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ABSTRACT

The economic crisis of the mid-1970's is a symptom of a major social transition caused by the shift of the major industrial societies to postindustrial societies. The postindustrial society is one in which the dominant labor activity is information processing rather than industrial production. This shift has great significance for the resolution of social problems of society, particularly in the economic sector. The information based society is a more efficient user of energy and resources; furthermore the information industry itself is not an intensive user of energy and resources. This shift also requires the re-examination of key areas of economic policy problems such as productivity, natural resource constraints, information, international interdependence, and social issues (such as the distribution of information technology, privacy, property rights in information, and the use of leisure time). Computer telecommunication technology will impact a variety of applications areas of concern to governments: education, funds transfer, trade, consumer information, public administration, teleconferencing, and health services. In turn the structural change will require consideration of questions in relationship to research and policy analysis, economic infrastructure, research and development, network intercommunication, and right to access. (JY/SK)

SOCIAL IMPLICATIONS OF COMPUTER/TELECOMMUNICATIONS SYSTEMS*

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Social Implications of Computer/Telecommunications Systems

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Introduction

In the following remarks I have rejected the two most common approaches to a discussion of the social implications of computer/telecommunications systems as being too narrowly focussed on the technology. I prefer a broader approach that looks at the social problems our societies face and the institutional changes that might be appropriate for solving them, with computer/telecommunications technology in a subordinate role as one of the tools available for social problem solving.

The first of the rejected approaches is technological forecasting. Technological forecasting uses a variety of techniques, including the Delphi technique pioneered at the Rand Corporation, to project the trends in the technology. Such projections usually have an implicit assumption that there will be no significant change in the institutional structures controlling the technology. Forecasters can then speculate on the social consequences of the technological trends using social consensus to validate their speculations. Such speculation often looks optimistically at the potential of the technology, because the experts engaged in the forecasting exercise have a vested interest in the continued development of the technology they have expertise in . Such an approach carries with it the risk of falsely assuming technological determinism and thus implicitly or explicitly arguing that no social policy actions should be taken (other than to promote the development

of the technology itself) because the social results are inevitable.

This assumption of technological determinism, although often used to defend conservative institutions, is consistent with the Marxist argument that in the grand sweep of History (with a capital H), the underlying technology (the means of production) largely determines the institutional structure (the social organization of production) and that these institutions in turn shape the ideology of a society (the superstructure), that is its laws, political theories, science, art, etc. But in the shorter time scales we are concerned with when asking questions of social policy, what goes in the realm of ideas (for example, in scientific research) may influence the underlying means of production. And to a perhaps greater extent, the social institutions determine which areas of science receive funding for continued investigation and which technological possibilities are in fact implemented. Whatever we conclude about Historical Determinism, as viewed over a period of centuries, policy makers must deal with many relevant questions of national and international policy in the scale of years and decades. Policy makers may be merely trying to maintain their power by keeping in step with historical inevitability or they may be actually influencing the course of history. In either case, the focus should not be on the technology itself, but on the social policy options and the probable consequences of those policy choices.

The second rejected approach is that of technology assessment, in which one measures (or speculates about) the beneficial or harmful results of alternate forms of the technology. This is a valid approach for many purposes. But, as I have argued elsewhere (Parker, 1973), the short to medium range social effects are determined not by the technology itself, but by the

social institutions that can stimulate, inhibit, apply or divert the technology. The same technology that could enrich some people and institutions at the expense of others could also be used to increase the wealth of all while narrowing the gap between rich and poor. The same technology that could lead to centralized systems of social control such as those caricatured in George Orwell's 1984, could also be used to foster a participatory democracy in which political power is more widely distributed throughout the society. Which outcomes are achieved will depend on the institutional structure controlling the development of the technology. Therefore we should focus our attention on social problems and institutional analysis in order to keep the technology in appropriate perspective.

In the third approach to social implications of information technology that I recommend, awareness of the potential of the technology is still important. But policy analysis should instead begin with the social problems and social goals that need urgent attention, and purposively structure both the technology and institutions controlling the technology in order to accomplish long-range policy objectives. The technology sets limits or constraints on what is possible, but the more interesting questions concern the alternatives within those limits that are selected or rejected by the relevant institutions. In many cases, the key to solution of social problems is not changes in technology per se, but in changes in institutional structure. We all know that established institutions, whether governmental or business, are often extremely resistant to change. There are perhaps three occasions or kinds of events that are sufficiently destabilizing to institutions that there is a real opportunity for change. One is during a time of political crisis. The second is during a time of economic crisis. The third is during

a time of technological change. In the third instance, institutions are forced to adapt to, or defend themselves against, forces of change inherent in new technology. The key policy questions at such times should concern how to deal with the opportunity to restructure institutions so that they can better serve present and future social needs.

This focus on how institutions might be changed to better utilize relevant technologies has a disadvantage that should be made clear at the outset. By pointing out favorable scenarios of what is possible with the technology, given changes in institutions, there is a tendency to be unrealistically optimistic. Technology can be misused and institutions controlling technologies for their own ends may often exacerbate social problems rather than solve them. A conditional statement of favorable possible outcomes, depending on appropriate policy action, may be misinterpreted as a prediction of favorable consequences that follow from the technology itself rather than correctly interpreted as a statement of possible futures, with perhaps low probability of implementation by appropriate institutions. Being by nature an optimist, I have chosen to focus on the positive potential of the technological opportunities, even through a realistic prediction would anticipate most of the opportunities being missed and less socially desirable consequences resulting.

The social policy questions that I choose to focus on in this paper are economic ones. Although I am not an economist by training, I have convinced myself that a significant source of the present world-wide economic problems lies outside the boundaries of conventional economic theory in an area I do know something about. The relative lack of success of economic policies in dealing with the current world wide economic problems may make this an

opportune time for an analysis by an outsider to be heard by policy makers.

A Bold Hypothesis

Let me present a bold, only partially tested, hypothesis about the current state of the world economy. The economic crisis of the mid 1970s is a symptom of a major social transition, not transitory economic dislocations. The underlying cause, I hypothesize, is the shift of the major industrial societies to post-industrial societies and the concurrent introduction of post-industrial elements into the industrialization process in the lesser developed countries. In OECD countries our economies, our economic theories and our social institutions are largely geared to agricultural and industrial production and consumption. Now we are undergoing a major historical upheaval. Instead of being able to plan economic growth on the assumption of unlimited supply of energy and materials, we are now confronted with real limits to physical growth. No longer can we have unlimited or unrestrained growth of population, of material consumption or of environmental pollution. These new kinds of problems are now challenging the economic theories and institutions that were devised to stimulate and to cope with the growth of the industrial wealth.

We can now see more clearly than we could a few years ago how to characterize the post-industrial society. We are in the midst of a sometimes painful transition from an industrial society to an information society. We are moving into an era in which the dominant labor activity is information processing rather than industrial production. The growth of computer, communications and other information technology in the past 25 years has been aptly dubbed "a second industrial revolution."

In the industrial age, man was able to use his information processing power to design machines that greatly augmented his physical capacity. Those machines could use large amounts of energy to shape and transport physical goods under man's control and direction. In other words, man provided the necessary information to build and to control the machines that substituted for and vastly augmented human physical energy. In the information age that we are entering, the characteristic machine is one that processes information, augmenting not human physical energy but instead augmenting human information processing. The difference is a significant one. Since energy is used to manipulate symbols rather than physical objects, the consumption of energy and materials can be made arbitrarily small by using smaller and smaller physical representations of symbols in our information machines. This means that in an information age unlimited economic growth is theoretically possible even though we reach a steady zero-growth state with respect to energy and materials.

There are two aspects to this potentially unlimited growth. One is that some present consumption and much new consumption could be diverted into information-intensive rather than energy-intensive goods and services. The other is that continued application of information (for example, research and development) could lead to more efficient use of available energy and materials, permitting real growth of output given stable inputs. Buckminster Fuller, in his book Operating Manual for Spaceship Earth, (Fuller, 1969) perhaps has the latter point in mind when arguing that the potential for economic growth is unlimited because economic growth is dependent on limited physical resources coupled with unlimited metaphysical resources.

The kinds of economic policies and economic theories appropriate to

the industrial age are not the most appropriate theories or effective policies for an information age. Information is not a commodity like other industrial commodities. I will attempt to show that policies that were appropriate when information activities were a small part of the total economy become inappropriate and even counter-productive when information activities constitute the largest sector of national economies. This is because information is difficult to convert into an appropriable commodity whose title can be easily transferred from one economic agent to another. Even if we already had the better theories and policies needed for an information age, we are in the meantime faced with the even more difficult problem of successfully steering our societies and our economies through the difficult transition period. I'll return to these policy issues after presenting some descriptive data consistent with my hypothesis about the basic structural change underlying current economic difficulties.

