which, as a practical matter, can be virtually unenforceable outside the country that establishes them and, in the opinion of some, might even induce business and government organizations to locate their data processing and storage operations abroad simply to avoid having to comply with them.

To plug such gaps in their own "data protection" statutes, at least five countries--Sweden, West Germany, France, Denmark, and Austria--have included clauses that empower government regulatory authorities to decide whether the laws and regulations of other countries to which personal data may be sent for automated processing or storage adequately protect the privacy interests of the individuals concerned, and, if not, to keep such data from being exported.[8] Several other countries are also considering such legislation. Since enactments of this sort are at least potentially in conflict with the principle that information should flow unimpeded across national boundaries,[9] and since many countries that do not now have such legislation may soon enact it, harmonization in the sense of getting all the industrialized countries to agree to legislate a minimum set of generally applicable privacy protection requirements has seemed highly desirable. At the moment, three such efforts are under way--one sponsored by the Council of Europe; one by the Commission for the European Communities; and a third by the Organization for Economic Cooperation and Development (OECD).[10] In all three cases, the drafting task has been difficult, and substantial progress has been made only after several years of hard work. Although none of the industrialized countries seems opposed to the harmonization idea in principle, their different levels of information resource development, their different legal traditions, and their different viewpoints on the desirability of government regulation have been formidable obstacles to overcome.

In the U.S., for example, any agreement that required a signatory government to enact a data protection statute along the lines of the European ones now in force could subject thousands of small businesses to detailed regulation simply because they use computer-based information technology to keep necessary records about their customers.[11] In other countries, where large government and corporate bureaucracies could remain the technology's primary users for some time to come, broad-gauge data protection laws, applicable in the main to automated record keeping operations, may have little effect on small business. In addition, some legal experts foresee constitutional obstacles to any U.S. legislation that attempted to assert federal jurisdiction over all of the automated personal data record keeping operations of state and local governments, and, if the European model were followed to the letter, it is possible that the U.S. would also be required to establish a new federal regulatory authority at a time when both the Administration and the Congress are attempting to reduce rather than augment the regulatory burden on the private sector.

Although these kinds of problems are sometimes portrayed as unique to the United States, many other industrialized nations are also struggling to keep the push for harmonization of their domestic privacy protection policies from unduly constraining their pursuit of competing policy objectives. Thus, while the OECD harmonization project in particular appears to be making good progress through compromise and careful drafting, no one is able to say for sure whether harmonization will succeed or fail, or even how important success or failure will be for the countries involved. Some, however, believe that failure could lead to interruptions in the flow of data about identifiable individuals across national boundaries and thus to major changes in the way that particular countries develop, deploy, and manage their computing and telecommunications resources.

Personal data, moreover, are only one small component of the flow of information across national boundaries. Information used in business and trade, scientific and technical information, and information of a cultural or political nature flows in much larger volume, and all such information has the potential to create controversy by virtue of its economic, social, or ideological sensitivity. One issue of growing concern centers on the proprietary rights that may attach to information assembled as a result of some commercial venture as contrasted with the public

nature of information assembled by governments.[12] What policies ought to govern global access to each type? How should the availability of scientific, technological, or economic information be administered so as to facilitate the most efficient and equitable management of global resources? Such issues are increasingly a part of the emerging international controversy over information resource development today, and unfortunately there are pressures to resolve them in ways that careful research and analysis would probably show to be not only wasteful but also unwise as a matter of principle.

INFORMATION RESOURCE DEVELOPMENT AND ECONOMIC PROTECTIONISM: WILL THE JAPANESE MODEL BE EMULATED?

Some U.S. observers of the debate over national and international privacy protection policy suggest that it should be interpreted as a step toward legitimizing autarkical approaches to the control of computer-based information technology, and, if they are correct, that it will inevitably lead to a spate of protectionist measures aimed at insulating indigenous information industries of some countries from foreign competition. Although there is still little concrete evidence to support this view of the personal privacy laws, and although data protection regulations are surely among the clumsier devices for implementing discriminatory foreign trade policies, there apparently are reasons to be concerned about a general shift toward protectionism in the computing, telecommunications, and information services areas.

In Europe, for example, including U.S. information services in EURONET, the new European scientific and technological data network, has been strongly resisted.[13] In addition, it appears that in virtually all parts of the world today, information flows across national boundaries are becoming vulnerable to the erection of so-called "nontariff barriers to international trade." Typically, these take the form of preferential government procurement policies, subsidies to industries whose products could not otherwise compete with foreign ones, and such bureaucratic obstacles as complex and lengthy licensing procedures, which, because of their cost and uncertainty, tend to take the competitive edge off products and services coming from abroad. Steel, chemicals, textiles, and shipbuilding are areas in which such nontariff restrictions are well known, but the computing, telecommunications and information

service areas are susceptible too. During the recent "Tokyo Round" of international trade negotiations, for instance, it was only with great difficulty that the U.S. prevailed upon Japan to include procurements by the Nippon Telephone and Telegraph Public Corporation among those open to U.S. firms. Indeed, the difficulties encountered in the "Tokyo Round" indicate not only how hard it can be to eliminate nontariff barriers, once established, but also how easily new ones can be erected.

It is the latter possibility, in particular, that explains why many responsible people in the U.S. are now beginning to wonder whether the industrialized countries' efforts to mold the development and use of computer-based information technology might become a pretext for imposing protectionist constraints on "foreign" suppliers of computing and telecommunications equipment and services. In the past, all of the industrialized countries, except Japan, have been chary of doing so. Today, however, some observers believe that the disposition of the Western Europeans especially may be about to change, and their belief has been nourished by the conclusions of a report that a group of government officials and expert consultants submitted to French President Giscard d'Estaing.[14] This document, an analysis of the prospects for "computerizing" French society, recommends that the government of France begin immediately to establish various governmental authorities and quasi-governmental corporations to plan, develop, and manage the weaving of computer-based information technology into French economic and social life.

The rationale for this recommendation can be roughly summarized as follows: The rising cost of imported energy has created a steady drain on the French balance of trade, while at the same time making French exports more costly to produce and thus less competitive in world markets. As a result, domestic economic growth has slowed and unemployment has become a steadily growing problem. The obvious remedy for this situation, and perhaps also the only feasible one, is to use new applications of technology, and particularly new applications of computer-based information technology, to increase industrial and manufacturing productivity in areas that offer promising export opportunities. Doing so, however, could lead in the short run to even more people being thrown out of work with little hope of finding employment in the service sector of the economy where joblessness will also be growing due to the inroads the technology is making there.[15] These employment dislocations, the report contends, could lead to a resurgence of

the domestic instability that has plagued France in the past, and it is, therefore, incumbent upon the government to begin immediately to develop and execute a plan that will allow it to anticipate and manage the economic stresses that "computerization" seems destined to produce.

The type of plan the report envisages has a variety of interlocking dimensions. It includes merging several government telecommunications agencies into a single, national, telecommunications company capable of launching its own communications satellites.[16] It includes revising government agency procurement practices so that French manufacturers of computing hardware and software will have an advantage for their wares in the domestic market,[17] and it calls for substantial government investments in basic and applied research.[18] Further, the proposed plan would "nationalize the demand" for computer-based information technology and the services it makes possible by looking to the government to decide where productivity increasing applications of it should be made. Once having made those basic allocation decisions, moreover, the report recommends that the government offset the resulting rise in unemployment by subsidizing the creation of new jobs in areas such as transportation, education, health, culture, travel, and entertainment. These, the report states, are areas of economic activity "protected" from international competition and, and in addition, ones in which low levels of productivity can be tolerated long enough while the technological underpinnings of the industrial and manufacturing sectors of the economy are transformed.[19]

Reinforcing these concerns and prescriptions, one finds, in addition, a strong belief that even if the magnitude of the economic difficulties that lie ahead is somewhat overstated, "computerization" will rekindle historic struggles over economic equality and political liberty in French society. This is virtually inevitable, the report argues, because the more highly institutionalized elements--the large corporations and the large government agencies--are the best equipped to use computer-based information technology and can be counted on to do so in ways that will tend to consolidate their own hold on the levers of economic and political power. Thus, government intervention will be necessary if only to make sure that the technology is applied in ways that create counterweights to the centralizing and rigidifying tendencies that French economic and political institutions have historically exhibited.[20]

Finally, the report worries about the possible weakening

of French cultural identity if the government fails to stimulate the use of computer-based information technology to develop indigenous stores of basic and applied knowledge. Data banks, the report asserts,

> are often international, and the development of communications allows access to them without any excessive tariff penalty from any point on the globe--whence the temptation in some countries to use American data banks without setting up any on their own soil.
>
> Indifference to this phenomenon lies in the belief that this dependence would be no stronger and no more disturbing than for any other type of supply. But the risk is of a different nature. Data are inseparable from their organization, their mode of storage. In the long run, it is not a question only of the advantage which may be conferred by familiarity with such and such a datum ... Leaving to others ... the responsibility for organizing this 'collective memory,' while being content to dig into it, is equivalent to accepting cultural alienation.[21]

From a U.S. perspective, one of the most interesting features of the French experts' analysis is their argument that changes in the structure of the U.S. information industry, and particularly changes resulting from a proposed offering of direct satellite data communications services,[22] threaten to deprive France of effective control over the development of its own, indigenous, information resources. The argument, in a nutshell, is that whereas governments until now have been able to control the way that computers are used by channeling the way that telecommunications are used, if a foreign-based multinational corporation is able to combine both technologies into a single equipment or service offering, governments will find themselves unable to control the uses that are made of either one.[23] Given the disruptions that the conjoint use of computing and telecommunications is believed to be capable of producing in a country like France, such a prospect is understandably considered a poor one and is a principal justification in the report for urging the government to take steps to develop a wholly domestic information industry that will eventually make France self-sufficient in everything from computer manufacturing to satellite-launching facilities.

The report's insistence on the need for government

measures to stimulate the development of a fully articulated French information industry, and the protectionist implications of many of the resulting recommendations, surely warrant attention. Although additional competition in the international market for high-technology information resources could be a strong force for innovation, and deserves to be encouraged for that reason if no other, a competitive situation in which some players are subsidized by their governments while others are not seems unlikely to remain that way very long. In fact, for some U.S. observers, the French report's recommendations call forth the image of a protectionist industrial development program similar in effect to the one that the Japanese launched in 1970.