The Information Society

A society can reasonably be characterized by what most of its people do and an economy can be characterized by the major economic activities contributing to the National Income. For example, the United States of 1860 was still predominantly an agricultural society because more workers within the U. S. labor force were engaged in agriculture than were engaged in either industrial or service occupations. Agriculture contributed a significant portion of the national income. By the middle of the 20th century, the United States was predominantly an industrial society, properly so-called because a higher percentage of the labor force was engaged in manufacturing than in other occupations. Now, since about 1950, the structure of the U. S. economy has been changing.

By the conventional classification scheme of primary (agriculture and extractive activities), secondary (manufacturing), and tertiary (service activities), the relative decline of both primary and secondary activities is reflected in the relative increasein tertiary or service activities. That traditional classification scheme now conceals more than it exposes. A century ago service occupations included a large number of personal servants, shoe-shine boys, and others providing physical services. Now, maids, butlers and shoe-shine boys are rare, and most service occupations are less often physical services and are now primarily information services (lawyers, accountants and computer programmers, for example). Even within the primary and secondary sectors of the economy, many of the occupations are concerned with information processing rather than processing of energy and materials. In U. S. agri-business, a growing proportion of the total labor force is in managerial, clerical, or financial occupations. In manufacturing, the number of blue-collar workers on the production line is declining relative to the white-collar information processing jobs.

My colleague Marc Porat (1974) has analyzed data on the United States labor force made available by the U. S. Bureau of Labor Statistics. We chose to look at U. S. data partly on the basis of convenience, but also because the U. S. is farther advanced into the post-industrial information age, and therefore, U. S. experience may be viewed as an indicator of things to come in other industrialized societies.

Figure 1 shows the percentages of the U. S. labor engaged in agricultural, industrial, and service occupations from 1860 to 1980, based on Bureau of Labor Statistics data through 1970 and BLS occupational projections for 1980. By this rather conventional classification scheme, agriculture has continued to

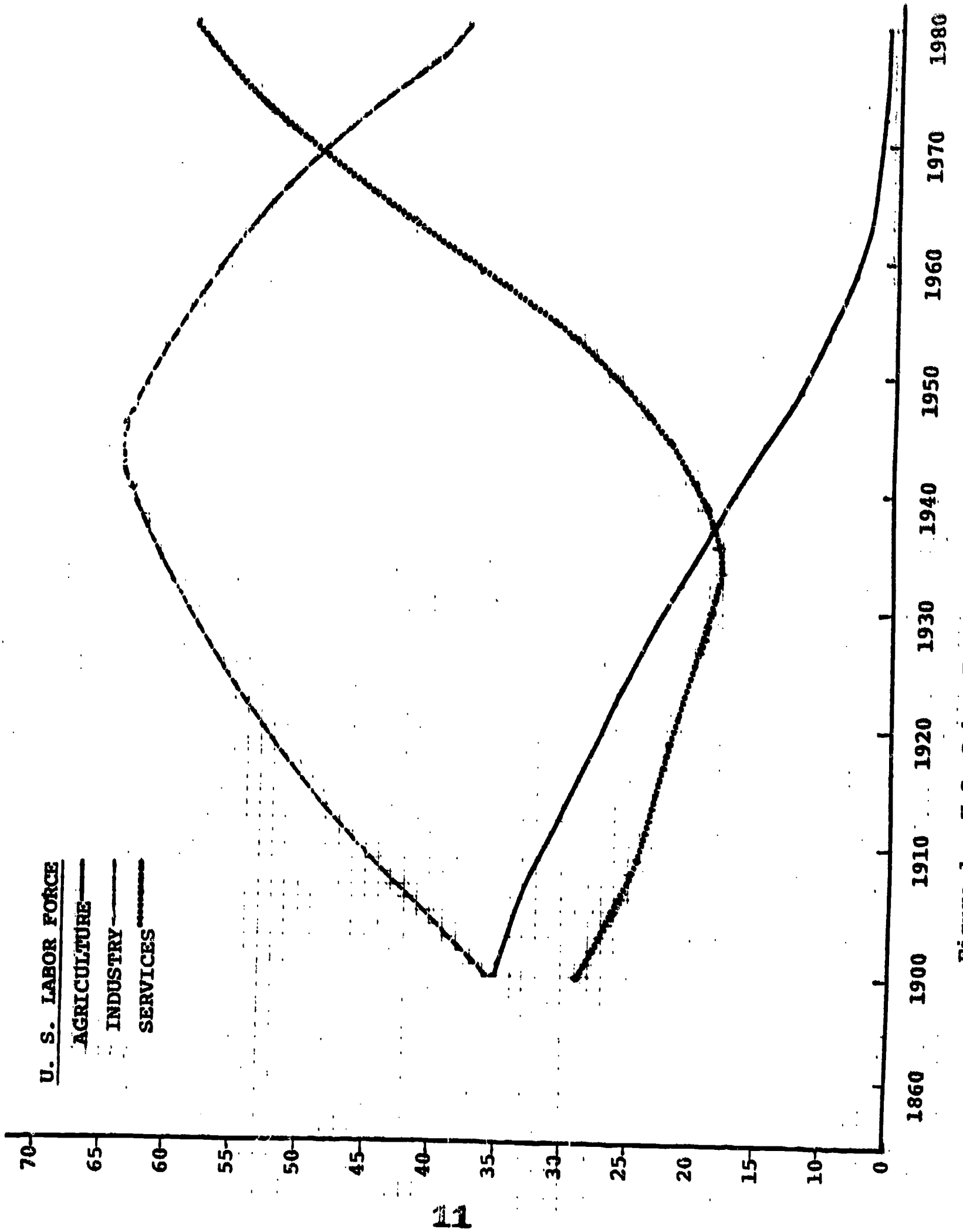

Figure 1. U.S. Labor Force: 3 Sector Aggregation.

decline relative to other sectors of the economy, despite real gains in agricultural output. Industrial activities reached their relative peak about 1950 and have been declining since. Service occupations are growing rapidly and employing an ever greater percentage of the labor force.

Figure 2 is based on a slightly different classification scheme in which all occupations where the primary activity is processing information have been separately classified into a fourth or 'information sector' of the economy. The other three categories are net of information processing occupations. (Appendix A lists the occupations that have been classified into each of these four categories. In the case of information occupations, a further classification is provided to indicate how they were distributed into the three original categories.)

The resulting four-fold classification shows that service occupations (net of information services) are now a smaller percentage of the labor force than they were in 1900. The basic structural change that has taken place in the economy since 1950 is the growth of information occupations relative to industrial occupations.

Figure 3 highlights the basic change in the structure of the economy by contrasting information occupations with all other occupations. Starting from a small base in 1950, at a level that had been virtually unchanged since the beginning of the century, information occupations grew such that by 1975 we have reached the cross-over point at which 50 per cent of the U. S. labor force is engaged in information processing occupations. How long that growth will continue before stabilizing is a major uncertainty. At its peak, industrial occupations accounted for approximately 65 per cent of the labor force. Perhaps information occupations may reach a similar peak at the height of the

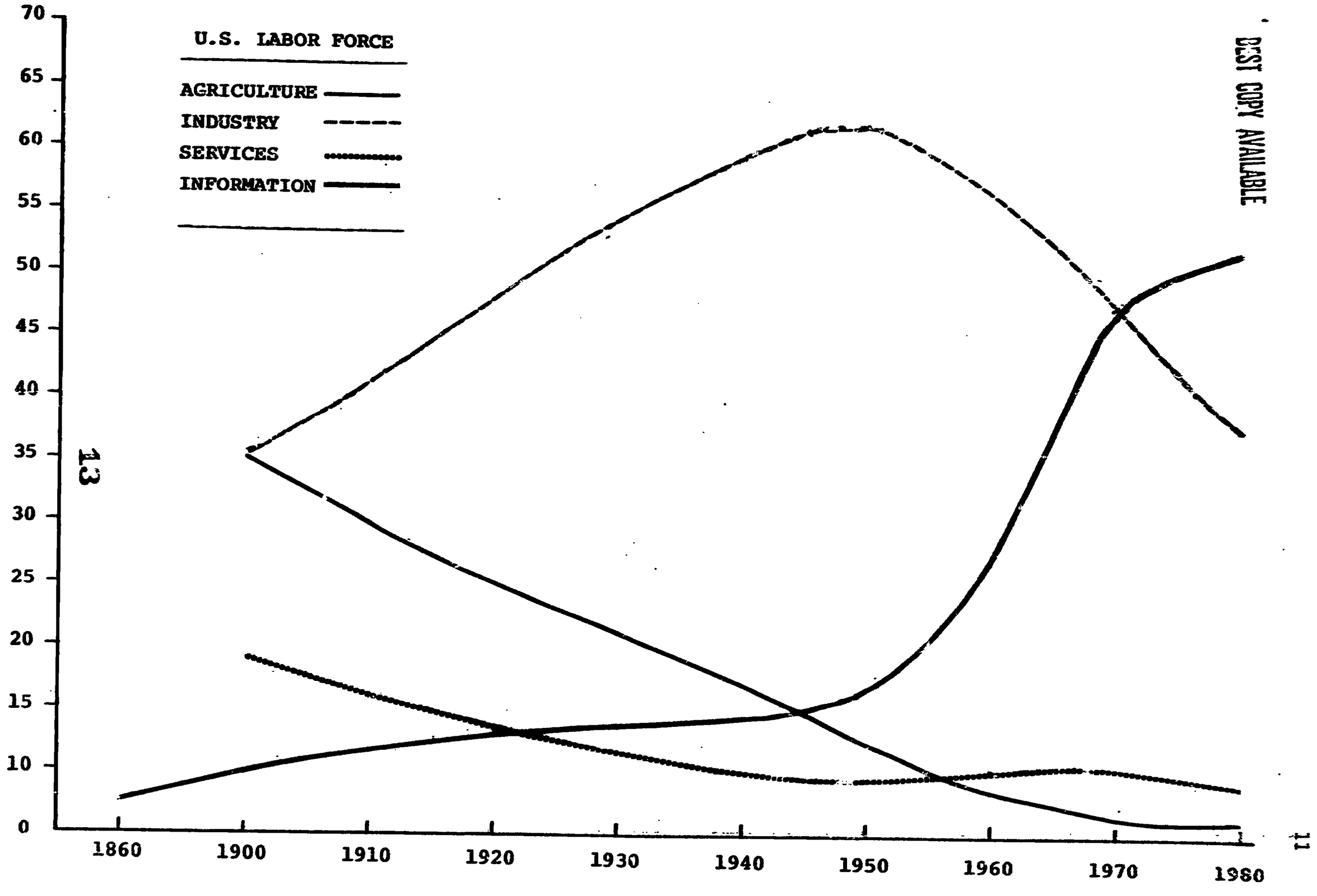

Figure 2. U.S. Labor Force: 4 Sector Aggregation

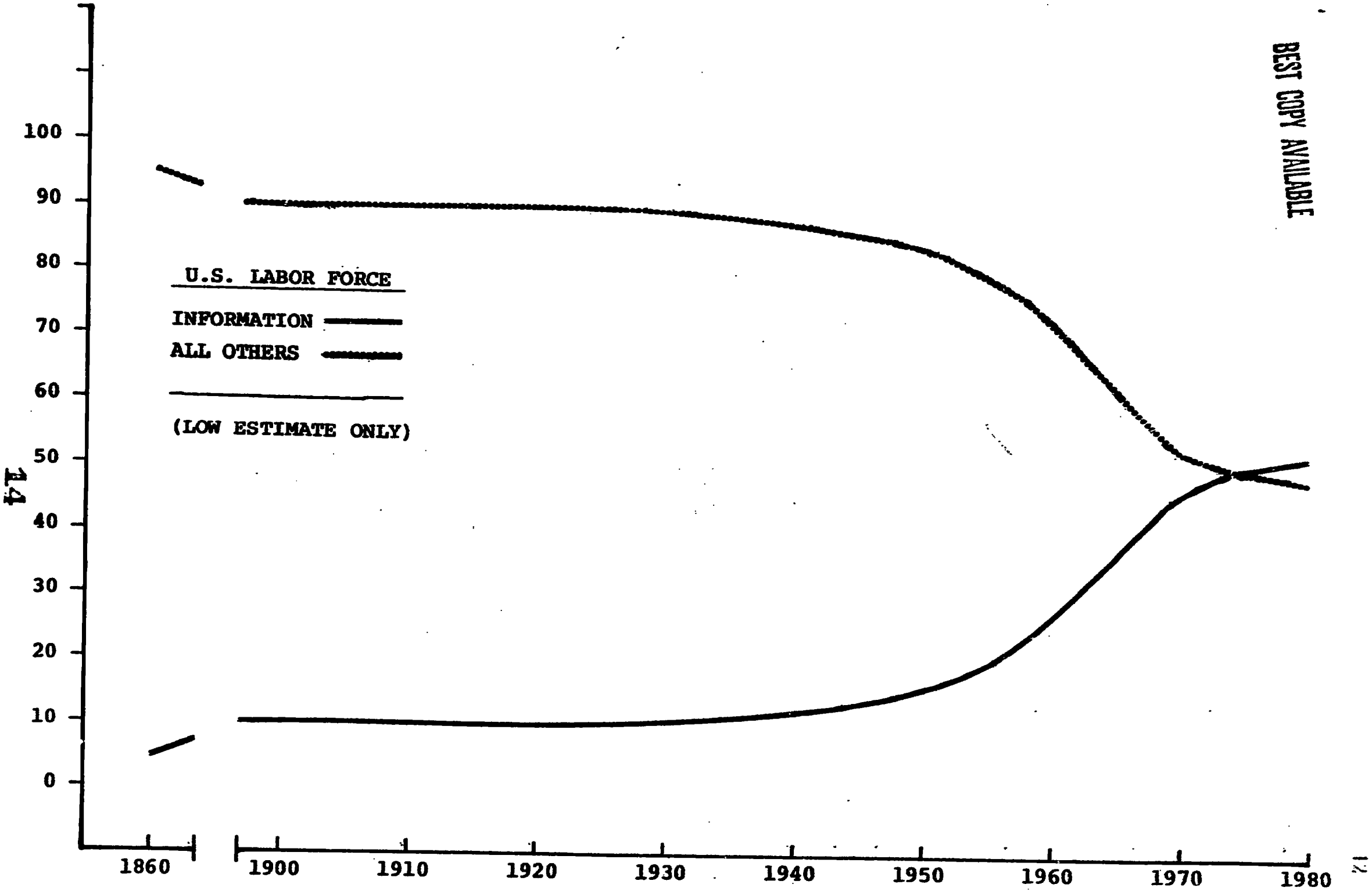

Figure 3. U.S. Labor Force: 2 Sector Aggregation.

information age.

There is a certain amount of arbitrariness in the classification of occupations into information processing versus other activities. By using a more liberal or more conservative definition of what is an information-related occupation, somewhat different results would be obtained. Figure 4 highlights the effects of such definitional differences by showing both an upper and a lower bound on the percentage of the labor force engaged in information occupations between 1960 and 1980. By the more liberal definitions, information occupations accounted for more than half the labor force in 1970. By the more conservative definitions, that 50 per cent won't be reached until 1980. (Appendix A indicates which occupations are shifted by these definitional variations.) Either way, the general trend is clear.

There are other ways to characterize a society than by the distribution of occupations in the labor force. One way is to look at the annual Gross National Product or the annual National Income and see what percentage (in units of dollars or other national currency) can be attributed to the agricultural, industrial, services or information sector of the economy. Fritz Machlup, in his book, The Production and Distribution of Knowledge in the United States (Machlup, 1962), examined U. S. national income accounts for the year 1958 and concluded that, by 1958, 30 per cent of the U. S. economy was devoted to the production and distribution of information. He also projected a rate of growth in the information sector much faster than other sectors of the economy, consistent with the trends in information occupations described above.