In the Japanese case, the government, through its Ministry of International Trade and Industry (MITI), has managed in less than 10 years to strengthen the Japanese information industry to the point where it may soon be capable of rivaling the U.S. as the world's leading exporter of computing and telecommunications technology. This has been achieved by a government policy that combines import quotas, tax incentives, cash grants, low-interest loans, and limitations on foreign ownership of Japanese firms, with preferential procurement rules, government-guided restructuring of computer hardware and software production, and generous subsidies for research projects carried out cooperatively by Japan's leading computing and telecommunications suppliers. Furthermore, although the Japanese, as part of the "Tokyo Round" of international tariff negotiations, have now backed away from the most severely protectionist of the measures, they are still far from adopting a policy of free and open competition. Most foreign competitors find their path into the Japanese domestic market blocked by what has been aptly described as an "impenetrable thicket of nontariff barriers,"[24] and, according to some analysts, Japanese computer manufacturers are now beginning to export at prices below what would be possible if their government were not helping them out at home.[25]

That such protectionism pays off, moreover, seems undeniable. The Japanese domestic market for computer-based information technology is today the second largest in the world, and Japanese suppliers of the technology are pushing toward the government's export goal of $2 billion per year by 1985, or 16 percent of the country's hardware and software output.[26] This compares favorably with the situation of the U.S. suppliers who are expected to export approximately $12 billion per year by 1981, or 39 percent of

their total shipments.[27] In addition, even if the 1985 export target is not reached, some experts believe that by developing a large population of domestic users, Japan will so transform the productive base of its economy as to assure it a leading position in many fields of international commerce for decades to come.[28]

It should be noted, moreover, that France and Japan are not the only industrialized countries in which one finds strong voices in favor of strict national control over indigenous information resources. In Canada official policy strongly emphasizes the need to stimulate and preserve a distinct Canadian culture along with the role that domestically developed and controlled information resources can play in achieving that objective. Canadian officials also believe that planned development of such resources can foster internal economic stability and have set out to see that they do so.[29]

Since 1972, Canada has been diligently examining its information policy options in a series of task force and commission reports. These studies have cautioned, among other things, against the loss of Canadian data processing business to other countries, argued for effective domestic control over Canadian data banks, and stressed the importance of data processing as a source of new jobs for Canadians. Furthermore, in the broadcasting and cable television fields, unequivocal policy now favors Canadian-owned systems that aim to help strengthen both Canadian culture and the Canadian economy. As a result, there have been numerous controversies in recent years over the airing of programs and commercials produced in the United States.

Canada, in pursuit of its information resource goals, has also been unusually innovative in the development of communications satellites, cable television facilities, and videotex systems.[30] Nonetheless, the extent to which the Canadian information industry is domestically owned, the industry's contribution to Canada's foreign trade, and the percentage of GNP devoted to pertinent research and development are still considered by the Canadian government to be less than satisfactory.[31]

THE DANGERS OF THE PROTECTIONIST APPROACH: A UNITED STATES VIEW

Whether protectionist approaches to information research and development will become widespread remains to be seen. The French experts' recommendations are not official policy

of the French government and may never become so. As indicated, the "Japanese model" has to some extent been abandoned even in Japan, and Japan's effort to reduce its trade surplus, coupled with the buying power of the yen abroad, may now force further departures from it.[32] The ultimate Canadian position will inevitably make some allowances for Canada's long-standing, special relationship with the United States and the outlooks that the two countries share. Yet, since each country's situation is somewhat different, and since France, Japan, and Canada are not the only ones that could find a protectionist development strategy appealing,[33] the possibility of more rather than less protectionism in the international market for computer-based information technology, and for the information processing services it makes possible, cannot be casually dismissed.

To appreciate why, one need only consider a few of the undesirable conditions that could be created if the industrialized countries' efforts to stimulate and control the development of their indigenous information industries degenerated into a hodgepodge of restrictions on the utilization of "foreign" technology and services.

One such condition, for example, could be the erasing of whatever economic and social benefits are still to be derived from internationalizing access to large segments of the industrialized world's accumulated store of basic and applied knowledge. No one can say how severe the economic and social consequences of balkanizing those knowledge resources might be, but neither can anyone reasonably expect them to be small.

Scientific and technical information resources, moreover, are not the only ones that could be affected. Many businesses, such as banks, airlines, credit card issuers, and multinational suppliers of data processing services could find themselves unable to take advantage of technological innovations and other cost saving efficiencies of potential benefit to their customers. In fact, under some circumstances, the pace of technological innovation could be slowed to the point where relying on it to provide opportunities for substantial productivity gains in either the private or the public sector would no longer be advisable.

These concerns about cost, efficiency, and innovation must also be arrayed alongside the impact that some industrialized countries' information resource strategies could have on the attitudes and aspirations of the developing ones. Particularly if the Western Europeans abandon their commitment to the idea that information resource development should proceed as freely and openly as possible, many

of the developing countries may see little reason why they should not abandon their commitment to it too. Furthermore, if the industrialized nations, including the United States, behave in ways that make their information resources even less accessible to others than they have been in the past, the developing countries could be prompted to retaliate in a manner that would inflict great hardship on the industrialized world.

As indicated earlier, many of the developing countries have already shown a preference for modes of information resource development that legitimize government control over the flow of information and information technologies into and out of their respective jurisdictions. Although their principal interest to date has been in regulating the activities of foreign news gathering and broadcasting operations, the step from there to regulating all types of information resource development is not a large one. Brazil, for example, has moved to protect its indigenous computer hardware manufacturers by enacting legislation to restrict the importation of minicomputers, and nationalization or mandated local ownership of computer-supply houses and data processing facilities in other developing countries is on the increase.[34]

Some observers, moreover, are fearful that the developing countries may eventually try to control the use and dissemination of information originating in the industrialized world by banding together to force major changes in the way access to the electromagnetic spectrum is allocated.[35] By using their votes in international forums to obtain increased allocations of the spectrum's capacity, for example, the developing countries would be in a position to lease the use of it to the industrialized countries, pending their own ability to use it.[36] While most experts doubt that a majority of the developing countries would support such a move, no one familiar with their concerns and objectives seems willing to rule out the possibility completely. Should the experts be wrong, the consequences for the way that the industrialized world develops and uses information technologies of all kinds could be profound.

Depending on the portions of the spectrum most heavily affected, the communications systems that support air travel, overseas telephone calls, maritime navigation, strategic weapons systems, international funds transfer networks, and orbital intelligence gathering and environmental monitoring facilities might all have to be modified at substantial cost and, in some cases, perhaps even curtailed. Indeed,

just a decline in the quality of providable service could create a scarcity situation that might require governments like our own to charge a fee for using some portions of the spectrum, in contrast to the current system of cost-free licensing.

The thought that any of these outcomes might be realized can seem preposterous until one considers that 10 percent of the world's population currently uses 90 percent of the spectrum's capacity. In fact, in the shortwave broadcasting spectrum, 1.5 percent of the world's nations use one-fourth of what is available and the imbalance is even greater for some other parts of the spectrum. Such striking disparities can give an aura of respectability even to those who advocate drastic reform regardless of cost. Most importantly, however, they can be, and apparently are being, used to frighten some of the developing countries into believing that unless they individually or collectively reserve sizeable portions of the spectrum's capacity now, the industrialized nations will intensify their utilization of it to the point where capacity shortages will become a constraint on the rest of the world's modernization ambitions.[37] This, of course, need not be. There are alternatives, such as the concept of shared allocations, whereby flexible arrangements are promised for spectrum use by the developing countries as future need and technology evolve, while in the meantime the industrialized nations may have access to the unused portions. The problem, however, is how to assure that such alternatives will be given due consideration.

Although no one can say whether or how an outbreak of protectionism in the industrialized world might affect the developing countries' restrictive inclinations, opportunities for the one to reinforce the other are clearly apparent. Furthermore, even if it were possible to keep the two from becoming intertwined (and, in the short run at least, it may be possible to do so), there seems to be little doubt that the United States, in particular, should do all it can to promote modes of national and international information resource development that avoid, to the maximum extent possible, any resort to protectionist actions.

Of all the countries that could suffer from a barrage of national and international initiatives aimed at restricting the utilization of "foreign" information technologies and services, the United States is surely the one that could suffer the most. Today, the United States is not only the world's leading producer and consumer of information technologies and services; it is also the leading supplier of

them to other nations. As indicated in Chapter I,[38] even a narrow definition of the U.S. "information industry" yields a sizeable and growing contribution to the nation's Gross National Product, and, in addition, an estimate of net annual exports in the billions of dollars.

Compared to other countries' information industries, moreover, the U.S. one is among the few that have prospered without looking to government to fund the majority of its research and development efforts or to provide direct support for the education and training of its skilled work force. Although the U.S. manned space program prompted important advances in semiconductor technology, and in the design and application of microcomputers, most of the rest of the government's research, development, and training support has come from the Department of Defense for needs specific to the military. Furthermore, the amount of the government's R&D contribution, in constant dollars, is declining, both in absolute terms, and as a percentage of the industry's independent research and development investments.[39]

Nor have government procurement policies been a major stimulus to industry development. Although the federal government was the first significant purchaser of electronic computing equipment, today it manages less than 10 percent of the nation's installed computing capacity, and much the same situation holds for telecommunications equipment and services.[40] In short, the U.S. information industry is far more responsive to the "pull" of the commercial marketplace than to any government stimulus, and hence, it is from that marketplace, both domestically and internationally, that it derives not only the incentives but also the financial resources that allow it to sustain its unparalleled rate of technological and service innovation.

If the U.S. information industry had its "druthers," it would no doubt prefer even less dependence on government than it has had in the past. Today, however, it is facing market uncertainty both at home and abroad--at home because of the slowness with which government regulatory policy has been responding to technological change,[41] and abroad because of the restrictions on purchasing or using the U.S. industry's products that other governments seem to be contemplating. This situation is also being exacerbated by the U.S. government's continuing lack of organizational arrangements suited to assuring a close fit between the postures it takes on matters affecting the industry's development domestically and the postures it takes on matters affecting the industry's performance outside the U.S.

Unlike many other governments, ours has been slow to recognize how a well developed information industry can contribute to the nation's economic health while also promoting efficient use of information technology and services elsewhere in the world. In recent years, the U.S. government's principal policy concern has been to make the information industry's domestic markets as competitive as possible. Because of the expected links among competition, price, and innovation, that policy, all things being equal, should also be a boon to the industry abroad. The problem, however, is that all things will not be equal if other countries take steps that sharply constrain the U.S. industry's export opportunities.