The U. S. society has also been characterized as becoming a 'leisure

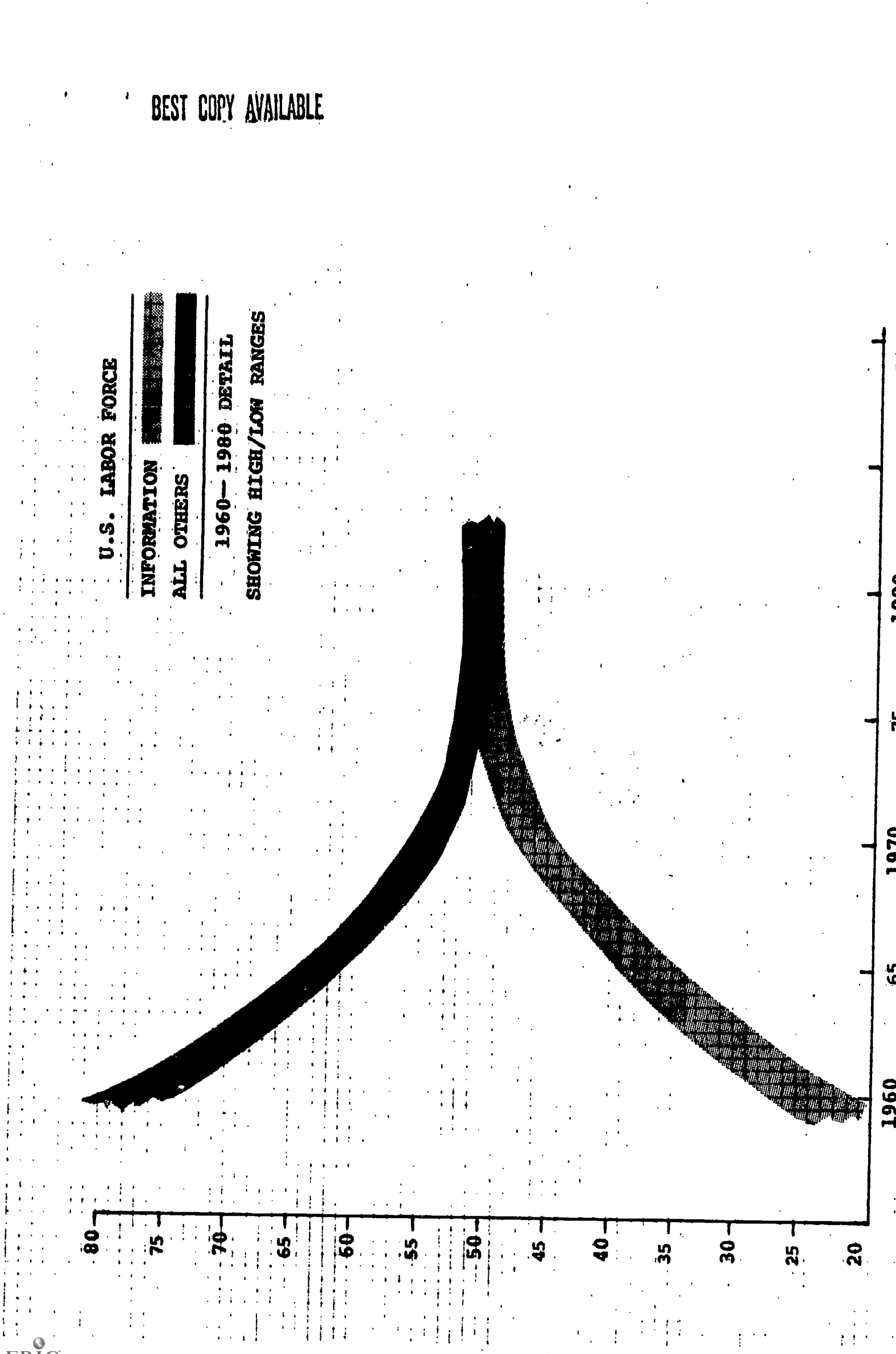

Figure 4. U.S. Labor Force: 2 Sector Aggregation. Detail 1960—1980 Showing High-Low Range.

society' in which shorter working weeks and longer holidays lead to an increased focus on leisure and consumption activities relative to work activities. A closer look at the distribution of personal consumption expenditures can provide another indication of the kind of society the U. S. is becoming. In the period from 1950 to 1971, the personal consumption expenditures declined slightly (by 5.7 per cent) relative to the Gross National Product. In that same 21-year period the amount of personal consumption allocated to information goods and services increased by 39 per cent.* Information goods and services were defined as: telephone, telegraph, private education, books, magazines, radio, TV, motion pictures, theatre and personal business such as legal, financial and counseling services.

Whether we look at trends in the distribution of the labor force, trends in the components of the National Income, or the trends in personal consumption, the same answer is obtained: The U. S. society is in the midst of a transition from an industrial society to an information society.

We can speculate about why the past 25 years have been characterized by this explosive growth in information activities. The primary reason may be the underlying technology of computers, transistors, integrated circuits, etc. The great reduction in the unit costs of information products and services as a result of these technological changes has led to a greater demand for information products and services both as final products (consumption items) and as intermediate products useful in the production of other goods and services (e.g. computer services within other businesses). The lower unit costs for information processing have made possible new kinds of activities not previously

*See U. S. Bureau of Economic Analysis, "The National Income and Product Accounts of the United States, 1929-1965," Tables 521 and 522. Also "Survey of Current Business," July 1973.

possible or economically viable. Hence the lowering of unit costs has led to increases in expenditure on information.

A second reason may be the satiation or levelling off of some physical needs with a consequent shift in new demand to concern with style, atmosphere or other intangible (i.e., information-related) attributes of consumption, or a direct shift in demand to information products and services.

A third reason may be increased recognition of the value of information for production. An extensively educated (i.e., information-rich) labor force may lead to more efficient production. Extensive social investment in research and development activities (i.e., the production of new information) may also lead to more efficient production.

A fourth reason may be increased use of information because of market inefficiencies. For example, expenditures on advertising may contribute little value to the advertised products. Production might be more efficient in some industries and profits correspondingly higher if all the competitors in the industry reduced their advertising budget. But if one competitor advertises, he may gain relative to the competition. The result may be that all surviving competitors must maintain sizeable advertising expenditures, even though the expenditure is inefficient from the perspective of the industry as a whole. Some expenditure for education may be of this sort. For example, if employers screen job applicants according to educational level, even though the education is not required to do the job, then job applicants may be forced to invest in excess education in order to compete for the job (Spence, 1972).

Economics of Information

At this point in the argument a critic or a skeptic may concede that

the U. S. is becoming a soc ' that reasonably can be labelled or defined as an information society. But he might well question the as yet untested hypothesis that the structural shift to an information society underlies the current economic problems. The critic may say, "So what? Can't information be dealt with in the economic system as a commodity like other commodities?" I argue that the answer is clearly, "No." But to understand why, a better definition of information is needed.

We need to distinguish between information on the one hand and energy or materials (matter-energy) on the other. Information is the pattern or shape or order that is imposed on or detected in matter-energy. Information and matter-energy come as a joint product, even though we analytically distinguish between the two. When we observe the pattern or shape of matter or detect variations in the flow of energy, we are receiving information. Even when the 'commodity' we value is pure information, there always must be some minimum amount of matter or energy flow on which the pattern is carried. For example, a microfilm copy of a newspaper uses less matter than the print on paper version, even though the relevant information content is the same. The energy consumed by a pocket electronic calculator may be less than the energy consumed by a large electro-mechanical calculator doing the same calculation, even though the same answer is obtained.

The recent rapid growth of what we have been calling the information sector of the economy is primarily in information goods and services that can be dealt with like other economic goods and services. Books, records, radios, and computers can be bought and sold like shoes, apples and washing machines. The personal services of a lawyer or psychiatrist can be purchased like the

personal services of a barber or cook. Because information is a joint product with some amount of matter-energy, it is possible in many cases to buy and sell the matter-energy (the marker) on which the information is carried.

Information as such is not a commodity that can be readily bought and sold. We don't have satisfactory units for measuring quantities of information, or for establishing a price per unit. Physical commodities have the property that when one person gives or sells them to another, the original owner gives up possession. This is not true for information, because the seller or giver of information retains the information after he has transmitted it to someone else. Sometimes the value of the information to the original possessor is increased after it is widely disseminated. Scientific or artistic works often have this property.

Because information isn't a commodity like other commodities, and thus doesn't fit within our economic theories, we have created legislation that attempts by legal fiat to create property rights in information. Four areas of law are involved: patents, copyright, trade secrets, and privacy. In the case of patent and copyright laws, an attempt has been made to facilitate widespread distribution of information while still retaining the property rights of the owner who benefits from receiving license or royalty fees from other users. In the case of trade secrets and privacy laws, an attempt has been made to restrict distribution of information which is more valuable to the owner if not disseminated. But ownership of information based on the analogy of ownership of physical goods remains a forced analogy. It is not surprising that there are continuing problems with these four areas of law attempting in different ways to make a commodity out of something that is not a commodity, especially at a time when information technology is rapidly changing.