Figuring out how to foster healthy competition at home while protecting the industry from discrimination in its overseas markets is obviously a complex task. Regulatory policy is only one and, in the final analysis, perhaps not even the most important factor to be considered. Fiscal and monetary policies that seek to encourage or discourage economic growth generally; policies that commit the U.S. government to helping other governments harness information technology and services to the pursuit of shared economic and social objectives; anti-trust, tax, government-industry collaboration, and research and development policies that provide specific incentives for specific categories of industrial and commercial activity such as innovation and trade; and policies that assure adequate coordination between the government's domestic and foreign initiatives could all play crucial roles. Indeed, through modifications in these other policy areas, one might conceivably offset vulnerabilities created by unregulated competition in the information industry's domestic markets. At the moment, however, no one can say whether or how that might be done, since few in the U.S. seem to recognize that a problem exists and fewer seem prepared to begin tackling it systematically.

THE ROLE FOR INDEPENDENT POLICY RESEARCH

If the United States is to be in a position to influence the outcome of today's controversies over national and international information resource policy, it must be much better equipped than it now is to understand the factors that account for other countries' needs and aspirations and also, and most importantly, to understand how its own interest might be more or less at risk, depending on how

those needs and aspirations are satisfied. To acquire that understanding, many questions need to be answered. Six questions are of the utmost importance:

(1) What classes of information ought to be treated as a public good[42] and therefore available at the cost of access alone, and what classes ought to be treated as a valuable product and therefore available at prices determined by market mechanisms?
(2) How can information technology and services be used to help assure sound management and fair allocation of other types of global resources?
(3) How does the international market for information technology and services currently operate, and what are the economic factors in the current situation that might shape its future development?
(4) How do other countries differentiate between protectionist policies and free trade ones, and what do they perceive to be a reasonable justification for choosing protectionism in lieu of other alternatives open to them?
(5) How can the U.S. improve its effectiveness in international negotiations involving information resource issues?
(6) How do the U.S. government's domestic policies affect the international market for information technology and services, and, particularly, how do they affect the market position of the U.S. information industry?

These six questions and the specific lines of inquiry that each suggests are discussed briefly below.

Information as Public Good and Marketable Commodity

There is an important controversy today over where the dividing line should be between information treated as a public good and information treated as a marketable commodity. The traditional view is that the dissemination of information in the public domain is so socially desirable that its price should be based on its marginal cost--i.e., the cost of supplying one more book or one more newspaper. Because of the non-depletable nature of information taken together with the techniques of mass production, this marginal cost approaches zero, a characteristic of one more unit of consumption of a public good, such as a park.

Notwithstanding, authors, artists, and inventors are allowed to profit from their works as an incentive to produce them, and as a result we have the private domain of publishing, motion pictures, television programming, technological know-how, and specialized data bases. There is an obvious tension between the two notions: On the one hand, the public domain should be as large as possible to realize the secondary benefits of wide information use. On the other hand, the ability of the private domain to profit from information products should be protected to encourage enterprise and innovation. The trade-offs between these policies are not well described and understood, especially as to how they produce either national income or world-wide developmental benefits. Consequently, this problem can add to the controversy over information resource development.

Topics for research would include a comparative analysis of various national practices and philosophies with respect to the domain of information content. The system of incentives and remuneration for the production of information of various types would also be evaluated as to its effectiveness. Alternative pricing policies would be examined, taking into account both the cost and the value of particular kinds of information, such as technological, economic, and demographic. Methods for tracing the benefits that flow from the application of information should be devised so that governments can make judgments as to whether a market economy or a subsidy economy would be likely to maximize the total benefits relevant to national objectives. The results of this research would permit informed decisions about international access to public and private information sources, national and international support of information dissemination, and the relative cost and value of such support in pursuing foreign policy objectives.

Information Technology for Global Resource Management

One of the benefits that computer-based information technology holds out to the world in general is the opportunity for individual countries and groups of countries to help solve their domestic and international problems using commonly accessible stores of data and knowledge.[43] Already a variety of international organizations, including the International Council of Scientific Unions (ICSU)[44] and its component unions and scientific programs, the United Nations[45] and its specialized agencies such as the World Health Organization, the International Atomic Energy Agency,

the Food and Agricultural Organization, UNESCO, and the International Telecommunication Union itself, are using computer-based information technology to store and analyze data pertinent to their missions. Many more will surely want to do so as countries increasingly recognize the need to manage their respective material and intellectual resources through international agreements and institutions. Satisfaction with the quality of these services is mixed, however, and the pros and cons of expanding them under the aegis of a supranational bureaucracy need to be carefully studied.

While the United States is currently a leading participant in many international data and knowledge sharing arrangements, its leadership role results in the main from other countries wanting to take advantage of its expertise. As a rule, the U.S. has not been an independent initiator of such arrangements and, in fact, is poorly equipped to be.[46] On one hand, the expertise necessary to harness computer-based information technology to global or regional resource management objectives tends in this country to be concentrated in the private sector, with a few important exceptions, like meteorology, earth resources sensing, and national statistics. On the other hand, few in the private sector are inclined to invest in high-technology information gathering and retrieval services so long as they face the possibility of competing with similar ones developed by government or international agencies. Furthermore, neither government nor the private sector in this country has much understanding of the kinds of formal institutional arrangements other countries may require before they can benefit from what the U.S. has to offer, nor do they have the will and the resources to make a start.

The current situation, in short, strongly suggests a need for research to identify key areas in which computer-based information technology could be applied to marshalling--from multiple national sources--information useful for international decision making on matters having to do with global resource management--information on mineral resources, for example, or on crops, or diseases, or population growth and environmental pollution. Such research should begin by assembling an inventory of what the U.S. is already doing, and what other programs exist that the U.S. is not participating in, and why; the organizational arrangements through which information about global resource development is marshalled and exchanged; the level of technology being used; the amount of investment being made; the extent to which data and knowledge stores are

being duplicated unnecessarily; and the impediments created by nationally imposed restrictions on information gathering and dissemination. Once having illuminated those aspects of the question, the focus of the research should then be shifted to helping government policy makers decide what new types of information sharing arrangements ought to be initiated and, among those, which would be most advantageously developed by private institutions and which by government ones, including the international organizations. Finally, there is an urgent need for sound analysis of the relative benefits that may accrue to the rich nations and the poor ones as a result of new sharing initiatives and also of the advisability of taking initial design and demonstration steps unilaterally.

The International Market for Information Technology and Services

Most discussions of information resource policy today suffer from a paucity of facts as to the supply and demand for information, the nature of international information flows, and how the international market for information technology and services actually operates. Today, far more information of relevance to economic and social development flows from governmental sources than from private ones, and yet there is much that the private sector might usefully market. Also, as pointed out earlier, many developing countries seem eager to exploit computer-based information technology and other forms of information processing machinery during the early stages of modernization, but even they recognize how much needs to be done to pave the way for transferring such technology to them. Meanwhile, many of the industrialized nations contend that developing their own indigenous information industries is a necessary step toward assuring sustained economic growth, even though others claim equally strongly that restricting the use of "foreign" information technology and services, for whatever reason, will tend to undermine the economic health of the industrialized world generally. There are, in short, strong beliefs that affect the market, but few facts to characterize it, and almost no suggestions as to how the industrialized countries might proceed to identify and capitalize on opportunities for constructive, cooperative action.

The empirical void is, in a word, gaping, and needs to be filled from several directions simultaneously. One line

of studies, for example, should aim to characterize existing and future international information markets by types of products, types of users, growth potential, and so on. This, in turn, should be supplemented by studies mapping today's international information flows (characterized by type, direction, and intensity), so as to help policy makers determine (a) whether there is in fact more transfer of information content by commercial means than through public distribution and (b) whether and how any new restrictions imposed by the industrialized countries might work to their own or others' disadvantage.

Second, the economics of the international information market today need to be thoroughly analyzed in the light of the findings of research on information as a marketable commodity. What effect might alternative pricing policies have on the flow of information into and out of the U.S.? What balance should be struck between the information supply role that governments play and the one that private sector entrepreneurs might sensibly play?

Finally, little is known (although a great deal is surmised) about the role that information resources play (or might play) in enhancing the developing countries' ability to achieve their modernization objectives. What are their requirements and what do they need in the way of institutional arrangements if they are to make effective use of the information resources to which they now have access or might have access in the future?

Understanding the Rationale for Protectionism

Protectionism can have many motivations, and in the information resources area few of the ones so far identified are well understood. Yet, unless they are understood, the U.S. can be ill-equipped to participate in discussions and negotiations with other countries.

Concern about personal privacy, for instance, has made "transborder data flow" an object of interest for many governments. In responding to that interest, the U.S. must be able to differentiate between genuine privacy concerns and concerns that are actually protectionist pleadings in disguise. Similarly, many governments today are legitimately concerned about how technical standards may affect their world trade position, the health of their domestic economy, or the quality of life of their people. Most Third World countries want to harness information technology to the pursuit of their economic development objectives, and both

the developing countries and the industrialized ones are sensitive to the idea that dependence on other countries' information technologies and services may subtly threaten the integrity of their national security and even their national culture.

These economic, political, and cultural concerns are obviously pertinent to present and future U.S. trade relationships and also to the prospects for maintaining a cooperative atmosphere in international policy making bodies. Hence, compromises must be reached, and they must be compromises that, while sensitive to sovereignty concerns, nonetheless permit an unimpeded flow of the kinds of information on which industry and commerce depend.

To date, the U.S. has tended to deal with these issues piecemeal, and in terms of its own idiosyncratic reading of what other countries' motivations are or ought to be. Plainly, this approach will not suffice much longer, and thus it is important to establish, as expeditiously as possible, where we and other countries actually stand on the protectionism question. Three types of studies are needed.

First, it is essential to identify the foreign regulations and standards that force unique requirements on imported information technology and services; that dictate the design of computer hardware and software; that impede the flow of information across national boundaries; that require that data bases be duplicated for domestic use; or that restrict the ownership or management of computer systems or facilities.

Second, a study should be made of what other countries consider evidence of economic or cultural domination by "foreign" information industries and of how such evidence affects their decisions on specific information resource issues. Is there, in fact, a predictable relationship between the positions they espouse rhetorically and the positions they take on specific policy questions, either domestically or internationally?