According to neoclassical economic theory and conventional wisdom in economic policy, the production and distribution of physical commodities can best be handled within a competitive economic system. When all the assumptions of the economic theory are met, then unrestricted competition should lead to optimal total investment (even if the distribution of benefits from that investment offends our social consciences). But one of the key assumptions of the economic theory leading to that conclusion is the assumption of standardized products about which consumers have perfect information. This leads to impossible contradictions in the case of information treated as a commodity. If the buyer has perfect information about the information he is considering buying, he has no need to buy it. In addition, the seller can't relinquish possession of the information because he still has it after the transaction. Consequently, cooperative rather than competitive strategies are more appropriate to information. The total gains to the society are likely to be greater under cooperation than under competition. Unfortunately, we don't have completely satisfactory mechanisms for such cooperation. In a competitive society, some possible forms of cooperation may come under legal attack as anti-competitive practices subject to legal action under anti-trust legislation.

The distribution of information has a declining marginal cost, that is the cost of providing the information to the n'th user once the information has been produced and distributed to the previous users is small relative to the earlier costs. What is the cost of providing a library book on loan to the 25th user, when its purchase was already paid for? What is the cost of adding one more member to a radio or television audience that already may number in the millions? These declining marginal cost problems make it very difficult to create appropriate incentives for the original production of information.

Some conclude from these considerations that information is a public good like other public goods such as roads and police services. Some information goods and services, for example most schools, libraries and scientific research, are already treated as public goods which require governmental support. Calling it a public good doesn't solve the policy questions, however. That just affirms that many of the relevant investment and allocation decisions have to be made collectively, presumably through governmental decision processes. Calling information a public good doesn't solve the vexing social policy questions of how much to invest in what kinds of information production and distribution. Since there are no economic units in which to measure quantities of information, the question of how much information can be bought for a given amount of money is a meaningless question. And since information is not a standard commodity, the question of what kind of information is a crucial value question. In the case of production of information (e.g. research), as distinguished from distribution of information (e.g. education), there's the further difficulty that we can't know in advance what information will be produced.

There is now an exciting and growing sub-area of economic theory concerned with the economics of information, stimulated by Kenneth Arrow and others (Arrow, 1974;Spence, 1974, Hirschleifer, 1973). So far, these economists of information have been able to show that an absence of collective decision-making with respect to information leads to non-optimal economic results. But they haven't yet provided clear policy guidance concerning what an effective information policy should be.

As the information sector of the economies of developed societies continues to grow, these problems will become more and more difficult. As the cost of the matter-energy component of information (the markers on which

information is stored and transmitted) continues to decline relative to the cost (primarily intellectual labor) of providing the information itself, the competitive market place will become less and less effective as an efficient allocator of investment resources.

Now we can return to my hypothesis that the structural shift from an industrial society to an information society underlies many of the current economic problems. One part of the problem is the physical resource constraints limiting or restricting economic growth in conventional ways. The other is the absence of automatic mechanisms for providing efficient investment in the growing information sector of the economy. The twin problems of stagnation in the traditional sectors and inefficient investment in the growing sector will require major policy analysis in the next several years. As we saw in the U. S. data presented earlier, the U. S. is already far advanced in the transition. Given the present international interdependencies, the resulting U. S. problems are affecting other economies also. And other economies following the same path as the U. S. may be beginning to suffer from similar problems in their own right, depending on how far into the transition stage they have advanced.

National Economic Policy Questions

It may prove fruitful to re-examine key areas of economic policy problems in the light of this hypothesis concerning structural change in the economy. Although the questions are inter-related, I have singled out for discussion the following four topics: productivity, natural resource constraints, inflation, and international interdependence. Even if my major hypothesis is later shown to be at least partly false, much of the analysis of the specific problems

may still be relevant.

A. Productivity

At a time of economic recession, with or without inflation, a key question has to be how to stimulate economic growth. In the United States the fastest recent economic growth seemed to coincide with the peak of the industrial age. As we began the shift into the information age the companies that grew the most rapidly were those with information processing products, for example IBM and Xerox. Economic productivity gains were achieved in the industrial sector of the society, including those making information machines. But as the percentage of the economy devoted to manufacturing declined, the rate of economic growth has slowed. Most observers agree that the primary source of productivity gains is information -- information in the form of education for a more highly skilled labor force, and information in the form of research and development leading to more efficient products and production techniques. When the information sector of the economy was small relative to the industrial sector, increased expenditure on information apparently paid off. Now that the information sector of the economy is larger than the industrial sector, that strategy may be reaching a point of diminishing returns. One U. S. observer (Pake, 1971) points to declining productivity in U. S. universities, citing costs per unit of instruction increasing by a factor of four in the decade of the 1960s. Although this is extreme rather than typical of costs of information services, it is still easy to see that declining productivity in the information sector could offset any productivity gains in industry at a time when the information sector is larger than the industrial sector. Despite the introduction of information machines, the information sector of the economy (including education and most of government) is strongly labor-

intensive. If information sector wages are set at levels consistent with productivity gains in industry without corresponding productivity gains in the information sector, then the advantages of productivity gains in the smaller industrial sector may be nullified.

At a time when the information sector of the economy is the largest and fastest growing sector, and when information technology is a cost-declining technology providing opportunities for productivity gains, it may be counter-productive for governments to pump more and more money into labor-intensive information activities with declining productivity. More of the same, even though it apparently worked to achieve productivity gains in the period when the information sector was smaller, may now lead to the opposite of the intended effect. Now, instead of looking for productivity gains in the agricultural and industrial sectors by pumping more money directly into the information sector, governments could instead implement policies that would stimulate productivity gains in the information sector itself.

Since the information sector of western industrial societies is largely dominated by government (including most of education), government policies will be required to obtain productivity gains in this sector. The traditional incentives for the private sector to introduce new practices leading to productivity gains are absent. In any case the lack of easy appropriability of information and consequent under-incentive for the private sector to produce it was what led many governments to their present large involvement in the information sector of the economy in the first place. Consequently, reliance on traditional private sector incentives to produce productivity gains is likely to be futile.

B. Natural Resource Constraints

The end of the industrial age doesn't mean the end of industry, but it does mean the end of rapid growth in the consumption of energy and materials. Continued growth of the value of industrial output will require greater efficiencies so that more or better output can be obtained from available resources. To achieve greater efficiencies in production, information will need to be applied -- information in the form of research and development and in the form of education. The efficiency problem now needs to be posed differently than in the past. Instead of replacing human labor with ever greater application of physical energy, a new approach is called for. Physical energy and materials may be limiting factors. Increasing the output per worker under resource constraints requires a continuing search for better techniques. We need to have our industrial production work smarter rather than just work harder.

But industrial production shouldn't be the primary focus of attention in a post-industrial age. The more promising approach to economic growth (or growth in quality of life) is to reinforce the social trend away from conspicuous consumption. We should be able to maintain present consumption levels, but effect a shift in consumer perference away from resource-intensive goods. The trend in U. S. preference toward smaller, more economical cars concurrent with greater consumer expenditures on information goods and services is an indication of this kind of shift. Can we shift consumer preference such that the average citizen will receive as

much perceived utility, and hence social welfare, from a year of college education as from a new automobile? Or as much satisfaction from reading or writing a book as from acquiring material possessions? Can we learn to acquire status from the acquisition of education, mental health and the ability to process complex information instead of ever increasing quantities of physical consumption? Can the 'Protestant Ethic' of the industrial age be shifted in the information age such that ideas and not things become the object of much of our labor? Can we evolve beyond the basic biological drive for physical and material security and develop a desire for self-actualization?

Many of these trends are happening anyway, but government policies could ease the transition. For example, commercial advertising intended to stimulate consumption of energy and materials could be taxed more heavily than advertising intended to shift consumption to products and services requiring less energy and materials. And government policies could shift the focus of search for productivity gains from the resource consuming industrial section to the information sector where fewer energy and materials constraints should apply.

C. Inflation/Stagflation

The problem of inflation, or worse 'stagflation' combining inflation and economic stagnation at the same time, is a topic of such current concern and debate among economists and policy makers that it is perhaps foolhardy for a non-economist to make some necessarily oversimplified comments. But the topic is so important, that I must take the risk. Conventional remedies for inflation tend to have recessionary impact. Similarly, remedies for recession can fuel inflation. This is true whether the remedies are those of monetary policy or through fiscal policies of taxation and government expenditure. These remedi are designed primarily to act on the economy as a whole, rather than to redress structural imbalances within the economy. Policies designed to solve problems of stagflation need to be more selective in order to solve structural problems in the economy. It may be necessary to slow down those sectors of the economy that are heavily dependent on energy and materials (especially imported oil), while stimulating productivity gains and economic growth in sectors with less long-run inflationary impact and fewer balance of payments problems.

Shifting more money into the information sector of the economy to increase the amount of information services available at present levels of productivity may seem an attractive alternative, but this is not likely to reduce inflation in the long run. Salary increases in the presently labor-intensive information sector are likely to have an inflationary impact. To reduce the long-run inflationary impact of the information sector of the economy it will be necessary to make capital investments in information technologies that can stimulate the availability of more services at lower unit costs (i.e., productivity gains). Economists will quite rightly point out that such capital

investment may in the short run exacerbate inflationary tendencies. Nevertheless, such capital investment may be an essential part of the long-run solution to the problem of inflation and could be justified as part of a fiscal policy aimed at the twin problem of recession. Alternately, a technique like inflation indexing as used by the Brazilians might alleviate some of the bad effects of inflation while policies are implemented to remove the underlying structural problems.

One way in which information technologies might help to reduce inflation is to use information technology to provide economical information services that reduce market failures or inefficiencies and reduce transaction costs in other parts of the economy. According to economic theorists, economies work best when all consumers have perfect information about the products available and the prices offered by different producers and when producers have perfect information about the preferences of consumers and the prices they are willing to pay. In simple economies with a small number of relatively standard products the incidence of market failures through inadequate information may have been smaller. Now, in our increasingly complex societies with a bewildering array of choices, we often pay more than we need to for goods and services because we don't have sufficient information. Many of us may contribute to inflation by our own purchasing behavior because we have inadequate consumer information and cannot afford to take the time necessary to acquire better information. Government could stimulate better consumer information and encourage the establishment of marketplace or brokerage functions in areas where market failures are detected. Markets for information itself are especially troublesome because of the problems in the economics of information discussed above.

D. International Interdependence

As the amount of information flowing across national boundaries continues to increase, the same considerations that apply to national policies will increasingly apply to international policies. As our information interconnections increase we need to increasingly turn away from competitive strategies and toward cooperative strategies. Cooperation is essential to information flow; without cooperation we don't develop the common symbols with shared meanings that are essential for communication. A shift away from international competition to international cooperation doesn't imply that there should be no specialization and competition in the production of goods and services. It does imply that we need to avoid the disastrous international consequences of unrestrained international competition that leads to all nations losing. For many goods and services competition within and between nations will continue to be economically sound. But as the information sector of national economies and international exchange increases, the requirements for cooperation will increase. Competition will have to take place within the boundaries of cooperative agreements. Within the economies of both Japan and Sweden, at least as they appear to the casual outside observer, it appears that successful strategies have been found to encourage economically beneficial competition with a larger cooperative framework that ensures that the competition leads to greater success for all and not just redistribution of resources. Analogous approaches may be required on an international scale. As we learn to live with global resource constraints we will need to devise strategies leading to improved quality of life for all, rather than self defeating fights to grab a disproportional share of

scarce resources.

Given the major resource interdependencies, currently typified by global dependence on oil exporting countries, there isn't much of an alternative to cooperative strategies. Policies that lead to a widening of the economic gap between developed and less developed societies are likely to lead to dangerous instabilities. The old attitudes of an industrial age may force such instabilities if they are not modified to meet the new circumstances. If people think of their own self-interest in terms of material wealth in which resources one nation is using are not available to others, then exploitation or unstable competition may result. As the global economy shifts more to an information economy, then the knowledge of each society could be shared for mutual benefit, without loss to the sharing societies. As John Diebold (1973) argues in Foreign Affairs, the best opportunity for continued economic growth of information rich societies like the United States, western Europe and Japan is to sell that information to the developing countries in exchange for natural resources. The 'know-how' that is sold to the developing countries should enable them at least partially to close the industrial gap between the present rich and poor countries -- creating a more equitable and hence more stable distribution of physical wealth. The result of such an exchange would permit continued improvement in the quality of life in the presently industrialized societies at a faster rate than would otherwise be possible. This non-obvious conclusion follows from the nature of information -- the more of it you share the more you have left at the end of the transaction. This is because information exchanges lead to improvements in the quality of information rather than loss of information. The information game can be played on a global scale as an everybody wins game rather than the kind of

winnners and losers game that is played with material resources.

Social Issues

These economic trends and opportunities will have consequences and side effects that will be perceived as social or political.

A. Information is Power

There seems to be a certain validity in the claim that 'information is power.' The difference between George Orwell's 1984 and a hypothetical participatory democracy with widespread sharing of political power lies in the question of who controls the sending and receiving of information in the society. Information policies that cater to an information elite and serve to widen the gap between the information-rich and the information-poor may have short run advantages tc elites already in power. But they would have the effect of limiting economic growth and the effect of risking political upheaval by exacerbating inequities of political power.

Some proposals put forward in the name of distributing political power, especially electronic referenda proposals, may have the opposite of the claimed effect and lead to increased opportunities for demagoguery and manipulation (Parker, 1972). The real opportunity for wider participation lies in the issue of access.

Lowered technical costs associated with the manipulation, storage, transmission and reception of information will make it economically possible for near universal access to the information resources of the society. Communication costs via satellites and some computer networks are independent of distance,

thus potentially reducing disparities between the geographic power centers and their peripheries. Computer information retrieval systems can make it possible for any citizen to have access to stored information without expensive labor costs of access. Specific items of information being sought could be made accessible on demand without sorting through libraries full of paper. Low cost audio and video technologies can permit citizen access to the sending as well as the receiving ends of audio and video channels.

Elites currently in control of information channels may feel threatened by the political pressures that will build up behind arguments for access. In principle, in western democracies at least, equality of opportunity and equitable access to information channels (e.g., freedom of speech) are accepted as desirable goals. An informed electorate is more likely to lead to good government, we're told. The economic advantages to a society of widespread access to public information may be sufficient to enforce these ideals in practice in the long run. In the short run, those elites who see their own political and economic power being diluted through greater social access to information may fight a strong political rear-guard action.

A short run effect of introduction of new information technologies is to widen the gap between the information-rich and the information-poor because the rich and the well-educated are the first to obtain access to the new services and benefits. In the long run, after the benefits are widely diffused through the society, everyone may be better off. That is, unless there is a constant flow of new innovations that always leave the information-poor with the previous technologies. An excellent discussion of

this problem is provided by Katzman (1974). These considerations may lead some societies to defer or delay implementation of new information services until social and economic policies can be devised to make the benefits available to the entire society and not just the elite segments of the society.

B. Privacy

The opposite side of the coin from access is privacy. What is seen by some groups as legitimate access to information may be seen by others as unwarranted invasion of privacy. As the costs of access to information continue to decline and new information technologies become more widely available, new pressures and new abuses will inevitably occur. In situations of unequal access to information (for example, when large corporations or governmental units have data banks of information about individual citizens who in turn have difficulty finding out about the inner workings of the corporation or governmental unit), the weaker power (the citizen) may have to assert a right of privacy to avoid exploitation. On the other hand, partial redress of the imbalance may be possible through the opposite strategy of making the corporate and governmental information more accessible and hence more vulnerable to political or social pressure. These will be tricky issues for governments to deal with as our societies make the transition from the industrial age to the information age.

C. Property Rights in Information

The issue of property rights in information (copyright, patents, trade secrets) is likely to be difficult. The difficulty in protecting 'ownership' of computer programs through either copyright or patent protection may be

serious because there may be insufficient incentives to produce and share computer 'software' on an economically efficient scale. These laws attempting to create property rights in information and thereby create artificial incentives to stimulate the production of information may be ineffective or inefficient. As long as the rest of the economic system is geared to the production and distribution of physical goods, ad hoc legal arrangements will be necessary to make information more or less fit that kind of economic system.*

D. Work and Leisure

The shift to an information society is changing the distribution of occupations, as the data presented earlier indicated. Perhaps not so obvious is a possible shift in the distinction between work and leisure. Men and women are information processing animals. It is our information processing capability that distinguishes us from other animals. The distinction between production and consumption is harder to maintain when the activity is information processing. When we talk on the telephone we are both producing and consuming information. People in managerial, clerical, or other information related jobs both produce and consume information as part of their work. Most of us are information consumers in our leisure, whether watching television, or football, or reading a book. Before the age of mass media a higher proportion of leisure activity was production rather than

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*Eventually, economic theorists may be able to devise an economic theory appropriate to the information age, presumably a theory supporting an ideology of cooperation rather than an ideology of competition, and ways may need to be found to bring about a transition to a different type of economy. In such an economic system, different legal arrangements may need to be found to efficiently handle production and distribution of physical goods. But such problems are for the far distant future. For the foreseeable future, the legal and political problems will be those of trying to make information more or less fit an economic system designed for physical commodities.

consumption of information -- with people engaged in group singing or storytelling, for example. Now that the costs of machines for production as well as consumption of information are declining, there is more use of photography, home-recorded audio cassettes, and the beginnings of amateur use of videotape technology. With lower costs and a more affluent and more educated population, production of information is growing as a leisure activity.