Finally, existing efforts to harmonize national laws enacted for bona fide data protection purposes--efforts such as the ones currently being made by the Organization for Economic Cooperation and Development and the Council of Europe--need to be supported in some areas by competent research. How, for example, can the U.S. contribute to the development of a body of international law that will enhance the utilization of computer-based information technology by providing for expeditious administration and adjudication of cases of alleged privacy invasion or

computer-related fraud involving the laws of more than one country?

Improving U.S. Effectiveness in International Negotiations

The processes by which the U.S. government prepares for international negotiations on information resource questions too frequently fail to assess the national interest broadly and often get under way much too late. In part, this is because the policy making jurisdiction is splintered among several agencies of the Executive branch, the Congress, and a half-dozen regulatory agencies. In part, however, it also reflects a historic inattention to how the government's domestic and foreign policy initiatives may interact in the information policy area. While being able to coordinate the positions and views of all the interested branches and agencies would be ideal, a process that would do no more than make each of them aware of what the others are doing could improve the current situation greatly.[47]

In addition, there are also many nongovernmental meetings and conferences that internationally recognized professionals attend as experts on specialized topics rather than as representatives of their respective governments. In information, computing, and telecommunications, these gatherings typically deal with the design and implementation of international research projects, reporting on the results of scientific and technical research, the development of technical standards and operating procedures, and the design of education and training programs. Hence, they contribute to the overall representation of U.S. viewpoints and practices with regard to certain information policy questions, and U.S. attendees, therefore, should prepare themselves both in a timely manner and with an eye to how they can help to promote the national interest through prior coordination, consultation, and formulation of specific objectives to be sought at such meetings.

As a step toward strengthening the government's negotiating and representational capabilities, two studies would seem to be useful: first, a retrospective case study of U.S. preparations for a recent international conference on information resource questions, and, second, an analysis of how the pertinent U.S. government agencies and the private sector have worked together in preparing for international nongovernmental meetings of experts. The former might well focus on the 1977 and 1979 World Administrative Radio

Conferences (WARC). Since a competent study would reveal how U.S. positions were prepared and what problems were encountered in the course of doing so, such a study, if undertaken soon, could help in preparing for the next WARC conferences scheduled for 1982-83 on mobile radio and also for the 1982 Plenipotentiary Meeting of the International Telecommunication Union.

Effects of U.S. Domestic Policy on the International Information Market

Government policy makers and leaders in business and education need help in understanding the economic and social importance of a nation's information industry. In the U.S. in particular, failing to develop that understanding could lead not only to gross misuse of a valuable resource, but also to forfeiture of the U.S. industry's world preeminence. Thus, among the key questions to be studied are the following:

(1) What accounts for the U.S. information industry's past success?
(2) How is the U.S. information industry currently benefited or disadvantaged by government fiscal, monetary, tax, antitrust, procurement, and research and development policies, or by government positions on non-tariff barriers to trade with other countries (such as export licensing, for example)?
(3) What is the likelihood that increased competition within the U.S. information industry will strengthen or weaken its competitive position abroad and thus its consistently significant contribution to the nation's foreign trade balance?
(4) Would the industry benefit from stepped-up investment in research and development and, if so, stepped-up by whom?
(5) Are new sources of venture capital needed and, if so, for what segments of the industry?

NOTES AND REFERENCES

1. Official manifestations of this view first became prominent at the *Fourth Conference of Heads of State or Government of the Non-Aligned Countries* (Algiers, 1973). In their Action Program for Economic Cooperation (Articles 13 and 14) seventy-five member nations called for developing countries to: "reorganize existing communication channels which are the legacy of the colonial past, and which have hampered free, direct and fast communications among them; initiate joint action for the revision of existing multilateral agreement with a view to reviewing press cable rates and facilitating faster and cheaper intercommunication; take urgent steps to expedite the process of collective ownership of communications satellites and evolve a code of conduct for directing their use; promote increased contact between the mass media, universities, libraries, planning and research bodies and other institutions so as to enable developing countries to exchange experience and expertise and share ideas; exchange and disseminate information concerning their mutual achievements in all fields through newspapers and periodicals, radio, television and the news media of their respective countries; and formulate plans for sharing experience in this field, *inter alia* through reciprocal visits of delegations from information media and through exchange of radio and television programs, films, books, photographs, and through cultural events and arts festivals."

   Similar concerns and calls for action were reiterated at ministerial and specialized conferences of the non-aligned nations in Lima (1975), Tunis, Mexico City, and New Delhi (1976), and at the fifth summit meeting of heads of state in Colombo (August, 1976), where eighty-four participating nations adopted a Political Declaration stating that "a new international order in the fields of information and mass communication is as vital as a new international economic order." These issues continue to occupy an important place in the deliberations of the non-aligned nations.

   These concerns have also been debated extensively within UNESCO, most recently by the *International Commission for the Study of Communications Programs* (commonly known as the MacBride Commission). An extensive exposition of the issues in controversy is contained in the more than 100 working papers produced in this

2-year study in addition to its provisional *Final Report* (Paris: UNESCO), November 1979.

For a useful overview of issues, developments and players involved in the debate on the "world information order," particularly as they relate to U.S. interests, the reader is also referred to Jonathan F. Gunter, *et al. The United States and the Debate on the World Information Order*. Washington, D.C.: Academy for Educational Development, Inc., June 1979 (Revised). This study report, sponsored by the Ford Foundation and the International Communications Agency, and based on an extensive review of primary documents, as well as consultations with several industry, governmental and academic advisors, was prepared to assist the U.S. Government in preparations for the UNESCO General Conference in October 1978 and in its continuing deliberations on international communications policy.

2. The belief that modern information technologies are keys to, rather than the results of, economic and social development is a basic premise underlying many of the recommendations and calls for action by developing countries at recent UN Conferences. See for example, the *Main Working Document* (SC/78/Conf. 210/Col. 5, 1978) and the *Final Report* (SC/MD/64, March, 1979) of the *Intergovernmental Conference on Strategies and Policies for Informatics*, August 28-September 6, 1978, Torremolinos, Spain (Paris: UNESCO and the Intergovernmental Bureau for Informatics); the working documents and proposals considered at the World Administrative Radio Conference, September 24-December 6, 1979, Geneva. *Final List of Documents*. Document #984, May 15, 1980 (Geneva: International Telecommunication Union); and *The Vienna Program of Action on Science and Technology for Development*, adopted by the United Nations Conference on Science and Technology for Development (UNCSTD) in August 1979.

The voluminous UNCSTD documentation (reports of preparatory meetings, special reports, national papers, and related studies) is replete with references to the need for these technologies and to the information access they will facilitate. See, for example, *Analysis of UNCSTD Developing Country National Papers-Working Note*, prepared by Barbara Lucas, Division of Policy Research and Analysis, National Science Foundation, August, 1979; and *Science and Technology*

for Development, International Conflict and Cooperation--A Bibliography of Studies and Documents Related to the 1979 UN Conference on Science and Technology for Development, prepared by the Research Policy Institute, University of Lund, Sweden, and the Program on International Science and Technology Affairs, Council on International and Public Affairs, New York, Vols. 1-6. Lund, April 1977-November 1979.

See also, Heather Hudson, *et al. The Role of Telecommunications in Socio-Economic Development: A Review of the Literature with Guidelines for Further Investigations*, prepared for the International Telecommunication Union (ITU); (Keewatin Communications), May, 1979, the reports of the UN Secretary-General on the *Application of Computer Science and Technology to Development*. New York: United Nations Department of Economic and Social Affairs, 1971, 1973, and 1976, and the 37 papers presented at the "Meeting on The Knowledge Industry and the Process of Development," held in Paris, June 9-12, 1980, under the sponsorship of the OECD Development Centre.

3. For example, the International Telecommunications Union (ITU) and its subsidiary bodies such as Consultative Committee on International Telephone and Telegraph, International Telecommunication Union (CCITT) and World Administrative Radio Conference (WARC); Coordinating Committee of the NATO countries, plus Japan, minus Iceland, which deals with trade items having strategic implications (COCOM); United Nations Educational Scientific and Cultural Organization (UNESCO); Committee on European Posts Telecommunications (CEPT); International Telecommunications Satellite Consortium (INTELSAT): (International Maritime Satellite Consortium (INMARSAT).

4. See for example, Tefko Saracevic, "Perception of the Needs for Scientific and Technical Information in Less Developed Countries" (A Review of the Literature from Developing Countries and International Organizations), in Vladimir Slamecka, (ed.), *Scientific and Technical Information Services for Socioeconomic Development*, prepared for the Agency for International Development. Washington, D.C.: International Science and Technology Institute, Inc.; April, 1979.

Developing country positions on their information resource needs, and the assistance required to meet

these needs are also documented in the preparatory deliberations and reports of the *U.N. Conference on Technical Cooperation among Developing Countries* (Buenos Aires, Argentina), August-September, 1978; the *Unesco Intergovernmental Conference on Scientific and Technological Information for Development*, May 28-June 1, 1979, and UNCSTD (see references in Footnote 2).

5. See, for example, the studies and concerns of the OECD Working Party on Information, Computer and Communications Policy and of the Commission of the European Communities' Directorate for Scientific and Technical Information and Information Management. See also Paul G. Zurkowski, "Misconceptions About Information Costing the United States a Bundle," *Publishers' Weekly*, July 9, 1979, pp. 37-38.

6. See, for example, Marc Uri Porat, *The Information Economy: Definition and Measurement*, OT Special Publication 77-12(1), Office of Telecommunications, U.S. Department of Commerce (Washington, D.C.: U.S. Government Printing Office), May 1977; and Simon Nora and Alain Minc, *L'Informatisation de la Société*, Rapport à M. le President de la République (Paris: La Documentation Française), 1978. The latter has been translated into English by Transmantics, Inc. of Washington, D.C.

7. Rein Turn, (ed.), *Transborder Data Flows: Concerns in Privacy Protection and Free Flow of Information* [Volume 1: *Report of the AFIPS Panel on Transborder Data Flow*; Volume 2: *Supporting Documents* (Annotated Bibliography; National Laws; International Resolutions, Conventions and Guidelines)] (Arlington, Virginia: American Federation of Information Processing Societies, Inc.), 1979.