Many people in information processing jobs requiring responsibility and orginality enjoy their work not just because of the financial rewards but because of the intrinsic pleasure of their work. No longer should we distinguish between work and leisure on the assumption that work is painful or stressful and leisure is fun. There are growing numbers of us who like our work and choose our jobs not on the basis of financial reward, but on the basis of intrinsic job satisfaction. Our work is fun and we spend long hours at it because we enjoy it. We may be in a small minority now, but the trend is now upward as we go beyond the alienating assembly-line work style typical of the late industrial age.

Before the industrial revolution many 'industries' were cottage industries with people working in their own home. In an information age it may be desirable to partially return to a style of work at home for many information occupations. When computer terminals and computer networks are as accessible to every home as telephones and the cost of word processing on computer terminals with electronic storage is cheaper than word processing on typewriters with paper storage, then many people in word processing occupations will work from home the way many computer programmers in the United States now work from home using portable computer terminals and telephone connections. The cost in money, time and consumption of natural resources

required to commute to and from the office from a distant residence every work day is considerable when summed across all commuters. With sufficiently cheap electronic communication, significant reductions in oil consumption are possible.

For the immediate future we'll see small blurrings of the distinction between work and leisure, home and office. In the more distant future that we don't have to worry about yet, we may find that we can somewhat decouple the physical reward system from the workplace and provide all citizens with the minimum of food, clothing and shelter needed to meet their physical needs, whether or not they work in the usual sense of the term. The rewards that drive a fully developed information economy may be intrinsic satisfaction and a kind of cooperative barter economy in information such that exchanging information is not a direct economic transaction. We may pay a flat or metered rate for the use of the communication network itself (like a monthly telephone rate permitting unlimited calls or an electric utility rate based on kilowatts consumed). Information travelling over that network then may be exchanged freely, just as in most telephone conversations today. Meanwhile, for the present, policies still will be required to facilitate the sale of information without incurring unduly high transaction costs.

Application Areas

The policy implications and policy questions associated with computer/telecommunications technology will emerge in a variety of different applications areas of concern to governments.

A. Education

Governments already influence the productivity gains or losses in the information sector of national economies through their education policy. If almost all government expenditures for education are for construction of buildings or for current operating expenses, then productivity gains are extremely unlikely if not impossible. Capital investment in less labor-intensive technologies with cost-declining characteristics will be necessary to achieve economic productivity gains in education. Shifts to use of video textbooks and computer instructional techniques could permit lower unit costs (after appropriate research and development has taken place and an economic national infrastructure for such services is in place). Without the development of instructional techniques with lower unit costs (e.g., through Open Universities or other institutional innovations), it is unlikely that any of our countries could afford to provide open access to lifelong learning opportunities for all its citizens. Yet both national economic policies and social policies seem to be creating pressures in the direction of just such extended learning opportunities for all citizens.

If new information technology is added to existing educational institutions without either decreasing the investment in building construction or teacher salaries, or increasing the number of students, then unit costs will obviously be higher rather than lower. On the other hand, if new investment in information technology for education is justified solely on the basis of saving labor costs, the political pressure from teacher organizations may be strong enough to block reform. One answer to this dilemma may be to experiment with new technology-intensive education techniques for extending educational services to those members of society not now being served by present educational institutions.

The Canadian Department of Communication, through its Educational Technology Program, is experimenting with new uses of computers, audio-visual technology, and telecommunications systems for education. In the United States, a new Consortium of users of educational television was formed in December of 1974 to purchase or lease operational services from a high-powered communications satellite that could distribute television nati n-wide to ground receivers costing less than $10,000 each. The operational satellite is expected to reduce video distribution costs (including administrative costs and videotape inventories) below those incurred in shipping videotapes by mail. At the same time the satellite will permit instructional television service to remote areas (e.g. in remote Alaska villages) not now served by television at all. This a logical sequel to current experiments with instructional television distribution via an experimental communication satellite soon to be moved to India for use there. Those of you more familiar with the European, Japanese or Australian experience could doubtless add many other examples.

B. Funds Transfer

Electronic funds transfer or credit checking applications are now being implemented or seriously considered. The cost savings over present methods of funds transfer based on checks and paper is likely to push this application quickly. Transfer between financial institutions and between large businesses and financial institutions will likely lead to inter-connections at retail points of sale. Hence, a nationally (and internationally?) interconnected computer network reaching into most business establishments will be an economically desirable infrastructure in support of such applications especially if the same infrastructure can support other applications also.

As in any change in systems and procedures, there will be inevitable adjustment problems. The reduction in 'float' may cause one such adjustment problem when people and institutions can no longer count on a few days between the time of writing a check and having it cashed.

The social disadvantages of such a system may be more than temporary problems of adjustment, however. Some responsible and knowledgeable computer professionals are urging that such a system never be implemented. Their reason is that it would create a complete electronic record of the financial transactions of all members of society and permit invasion of privacy, surveillance, and violation of civil rights on an unprecendented scale. If policy decisions are made to proceed with such systems, then careful attention will need to be paid to the safeguards required to keep such systems from leading to morally repugnant systems of social control.

C. Facilitating Trade

One example of the use of computer/telecommunication technology to facilitate trade is the Canadian Organization for the Simplification of Trade Procedures (COSTPRO). The 1974 COSTPRO president's report comments that their initial work offers its users up to 70 per cent reduction in paperwork costs associated with Canadian exports. It reports that unnecessary delays due to documentation and procedures occur on 20 to 25 per cent of all shipments, that a reduction in total transaction time of one day could produce savings in interest on capital invested in excess of $10 million per year, and that elimination of one particular document could alone save $80 million each year.

At every level of trade from large scale international import-export trade to local retail trade there are likely to be opportunities for improving the efficiency of trade. Economic theorists agree that markets operate better when buyers and sellers have complete information. Absence of information is considered a serious market imperfection that results in a less than optimum result overall. Government intervention may be required to facilitate orderly and honest development of market information and brokerage services based on new information technology. Policies that encourage appropriate information standards, interconnection of communication hardware, access of service vendors to hardware networks, and cooperative directories of services may be desirable. Some waiver of anti-trust laws or government participation may be needed to permit the industry cooperation essential to common information directory and brokerage services.

D. Consumer Information

A logical extension of systems to improve funds transfer and facilitate trade would be consumer information systems. Even though some individual manufacturers might oppose the extension of the consumer movement to include accurate product and price information made readily available to most consumers, nevertheless, the industry and the economy as a whole are likely to benefit from such services, as will individual consumers. Computer terminals available in libraries or other public places providing access to up-to-date on-line directories of products and services available for consumers could prove to be a valuable social service.

E. Public Administration

The business of government is largely information processing and decision-making. Use of computer communication techniques may be the best

hope for improved efficiency and productivity in government. OECD has already devoted special effort to studying this issue and has reported on it in the recent document "Automated Information Management in Public Administration." (OECD, 1973). Education and government are the two largest components within the information sector of post-industrial societies. If our societies are not to stagnate economically, these components of our economies must find a way to avoid inflationary increases in the unit costs of the public services provided. Technology will not provide a panacea and transition problems will be difficult. The prime potential of the new technology might not be in cost reductions for existing services, but in the rational reorganization of bureaucracies that may become politically possible at a time of adapting to new technologies.

F. Teleconferencing

U. S. experience has shown that fully switched point to point two-way video service is still extremely expensive and, in the opinion of most potential customers, not worth the cost. Nevertheless, there are more reasonable alternatives to videophones for teleconferencing applications. The most promising alternative is a capability providing a combination of voice and data capability for group conferences. Such capabilities are unlikely to substitute for face-to-face meetings that occur infrequently and in which one of the purposes is for participants to meet and get to know each other better. But for more frequently occurring conferences (e.g., weekly or monthly sales meetings) among people who already know each other, the demand for such services, if offered, is likely to be great because of the potential savings in travel time and costs.

Telephone conference calls of the sort now available are unsatisfactory for a variety of reasons. The prime disadvantage of telephone conferences over face-to-face conferences is the lack of a parallel scheduling channel for signals to and from the chairman concurrently with the primary discussion. In face-to-face conferences this usually goes on through visual signals or passing of written messages that do not interrupt the flow of conversation. With a computer communications channel parallelling the voice channel, a variety of control and signalling messages as well as drafts of documents being discussed can be distributed to some or all participants in the conference. For such a teleconferencing system to work smoothly, it will require an automatic dialing capability that doesn't require telephone operator intervention and that permits participants to dial additional potential participants while the conference is in progress.