8. The text of these statutes can be found in various English-language sources. See, for example, U.S. Department of Commerce, Office of Telecommunications, *Selected Foreign National Data Protection Laws and Bills*. Washington, D.C.: U.S. Government Printing Office, March, 1978; Ulrich Dammann, Otto Mallmann, and Spiros Simitis (eds.), *Data Protection Legislation: An International Documentation*. Frankfurt am Main: Alfred Metzner Verlag GmbH, 1977; and *Transnational Data Report*, a bi-monthly report on

international information politics and regulation. Washington, D.C.: The Wayne Smith Company, 1978.

9. This principle has traditionally guided the work of, for example, the International Telecommunication Union (ITU) and its affiliated bodies. See, for example, *International Telecommunications Convention: Final Protocol to the Convention; Additional Protocols to the Convention; Resolutions, Recommendations and Opinion*. Geneva: General Secretariat of the International Telecommunication Union, 1959, especially Chapter IV relating to public use and establishment of channels.

   The principle of "free flow of information" across boundaries is also variously expressed in: 1) the *U.N. Declaration on Freedom of Information*, (1946) which notes that "all states should proclaim policies under which the free flow of information within countries and across frontiers will be protected. The right to seek and transmit information should be insured to enable the public to ascertain facts and appraise events ..." (U.N. General Assembly Resolution 59(I)); 2) Article 19 of the *Universal Declaration of Human Rights* (1948), which states that the right to freedom of opinion and expression includes... "freedom to hold opinions without interference and to seek, receive and impart information and ideas through any media and regardless of frontiers"; and 3) the *International Covenant on Civil and Political Rights* (1966), which stipulates that the right to freedom of expression "comprises the freedom to seek out, to receive and to communicate information and ideas of all kinds, *regardless* of frontier, whether in oral, printed or article form, *or by any other means* of the individual's choice" (emphasis added). Variations on this theme can also be found in *UNESCO's Constitution*, the *Declaration of the Principles of International Cultural Cooperation* (UNESCO, 1966; and the *Final Act of the Conference on Security and Cooperation in Europe*, Helsinki, 1975.

10. See, for example, Hans Peter Gassmann, "Data Networks: New Information Infrastructure," *The OECD Observer*, No. 95, (November 1978), pp. 11-16; and Phil Hirsch, "Europe's Privacy Laws, Fear of Inconsistency," *Datamation*, 25:2 (February 1979), pp. 85-88.

11. The impact of a broad-gauge, generally applicable privacy protection statute on small business was one of the reasons why the U.S. Privacy Protection Study Commission recommended against such legislation. The Commission also believed that the principal threat to personal privacy interests comes from the record keeping operations of public and private bureaucracies; that is, organizations that, unlike small businesses, tend to deal with individuals on the basis of records kept about them rather than on the basis of face-to-face contact. See *Personal Privacy in an Information Society: The Report of the U.S. Privacy Protection Study Commission*. Washington, D.C.: U.S. Government Printing Office, 1977.

12. This issue is one of several covered in the ongoing negotiations within the U.N. and its specialized agencies on international codes of conduct on the transfer of technology (United National Conference on Trade and Development); on transnational corporations (U.N. Commission on Transnational Corporations); and on the revision of the Paris Convention for the Protection of Industrial Property (World Intellectual Property Organization).

    This topic is also of concern to the OECD Working Party on Information, Computer and Communications Policies, and is likely to be considered in its forthcoming study of the legal and economic problems relating to the transborder flow of nonpersonal data, as well as in the deliberations of the proposed Consultative Group to assess OECD member countries' scientific and technical information programs for developing countries.

13. Roger K. Summit, "Euronet: Boon or Bomb," paper presented at the Annual Meeting of the National Federation of Abstracting & Indexing Services, Arlington, Virginia, March 6-8, 1979.

14. Simon Nora and Alain Minc, *L'Informatisation de la Société*, *op. cit.*

15. Over the next 10 years, for example, the report envisages the possibility of a decline on the order of 30 percent in the number of clerical and other types of low-to-mid-level white-collar jobs available in the private sector, and in certain areas of the

public sector. Ibid., pp. 35-38. This concern about the effects on white-collar employment is also found in British discussions of the impact of microprocessors on productivity. See, for example, Iann Barron, *et al., The Future with Microelectronics--Forecasting the Effects of Information Technology*. London: Frances Pinter Ltd.; May, 1979; Kenneth Owen, "Microelectronics: This Could be Man's Greatest Leap Forward," *The Times*, October 2, 1978; and Peter Large, "Microchip Report Warns of 5M Jobless--The Challenge and Threat of the Micro-chip Revolution," *The Manchester Guardian*, October 6, 1978.

16. Nora and Minc, *op. cit.*, pp. 86 ff.

17. *Ibid.*, p. 14.

18. *Ibid.*, pp. 95-97.

19. *Ibid.*, pp. 44-49.

20. *Ibid.*, pp. 15-16.

21. *Ibid.*, pp. 71-72.

22. The report appears to be referring to Satellite Business Systems (SBS), a new corporation jointly owned by IBM, the Communications Satellite Corporation, and the Aetna Life and Casualty Company. Beginning in 1981, SBS will offer satellite-based data, voice, and video communications services to business enterprises in the United States.

23. Nora and Minc, *op. cit.*, pp. 44-66.

24. Bro Uttal, "Japan's Big Push in Computers." *Fortune*, September 25, 1978, p. 66.

25. A segment of the U.S. semiconductor industry has recently urged Congress to deal with what it considers unfair Japanese competition. Semiconductor technology has been likened to "the crude oil" of electronics--as oil is key to the entire U.S. economy, semiconductors are key to computers and the growing range of electronic products, consumer and industrial. See, Edward K. Yasaki, "Japan's Prowess in Semis", *Datamation*, 25:8. July, 1979, pp. 64, 67, 68.

26. Uttal, *op. cit.*, p. 65.

27. Philip S. Nyborg, *et al.* (eds.), *Information Processing in the United States, A Quantative Summary*. Washington, D.C.: American Federation of Information Processing Societies, Inc., October, 1977, Table 1-1.

28. Bro Uttal, "Exports Won't Come Easy for Japan's Computer Industry," *Fortune*, October 9, 1978, p. 146.

29. Oswald H. Ganley, *The Role of Communications and Information Resources in Canada*, Publication P 79-1. Cambridge: Harvard University Program on Information Resources Policy; June 1979. See also, "Canada Acts to Protect Sovereignty," *Information World*, 1:3. April, 1979, pp. 2, 13.

30. "VIDEOTEX" is a generic name recently applied (by the Canadians) to communications systems capable of delivering alphanumeric and simple graphic information to a home television receiver. In one variant, the information is encoded onto some of the vertical retrace lines of a broadcast or a cable television signal and decoded by a specialized circuit in the receiver. In another variant, the information is transmitted upon request, over a telephone line from a data bank dedicated to the VIDEOTEX service and similarly decoded by the receiver.

31. These preoccupations with the development and protection of Canada's domestic information resources are often expressed as a concern about "national sovereignty." The following quotation from a Canadian government news release captures the mood:
"The Canadian communications system is in the midst of a crisis more profound than any that has affected it since the 1930's....Many have drawn special attention to the need to safeguard Canada's cultural sovereignty....The recent hearings before the CRTC on the CBC license renewals, the spectacle of U.S. broadcasters seeking redress against Canadian legislation and tax laws, and the recent applications by the cable companies to deliver non-programming services (which are opposed by the telephone companies) provided other opportunities for the public and the media to add their voices to the chorus of concern.

"At the same time, developments in the areas of fibre optics, satellites, interactive television and computer technology threaten not only to exacerbate the existing problems, but also bring new ones and new opportunities in their wake. Among other things, these new technologies could: radically increase the amount of American television programming entering into the country; further aggravate the balance of payments problem in electronic products; increase the difficulties being experienced by the Post Office, schools and universities, publishing industries, and the clients they are meant to serve; and compromise the country's capacity to control future fundamental economic, political, social and cultural directions. On the other hand, these technologies could--if imaginatively and quickly applied--permit a significant re-patriation of the electronics industry; provide a new base for the development of the high technology area; stimulate the growth of a whole host of new programming and information-based services, and generate more private support for a revitalized cultural sector. It is apparent, therefore, that the new technologies constitute both threats and opportunities, which could be used either to further erode Canadian sovereignty or to strengthen it considerably." (See, Canada, Department of Communications, Independent Committee to Recommend on the Future of Telecommunications in Canada, *News Release*. Ottawa, November 30, 1978.

32. Uttal, "Exports Won't Come Easy ...", *op. cit.*, p. 139.

33. Some experts believe that Japan and the Western European countries, individually and collectively, are determined to build an information industry that will challenge U.S. leadership. An attempt was made a few years ago to form a combination of Siemens, CII, and ICH aimed at this result. Although it did not succeed, the determination to succeed has not diminished. The Commission of the European Communities is actively fostering the development of a European information industry. As a means of further strengthening their competitive position, some European firms are now attempting to acquire American computer, peripheral, and software/systems companies. See, for example, Ralph Emmett, "France's Thomson Eyes U.S.," *Datamation*, 25:3 (March, 1979), pp. 85-87.

34. See, Angeline Pantages, "Cracking Brazil Nuts," *Datamation*, 25:8 (February 1979), pp. 78-79; and Angeline Pantages, "Erosion Extends Around the World," *Datamation*, 24:4 (April 1978), p. 182.

35. *The New World Information Order*, A Report by George Kroloff and Scott Cohen to the Committee on Foreign Relations, U.S. Senate, November, 1977 (mimeographed).

36. The "electromagnetic spectrum" is the complete range of radio waves that space is capable of transmitting. The term is derived from the familiar "spectrum" of colors displayed by the passage of white light through a prism. More precisely, however, the spectrum is a framework for describing various radio waves by one of their distinguishing characteristics--their frequency of oscillation--much as house numbers on a street are a framework for describing houses by their position. A large or small house can be located at a given number, but two houses cannot be at the same number on the same street without producing congestion. Similarly, two radio waves of the same frequency cannot be at the same place without interfering with each other. It is thus necessary by the process of spectrum allocation to restrict radio frequencies to certain localities, and also to certain uses, to prevent congestion and interference--much as zoning provides for orderly land use. Access to the spectrum is allocated by the World Administrative Radio Conference (WARC), a subsidiary of the International Telecommunication Union.

37. Kroloff and Cohen, *op. cit.*, pp. 33-34.

38. Pp. 1-11, *supra*.

39. Amount Expended by Industry for R & D in the Office, Computing and Accounting Industries (SIC 357)

Year	Total	Contributed by Federal Government	Contributed by Industry
1975	2.220 B	486 M	1.734 B
1976	2.402 B	509 M	1.893 B
1977	2.758 B	546 M	2.212 B
1978	3.129 B	552 M	2.577 B

Source of the above information is: *Research & Development in Industry, 1977*, NSF 79-313. Washington, D.C.: National Science Foundation; 1979, pp. 13, 16, 19, and *Research and Development in Industry, 1978*, NSF 80-307. Washington, D.C.: National Science Foundation, 1980, pp. 11, 14. 17.

40. Martha M. Gray, *Computers in the Federal Government: A Compilation of Statistics--1978*, NBS Special Publication 500-46, Washington, D.C.: U.S. Department of Commerce, April, 1979.

41. See Chapter III, *supra*.

42. I.e., as that term is understood by economists.

43. International Institute for Applied Systems Analysis, Computer Science Group, *Study of the Potential Use of Informatics Technology for Problems in Scientific and Technological Cooperation*, prepared for UNESCO by the Computer Sciences Group, with the participation of the Management & Technology Area, Vienna, July, 1978.

44. International Council of Scientific Unions, *Organization and Activities*. (Paris), October, 1976. See also, International Council of Scientific Unions, Panel on World Data Centres, *Fourth Consolidated Guide to International Data Exchange through the World Data Centres*. Washington, D.C.: Secretariat, ICSU Panel on World Data Centres, June, 1979.

45. United Nations, Inter-Organization Board for Information Systems, *Directory of United Nations Information Systems and Services*. Geneva: United Nations, March, 1978.

46. National Science Foundation, Division of Policy Research & Analysis, *U.S. Government Participation in the Science & Technology Programs of Selected Multilateral Organizations*. Prepared by Eugene G. Kovach. Washington, D.C.: National Science Foundation, February 1978.

47. The *President's First Report to the Congress on International Information and Communications Issues* (in press) represents progress along these lines. See,

Department of State, *Reports Submitted to Congress Pursuant to the Foreign Relations Authorization Act, Fiscal Year 1979 (P.L. 95-426)* [Submitted to the Committee on Foreign Relations, U.S. Senate and the Committee on Foreign Affairs, U.S. House of Representatives. 96th Congress, lst Session]. Washington, D.C.: U.S. Government Printing Office, July, 1979. pp. 79-95. Likewise, the formation of a new Interagency Working Group on Information, under the Office of Science and Technology Policy Committee on International Science, Engineering and Technology, bodes well in this regard.

5 SOME KEY ISSUES IN THE PUBLIC SECTOR

Given the American taxpayer's growing concern about government inefficiency, and given the scale and complexity of the federal government's information dependent activities, one might expect the agencies of the federal Executive branch to be leading consumers of the most versatile and cost-effective applications of computer-based information technology. This is not the case. Although the federal government is the nation's largest consumer of computing and telecommunications equipment and services, the level and proficiency of use by individual agencies varies enormously. A recent study by the President's Reorganization Project during the Carter Administration cites many examples of obsolete and unnecessarily costly data processing operations,[1] and other related studies have pointed to major deficiencies in facilities planning and procurement.[2]

Indeed, no one knows for sure how serious the agencies' weaknesses may be. Reports based on summary statistics indicate that much of the federal government's computing equipment is of the mid-]960 vintage or older, and that much of the supporting software is also antiquated.[3] Such statements, however, do not distinguish between the computer-based data processing facilities that support key agency missions and the ones that are devoted to functions of lesser importance. Similarly, there are no precise measures of variables as elementary as funding and skill levels, and, none that would illuminate effectiveness in the delivery of government services the technology is used to support.

SOME KEY PROBLEM AREAS

Despite their uncertainty as to the actual status of the federal government's use of computer-based information

technology, experts seem to agree that substantial improvements are needed in three areas: (1) acquisition, (2) management education, and (3) access to high quality technical support on a continuing basis.

As to the first, both the President's Reorganization Project and the House Appropriations Committee investigative staff have recently evaluated the processes by which the federal government acquires computer-based information technology. Their reports are in substantial agreement with concerns expressed by the General Accounting Office in reports issued over the past few years.[4] They agree, for instance, that much more emphasis should be placed on defining the needs and uses for which a procurement is being made; that greater procurement responsibility should be delegated to the agencies; and that action needs to be taken to clarify the policies and responsibilities of the Office of Management and Budget and the General Services Administration with respect to the establishment and execution of procurement policies and procedures.[5] How this is to be accomplished is not spelled out.

Typical of the kinds of problems that arise is the difficulty that the Office of Management and Budget has had in introducing the procurement approach laid out in its Circular A-109. This directive, issued in August 1976, attempts to stimulate innovation in the procurement of large computer systems by using techniques similar to the ones that the Department of Defense uses in procuring aircraft. Under this "fly-before-you-buy" policy, the government does not set specifications but does define its functional requirements or mission needs--i.e., "what and why". The competitive process defines the "how" by contracting for more than one system design, and by testing out interim products, the system specifications, as set out by the winning contractor, become the government's specifications.

Critics of Circular A-109 note that it has an indirect antecedent in the so-called "Bell Report,"[6] which recommended in 1962 that the federal government fund large-scale research and development projects through a two-stage process in which the first stage would be the acquisition of specifications. They go on to state that a process that was originally designed to provide for the procurement of great numbers of the winning design does not necessarily lend itself to the procurement of computer systems and that there is no evidence to indicate that it will. Moreover, the amount of the initial investment necessary to obtain the desired degree of innovation is

not defined, and there is also no assurance that the Congress will be willing to provide the necessary funds until there is evidence that the A-109 process works. In short, A-109, through its emphasis on the specification of performance, does appear to be conducive to innovation, but it is not certain whether the same results could be achieved with other, less costly, and less time-consuming approaches.

As to management education, the second area in which improvements are needed, common sense suggests that key decisions affecting an agency's acquisition and use of computer-based information technology should be made by senior managers with a broad view of organizational objectives and needs. Such decisions should be made in close association with the agency's other management planning decisions and should be systematically evaluated with a view to reducing costs, countering the effects of inflation, increasing productivity, and improving services. In fact, however, senior agency officials may often lack an adequate understanding of how the technology can be deployed in support of their agencies' missions, as well as an adequate understanding of the advantages and disadvantages of the technology. As a result, they are reluctant to assume responsibility for bold and innovative uses of the technology, which, if competently developed and implemented, could greatly improve the efficiency and effectiveness of their information intensive enterprises.

To the need for better management education, moreover, one must also add the need for improved in-house technical support to assist management decision making on a continuing basis. P.L. 89-306, the so-called "Brooks Bill," assigns technical support responsibility to the Department of Commerce, and specifically to the National Bureau of Standards (NBS). The NBS program, however, is almost exclusively concerned with the federal government's use of *computers*; its responsibilities do not include technical support for the government's use of telecommunications, which falls within the province of the newly created National Telecommunications and Information Administration (NTIA) in the Department of Commerce.

These three problem areas--acquisition, management education, and technical support for management decision making--go far toward explaining the federal government's weakness in making efficient and effective use of computer-based information technology. Nonetheless, they are not the whole explanation, since, as one might expect, the agencies' performance here, as in other areas, is also

affected by their need to respond to an array of competing public policy concerns. Objectives and constraints established by laws such as the Freedom of Information Act,[7] the Federal Records Act,[8] and the Federal Reports Act[9] all have an effect on how the agencies perceive their opportunities to use modern information technology efficiently and effectively. In recent years, moreover, the legal and social policy issues surrounding efforts to prevent unwarranted intrusions on personal privacy have had an especially strong influence on agency acquisition and utilization practices and, in fact, have stymied, for good or ill, a great number of proposed system procurements.

THE AUTHORITY AND ACCOUNTABILITY DIMENSIONS OF THE PERSONAL PRIVACY ISSUE

As indicated in Chapter I, applications of computer-based information technology are believed by some to be capable of changing the balance of power both between organizations and individuals and among organizations themselves. Thus, as one thinks about improving the federal government's capacity to use the technology efficiently and effectively, two questions need to be asked: (1) Is it possible to protect personal privacy and other interests of individuals that have recently been established by statute or regulation? (2) Can the federal government's computing and telecommunications facilities be operated so as to allow politically and socially desirable distributions of institutional authority and accountability to be maintained or even enhanced?

The answer to the second of these questions, in particular, is far from clear.

The impact that applications of computer-based information technology can have on established patterns of institutional authority and accountability is not well understood. Nonetheless, the basic fear is that by augmenting an agency's ability to perform its mission, one may in fact enlarge its authority beyond what the Congress intended it to have or at least present the potential for such enlargement. This could lead to limitations on personal freedom for which the fair information practice and confidentiality rights afforded by conventional privacy protection laws provide no effective counter.

To appreciate this line of reasoning, one needs to recognize the breadth of federal agency enforcement authority and the traditional looseness of statutes governing

interagency disclosures of information about individuals. Thus, the issue is whether the agencies, in deciding when and how they will use computer-based information technology to perform their statutorily authorized missions, should be given a free hand to enforce any provision of law currently on the books, or whether the Congress should involve itself in the utilization decisions with a view to eliminating authorities that no longer make sense or which, if fully exercised, could become a vehicle for intruding into people's lives in unintended ways or on an unprecedented scale.

Because applications of computer-based information technology tend to make it easier and cheaper for an agency to store and retrieve the information it collects and maintains about individuals, who the users of that new capacity should be is increasingly debated. Should an agency whose disclosure practices are not tightly regulated be allowed to enlarge the amount of information it can readily retrieve from its files? Should an agency that historically has operated under tight constraints, but whose record-keeping systems now contain a much enriched store of easily retrievable records, be allowed or required to make those records available to other agencies?

Such questions rarely have simple answers. On the one hand, disclosure constraints tend to promote duplication of record systems at a cost that the taxpayer ultimately bears. Forbidding duplication or otherwise depriving an agency of useful information can also add to the taxpayer's bill by promoting inefficiency. On the other hand, failing to impose constraints or allowing existing ones to be relaxed can imply important changes in the relationship between what people *expect* to happen to the information they divulge to an agency about themselves and what *actually* happens to it. That, too, can have costs if individuals, to protect themselves against unanticipated disclosures, begin to refuse to divulge all the information asked of them or if, fearing that what they tell about themselves in one context will come back to haunt them in others, they begin to modify their behavior in ways they think will lessen the government's interest in them. Although there are many situations in which this could conceivably occur, one need not look beyond the "McCarthy" era and the "Watergate" years, for worrisome real-life examples.

In the Tax Reform Act of 1976,[10] some of these disclosure policy issues were squarely addressed with respect to the information individuals divulge about themselves to the Internal Revenue Services (IRS). There the Congress

decided that because people are legally compelled to file tax returns, and because the IRS could not function if most of them did not do so willingly, the disclosure rules governing other agencies' access to individual tax returns should be greatly tightened. So far, however, the IRS rules and practices are the only ones that have been subjected to such a thoroughgoing examination and revision.

As indicated, these concerns about mission expansion are also believed to have some potentially important structural and managerial dimensions. In the law enforcement area, for example, there is concern about whether a Federally sponsored or managed system for the exchange of criminal history information among federal, state, and local law enforcement entities will, in undesirable ways, augment the federal government's ability to influence the way law enforcement missions are performed at the regional, state, and local levels.[11]

Then, too, there are those who believe that giving any federal agency effective control over an information system essential to the states is a potentially undesirable step toward augmenting unnecessarily the power of the national government. The best way to keep bureaucratic authority in check, they argue, is to keep it from becoming centralized. One achieves that by making sure that in any area of bureaucratic activity there are multiple centers of politically accountable decision making authority and responsibility, decision making centers, that is, that cannot be ordered to fall in line and can veto suggestions that they do so. Historically, this has been achieved by making sure that principles of governance such as the federal separation of powers are respected.

Today, those principles can be threatened by applications of computer-based information technology tend to displace accountability from the state level to the federal one, or that join federal, state, and local government agencies into information sharing networks for which no one using agency can be held fully responsible. This threat, moreover, is believed to arise not so much because the technology is hostile to pluralistic forms of governance, but because those promoting its application are excessively concerned with achieving their own bureaucratic objectives. Their professional biases and expectations, as well as the budgetary and management pressures to which they are subject, are not conducive to thinking about how their own objectives can and should be balanced against other, competing, considerations.

Finally, there is concern about possible expansion of

agency missions at all levels of government as a consequence of what might be called "preemptive" uses of computer-based information technology. Consider, for example, the situation of an individual who applies to a state or local government agency for a license of some sort. The state agency, before issuing the license, uses the technology to query a data bank maintained by a federal agency to which other states regularly contribute information about license applicants. The query produces a "hit"; that is, a message from the federal agency that the applicant previously applied in another state and was rejected for some specified reason. The state receiving the message denies the application on the spot, despite the individual's insistence that he has never applied elsewhere or that whatever disqualifying information has been supplied about him is inaccurate or perhaps even false.

How should one react to such a situation? On one hand it could be argued that the societal interest served by denying licenses to people with certain disqualifying characteristics is so great that even if the individual is telling the truth, the state should turn him down, and, in addition, leave to him the task of getting the mistake corrected. This would involve his interceding not only with the federal agency that runs the data bank, but also with some other state that supposedly submitted the disqualifying information--no mean feat in either instance. On the other hand, one might say that because more than 50 jurisdictions contribute to the information system queried, the possibility of inaccurate information being retrieved from it is so great as to warrant requiring the state agency to take the individual at his word. If, upon further investigation, it turns out that he was, in fact, lying, the state agency can then rescind the license (assuming it is able to locate him).

Again, there is no easy solution. Yet given the possibilities for abuse when an individual's dealings with a government agency are not tempered by due process protections, it does seem reasonable to ask whether an agency, just because it has access to a new type of information processing system, should be permitted, at its own discretion, to change the way its due process obligations are fulfilled. Moreover, if it is allowed to make such changes, should it be forced to do so as a condition of participating in a federally sponsored or managed information sharing network? Or would that decision be left to the legislative authority in each participating political jurisdiction?

These kinds of problems were officially recognized in

the Privacy Act of 1974, which requires each federal agency to report publicly on the likely impacts a new record-keeping system or system modification on the privacy and other personal rights of individuals, as well as on the federal principle of separation of powers.[12] The legislative history of the act offers few insights into the means by which the mentioned rights and relationships might be adversely affected, and provides no guidance as to how a system's impact on them might be measured. Nor is it clear that they are the only areas or ways in which existing patterns of institutional authority and accountability might be upset. Meanwhile, for want of a clear understanding of the problem, to say nothing of a widely accepted solution to it, a number of agencies are currently unable to move forward in implementing needed improvements in their computing and telecommunications facilities.

The following questions drawn from actual cases illustrate the complexity of the agencies' current problems:

> (1) How might a nationwide network of automated record keeping systems to support the administration of federal and state social welfare programs be designed so as to assure that an individual's record is maintained according to fair information practices and its confidentiality is well protected? Does it make any difference whether the records pertaining to identifiable individuals in such a network are maintained locally or centrally, and, in either case, are there special kinds of accountability safeguards that should be considered indispensable?
> (2) When a network of communications linked computing facilities is being developed for use by state and local government agencies as well as federal ones, what limits should be placed on the participating parties' access to each others' record-keeping systems? Are there general rules that should be applied, or should the rules vary according to the kinds of record keeping operations the network will serve?
> (3) Where one federal agency's efficiency or effectiveness may be enhanced by allowing it access to another agency's personal data record keeping systems, what kinds of anticipatory analysis should be done to assess the impact of such a change on the records of subjects who may be directly affected by it? Likewise, what types of analysis should be made of the impact on the agency whose record systems may be made more accessible? How should the initial concern

for improved efficiency or effectiveness be balanced against any adverse impacts thereby identified? And by whom should this be done?

(4) If it appears that adequate protection for personal privacy and acceptable patterns of institutional authority and accountability can be assured by other means, does it still make sense to forbid one federal agency's computers to communicate electronically with those of another agency?

(5) Could a "common user"[13] network of communications linked computing facilities for use by the civilian agencies of the federal government be designed so as to make it easier rather than harder for the Congress to oversee the agencies' information sharing and use practices?

(6) What level of physical, technical, and administrative security should be required before a telecommunications facility is used to transmit personal information?

SHARING THE FEDERAL GOVERNMENT'S INFORMATION RESOURCES

The federal government, in the execution of its many programs, collects and maintains vast amounts of information. Yet much of that information does not appear to be efficiently used. Instead of sharing their information resources with one another, the agencies more often than not develop their own. As a consequence, the amount of duplicate information collection and maintenance is significant.

Overlap among agency programs suggests a need for much more interagency information sharing than occurs today. This is particularly true where agencies could benefit from evaluating related statistical data about the same populations, the same geographic areas, the same products, or the same industries.[14] In addition, there are benefits to be derived from making the federal government's information resources more accessible to users at other levels of government, in universities, other parts of the private sector, and to the public generally.

Currently, the agencies appear to have few incentives to encourage wide public use of the information they maintain. Some government regulations, such as the ones that govern the pricing of government documents, can actually impede rather than encourage information dissemination. For many potential users, even finding out what information is available is difficult, and for others the rules defining

proprietary rights to information can be formidable obstables. Privacy concerns can also be an undue impediment to sensible information sharing. Sometimes they properly justify withholding information, but on other occasions they may be used merely as a handy excuse.

Finally, there is an important but as yet unresolved argument as to whether the federal government should make public, at no cost, information that is, or might be available commercially. Should the government, in effect, compete with private industry in developing information gathering and retrieval services? As indicated in Chapter IV, the federal government's failure to develop a firm policy about commercial versus publicly funded services has adversely affected its relation with other countries.[15] Domestically, however, one can also identify similarly attractive opportunities that are being foregone for want of a clear understanding as to whether privately developed and marketed information gathering and retrieval services will end up competing with ones government establishes.

THE ROLE FOR INDEPENDENT POLICY RESEARCH

The efficiency and effectiveness with which the federal government uses computer-based information technology have not been systematically investigated, and analyses of the contribution that the technology has made or could make to improving agency productivity are not generally available. It seems clear, moreover, that a single study, pitched at a high level of generality, will not suffice. Rather, a variety of studies at different levels of resolution that reflect the great diversity among the federal government's many information related activities, and among its uses of available technology, will be needed.

In particular, the development of a methodology for evaluating both effectiveness of utilization and contribution to productivity needs consideration. This should be complemented by a study of the planning and budgeting processes that are needed to assure sound utilization of the technology by federal agencies and also by the development of a methodology for continuing evaluation of the level of computer-based information technology used to support key agency missions.

Finally, there should be a number of policy related studies aimed at moving forward the resolution of key issues in each of the five problem areas discussed above --*viz.*, acquisition, management education, access to

high quality technical support on a continuing basis, the authority and accountability dimensions of the personal privacy issue, and sharing the federal government's information resources.

Policy Research Focused on the Acquisition Process

Unless the processes by which the federal government acquires contemporary information technology are carried out well, the agencies are unlikely to use the technology efficiently and effectively. The federal procurement process, however, is an elaborate one. To protect the government from fraud and waste, complex and time consuming procedures have been developed. In addition there are many participants--the requesting agency, the vendor, the General Services Administration (GSA), the Office of Management and Budget (OMB), the General Accounting Office (GAO), and, with increasing frequency today, the Congress.

The President's Reorganization Project concluded that the acquisition process has a number of deficiencies.[16] Some of its conclusions would benefit from more in-depth study and independent validation. In addition, a study should be inaugurated to determine whether the current procedures for procuring computer-based information technology are an impediment to improving agency effectiveness and to assess the potential impact of the changes called for in the Reorganization Project's reports and related reports.

A study should also be made of the effectiveness of OMB Circular A-109 as a device for encouraging technological innovation in the procurement of major computer systems. In particular, a project should monitor an ongoing agency venture under A-109 to determine:

(1) whether there is a cause-effect relationship between the A-109 process and innovation;
(2) whether there are ways to evaluate products at the "fly off" point that will both minimize procurement costs and be highly predictive of ultimate system performance;
(3) whether the A-109 process, while seeking innovation, inhibits the use of standard software and the interchange of system modules between and among agencies; and
(4) whether the multiple development costs that A-109 requires appear to be justified by the amount of innovation actually achieved.

Policy Research Focused on Management Education

To help senior agency officials perform as competent, confident managers of the information intensive enterprises over which they preside, two different, but related, lines of analysis are needed. One is an investigation to determine how formal programs of management and computer science and engineering education can be used to train prospective managers and information systems professionals to treat computer-based information technology as the powerful management tool it is. The other is a study aimed at identifying and developing ways to train today's senior agency officials for more active roles in deciding how the technology can be used to increase agency effectiveness. With regard to the latter, it should also be noted that the management education problem in state and local governments is similar to that in the federal agencies. Thus, to facilitate the interchange of knowledge and experience between federal agencies and their state and local counterparts, public-sector managers with adequate background to make good decisions will be essential.[17]

Policy Research Focussed on Assuring High-Quality Technical Support

In addition to management competence, technical support competence is much needed. The areas in which much stronger technical support seems to be called for include:

- Application modelling and evaluation;
- Analysis of system costs and benefits;
- Data management: provision for interchange and shared usage;
- Networking and control of distributed applications;
- Software development and test techniques;
- System performance description, monitoring, and analysis;
- Evaluation of technical trends and costs associated with policies (on standards and leasing, for example) that aim to minimize costs at the subsystem level;
- Systems management training

A study should be mounted to determine the degree to which these types of functions are needed and how they should be organized, chartered, staffed, and institutionalized. Furthermore, because many of the same needs also

exist at state and local levels, the Advisory Committee on Intergovernmental Relations should be encouraged to interest itself in such undertakings.

Research on Authority and Accountability Dimensions of the Personal Privacy Issue

Computer-based information technology has many applications in which the users function interdependently. One of the more familiar ones is the "federal-state information system" in which users in different political jurisdictions share access to a centrally managed repository of records or data. Another is the conventional data processing service bureau in which public and private organizations share centrally managed computing capacity. Still a third is the "common user" network in which both data and computing capacity can be shared as the participants wish. The central management function is to primarily make sure that the communications links among the "nodes" in the network operate properly.

To those who see applications of computer-based information technology upsetting established patterns of authority and accountability, the differences among the several types of networking applications are usually considered to be less important than the similarities. In cases particularly where the users of a network are government agencies, some fear that network participation will become an excuse for revising established patterns of authority and accountability without asking for legislative permission to do so. In such situations, moreover, the "established" pattern can often be diffuse and ambiguous--the product of past political compromises that have assumed continuing legislative oversight without specifically providing for it. Thus, for the designers of a government computer network, a key question is whether the rules of participation should reflect such diffusion and ambiguity wherever it exists, or whether the network's construction should be the occasion for clarifying the users' authority and accountability relationships. Likewise, an equally important question is whether the network can be constructed so that subsequently each participant can easily be satisfied that modifying the control structure for technical or economic reasons will not upset the authority and accountability pattern originally agreed to. Or, conversely, that modifications desired by the users for their own reasons can be readily made.

A research project devoted to computer networking could

be quite useful, but it is essential that the research questions be framed in ways that make sense to policy makers as well as to technologists. The research effort must also be multidisciplinary (i.e., involving social scientists and lawyers, as well as specialists in computing and telecommunications), and it must be carried out openly, preferably with sponsorship by both the Executive branch and the Congress.

The research agenda should include:

(1) Documenting, analyzing, and evaluating, through a series of case studies, the ways in which existing and proposed networking applications of computer-based information technology have altered or been deemed capable of altering established patterns of institutional authority and accountability;
(2) Documenting, analyzing, and evaluating, through a series of case studies, the kinds of institutional objectives, concerns, and conflicts that shape the ways networking applications of computer-based information technology are proposed, developed, and implemented in the public sector;
(3) Developing a methodology for assessing the likely consequences for both agencies and individuals of proposed changes in the ways government entities collect, maintain, use, or disclose identifiable information;
(4) Stipulating the need, if any, for new legislation to define policies relating to the transfer of individually identifiable information between or among government agencies,[18] and between federal agencies and external organizations;
(5) Assessing the effectiveness of state-of-the-art computer and telecommunications security techniques and the relative costs for various levels of protection.

Research on Sharing the Federal Government's Information Resources

While the overlap among federal programs suggests a need for interagency information sharing, the need, if it indeed exists, and the means to satisfy it, still must be defined.[19] The following are some of the questions that need to be answered:

(1) Why have the efforts of some agencies to share their statistical data bases failed?
(2) How can interagency information sharing be encouraged without decreasing personal privacy or other legitimate individual or corporate interests?
(3) What are the ways of assuring that the information to be shared is accurate and up-to-date?
(4) What is the best way to organize and develop an experimental sharing arrangement?
(5) What criteria should be used to assess the cost-effectiveness of any new sharing arrangement?
(6) Can the requirements of cost-effective sharing be met using currently available computing and telecommunications technology?

In addition, the issue of whether or how the federal government and the private sector might divide or otherwise share responsibility for making the federal government's information resources more readily accessible to users at state and local levels of government, in the private sector and among the public generally, deserves to be thoroughly explored. Plainly, a key question to be considered is whether any new arrangement to encourage interagency sharing of information should be designed so as to make the shared information also available to users outside the government.

NOTES AND REFERENCES

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John Stucker, *et al., Information Technology-Challenges for Top Program Management in the General Government Agencies*, (Washington, D.C.: NTIS A/N PB-284 135), 1978.

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Philip J. Kiviat, *et al., Operational Management Team Report* (Washington, D.C.: NTIS A/N PB-287 176), 1978.

James McManama, *et al., Personnel Team Report* (Washington, D.C.: NTIS A/N PB-287 175), 1978.

Louis Haire, *et al., Science and Technology Team Report* (Washington, D.C.: NTIS A/N PB-201 698), 1978.

Herbert Pier, *et al., Small Users Team Report* (Washington, D.C.: NTIS A/N PB-284 134), 1978.

Paul Oliver, *et al., Standards Team Report* (Washington, D.C.: NTIS A/N PB-283 756), 1978.

2. See, for example, *Problems Found with Government Acquisition and Use of Computers from November, 1965 - December, 1976*, (Washington, D.C.: U.S. Government Printing Office, 1977; GAO Report No. FGMSD-77-14 and reports of several other studies carried out by the Automatic Data Processing group of GAO's Financial

and General Management Studies Division. These, and other relevant GAO reports, too numerous to list here, can be identified through the semi-annual publication *General Accounting Office Publications*, and the monthly *GAO Documents - Catalog of Reports, Decisions and Opinions, Testimonies and Speeches*.

3. See, for example, Martha M. Gray, *Computers in the Federal Government: A Compilation of Statistics - 1978*. NBS Special Publication 500-46 (Washington, D.C.: U.S. Department of Commerce), 1979, which presents statistical data on the numbers of computers installed in the Federal government and in specific federal agencies; the dollar values of computers installed; federal ADP costs by agencies; federal computers by acquisition date; and federal ADP work years.

4. See GAO publications referred to in Note 2 above. See also, U.S. House of Representatives, Committee on Appropriations, Surveys and Investigation Staff, *Acquisition of Automatic Data Processing Systems within the Department of Defense and Other Federal Agencies*, May, 1978.

5. *Ibid*. In supporting the need for such changes, these reports provide an extensive array of observations and facts that highlight a number of problems.

6. U.S. Bureau of the Budget. *Report to the President on Government Contracting for Research and Development*, prepared by the Bureau of the Budget and referred to, the Committee on Government Operations, United States Senate (Washington, D.C.: U.S. Government Printing Office), 1962. Also available as Senate Document No. 94, 87th Congress, Second Session, 1962.

7. 5 U.S.C. 552

8. 44 U.S.C. 3301-3314

9. 44 U.S.C. 3501-3511

10. P.L. 94-445

11. Concern is also being expressed about federal funds and technical expertise used to support computer-based information gathering activities of State and

local domestic intelligence units. To the extent that such applications of computer-based information technology are funded in whole or in part by a federal agency, the ability of any state or local legislative entity to monitor and control their information system operations may be limited.

12. 5 U.S.C. 552a (o)

13. A "common user" network is one that allows the participating organizations to use each other's computing equipment and associated applications programs and data bases. The ARPANET described in Chapter II, pp. 20-21, *supra.*, is the one Federally managed "common user" network currently operating. The ARPANET, has been developed by the Department of Defense to serve the computing needs of a group of government-funded research centers. In 1974, the General Services Administration proposed another "common user" facility, called FEDNET, for use by the civilian agencies. Congressional and public concern about threats to personal privacy, however, forced GSA to withdraw the proposal and to date it has not been revived.

14. With this in mind, the Executive Office of the President has recently been studying ways of using computer-based information technology to make timely, accurate information available to the President and the Congress.

15. Pp. 57-58, *supra*.

16. President's Reorganization Project, *Federal Data Processing Reorganization Study:* Harris G. Reiche, *et al., Acquisition Team Report, op. cit.*

17. State and local governments can also benefit significantly from effective use of computer-based information technology. To the extent that the problems of individual states are similar, it is important to share with them techniques that contribute to more effective use of available technology. On a different scale, this is also true of local governments.

    In support of these observations, one should note that:

    - The number of state and local government employees is approximately three times that of the Federal government and is faster growing.

- Revenue sharing and other delegations of federal authority increase the importance of sound management at the State and local level.
- Recent studies of how computer-based information technology is used at the state and local level in particular indicate the difficulties inherent in seeking to diffuse and utilize information about the technology's capabilities.

For a cogent analysis of some federal attempts to diffuse scientific and technological know-how to state and local governments, see, Irwin Feller, *Diffusion and Utilization of Scientific and Technological Knowledge within State and Local Governments, Report to the National Aeronautics and Space Administration* (University Park, PA: Institute for Policy Research and Evaluation, The Pennsylvania State University), January, 1979.

18. For a discussion of key issues in this area, see "The Relationship Between Citizen and Government: The Privacy Act of 1974," in U.S. Privacy Protection Study Commission, *Personal Privacy in an Information Society*, (Washington, D.C.: U.S. Government Printing Office), July, 1977, pp. 498-536.

19. See, for example, *A Report of the Commission on Federal Paperwork: Final Summary Report* (Washington, D.C.: Commission on Federal Paperwork), October 3, 1977; and, also, "The Citizen as Participant in Research and Statistical Studies," in *Personal Privacy in an Information Society, op. cit.*, pp. 567-604.