G. Health

Health care, except for surgery and physical therapy, is largely an information processing activity in which the health care provider obtains information from the patient to arrive at a diagnosis and treatment plan based on his store of information about diseases and their treatment. Medical information systems can facilitate many parts of this process. Examples include: automated patient record systems, on-line access by providers to medical research literature, drug information (including side-effects and interaction with other drugs), poison information, tele-consultation between patients and providers geographically distant from one another, etc.

A promising potential application may be in the area of preventive

community medicine. Many of our serious medical problems (e.g., heart disease and cancer) stem from our diets, our smoking and our lack of appropriate exercise. A community based nutrition information system which allowed each resident access (probably via a human interpreter at the end of a telephone) to nutrition information in a form relevant to his or her shopping, menu planning, and recipe decisions could make a significant difference to the level of health. A recent study in California has demonstrated that an intensive public information campaign can reduce the incidence of heart disease through triggering changes in diet, exercise and smoking behavior, that result in measurable differences in levels of cholesterol and triglicerides in a random sample of community residents. Savings in total health care costs and savings to insurance companies that result from increased life spans might be sufficient to economically justify a sizeable share of the costs of continuing public information services concerning health and nutrition.

For example, computers could store general nutrition information at a level more detailed than a dietician would normally try to explain in a face-to-face consultation. That information could be applied to a variety of recipes designed for different health goals (e.g., weight loss, reduction of cholesterol), different food budgets, and different taste pereferences. Local availability and prices for ingredients could be included in the information system so that recipes and menus are in fact responsive to current local availability and costs. If desired, individual medical records and the results of a food preference questionnaire could be included in the information system and taken into account in the resulting advice.

Local users could telephone a local nutrition information number, reaching a clerk who could conduct the on-line computer search necessary to retrieve the relevant information. The savings to the consumer resulting from more economical food shopping may be a major source of motivation to use such a system. In some ways, such a consumer-oriented health information system could be viewed as one segment of a larger consumer information system.

Conclusions

In conclusion I would like to suggest a few policy questions that I think should be considered in the light of the structural change our economies are going through and in the light of changes in computer and telecommunications technology.

A. Research and policy analysis

The first conclusion points to the need for research and policy analysis of the kinds of questions and hypotheses raised in this paper. The data presented here are crude first approximations that are descriptively consistent with the hypothesis of structural change. What is needed now is a program of economic research that develops, refines and validates new indicators of economic statistics appropriate to an information economy so we can better understand what is happening.

The now standard industrial economic indicator, Gross National Product (GNP) was introduced in the late 1940s just before the peak of the industrial age in 1950. New economic indicators and statistics appropriate to the policy problems of the information age should be devised and implemented now so that policy makers can better understand current economic trends.

Once the descriptive indicators are sharpened, and appropriate basic economic data have been tabulated, then a series of economic input-output analyses should be conducted to measure the relationship of the information sector of the economy to other sectors. For example, input-output analysis could determine the structural depth of the information sector to see, if, as I predict, it is of sufficient depth that changes there will reverberate through the entire economy. Secondly, looking at the input-output relationship between the information sector and other sectors (e.g. energy) could determine whether it is possible to have major economic growth in the economy as a whole, under the constraint of zero or limited energy growth, through appropriate investments in the information sector. These and other policy questions are open to scientific empirical analysis with presently available economic research tools and techniques. A major program of research along these lines should provide considerable assistance to policy makers trying to chart their way through unfamiliar territory.

B. Infrastructure

The greatest economic potential of computers and communications lies not in the share of the economy devoted to those activities (although it is likely to be large enough to merit attention on that basis alone). Rather, the greatest potential lies in the effects on the rest of the economy. Transportation networks and electric utilities provide a basic infrastructure permitting the economic development of new geographic regions, the development of new industries and services, and permitting the goods and services of one region to be accessible in another. Similarly, computer-communication facilities now being discussed, but not yet constructed, could serve as basic infrastructure for information economies.

If the social and economic benefits of the information society are to be achieved, then policies for development of an appropriate infrastructure need to be articulated and implemented. The applications discussed above are examples of a wide new range of information services that are developed once the infrastructure is there to permit the services to be implemented. It makes a great difference to the economic development of a country whether a communication network (or new nodes on the network) are treated as essential infrastructure needed for development or whether it is treated as a consumption or luxury item to be provided only after the demand is great. In the latter case, development will be slow, uneven, and probably inequitably distributed. Social policies designed to stimulate economic growth of the information sector of the economy will require policies that lead to creation of the needed infrastructure, just as government policies and investment support were needed to create railroad, highway, and electric power networks to serve industrial society. Social policy may require that the network be made available everywhere in the nation, not just in the large cities or on the main routes between the largest cities. Communication technologies with costs independent of distance may make such policy choices easier than physical transportation networks for which costs are a function of distance.

My conclusion is not to recommend a specific set of policies with respect to the development of computer-communications infrastructure. Instead, it is a conclusion that the policy decisions concerning such development (or postponement of development) should be made as a major national economic policy decision, not as a minor decision to be made within a telecommunications administration or a monopoly common carrier.

C. Research and Development

The peculiar economic nature of information makes it unlikely that the private sector of our economies will automatically generate optimal (i.e., economically efficient) amounts of capital for research and development of new services. The problem is analogous to the reasons behind the institution of copyright and patent laws and the reasons why governments already supply most of the basic research funds in a society. Given the kinds of economic systems we have, there is insufficient incentive for private expenditure on research and development of information services. Therefore, government research policies should be carefully examined to see if appropriate investments are being made in the kinds of research, development and demonstration projects needed to achieve productivity gains in the information sector of our economies.

D. Network Interconnection

Much of the economic and social potential of the new services we have been discussing will be dissipated if each service is developed on a private or leased line computer network or if it is dependent on telephone networks as they are now structured.

Use of line switching techniques suitable for telephone conversations will be economically inefficient for time-shared data transmission which the kind of long hold-times and long silences involved. A time-shared digital data network with redundant channels and error-checking procedures will be required. Even if the transmission lines use analog techniques, packet-switching techniques could be used for digital communication.

If each new service is developed on a separate computer network or series of disconnected networks, then most of the benefit will be lost because only those services with sufficient economic potential to justify their own network will appear. On the other hand, if a single generalized network or network interconnection system is required, then many new information services can be developed that require only a small portion of the network capability.

Since there is likely to be continued technological change in the area of computer communication, a more modular approach to multiple interconnected networks with common interconnection standards and a payments clearinghouse mechanism may be preferable to a monolithic single network, which would have a tendency to stifle technical innovation.

E. Access

The single most critical policy question concerns rights of access to information networks for both the transmission and the receipt of information. Individuals and groups within the society may find it in their narrow interest to restrict access. In the interests of economic growth and of social equity, principles of freedom of access to information networks need to be established. Information networks have common carrier and public utility characteristics similar to other common carriers or public utilities. The information networks of the information society will have to be open to all if the potential social benefits are to be achieved.

Monopoly ownership of the hardware facilities does not preclude open access to the facility for transmission of messages. Just as telephones can be available for people to speak what they wish, so other parts of the computer and communications infrastructure must be accessible. If those

owning or operating the hardware facilities of the information society are able to restrict access on the basis of selfish political or economic motives, then it would be better not to construct such facilities at all. Unless principles of open access to the information facilities are firmly established at the outset, then the path of development of such facilities is the path toward the worst features of Orwell's 1984. If the control is vested in the hands of commercial operators, then the results could be as bad as or worse than the society depicted by Orwell. The issue is not who owns or operates the hardware facilities. The issue is whether the facilities, however owned, are in fact accessible for use by all members of the society.

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Appendix A

THE LABOR FORCE AGGREGATION SCHEME

The aggregation scheme presented below formed the basis of Figures 1-4 in the paper. The category names are those used by the U. S. Bureau of Labor Statistics.*

The basic four-sector aggregation scheme divides the workforce into: (i) information workers (ii) industry workers (iii) services workers and (iv) agriculture workers.

The table contains a simple legend between the name and the number employed in these occupations in 1970. Figure 1 in the paper shows three sectors only (agriculture, industry and services). A "letter" in the space following the name indicates that, when the four sector scheme is collapsed into a three sector scheme, the labor type in question is shifted, as follows:

s indicates a shift into the service sector

i " " " " " industry "

a " " " " " agriculture "

Also, we use the asterisk * to indicate that under liberal assumption (see text, and figure 4 in particular), the worker would be classified into the information sector; but under the prevailing conservative assumptions, the worker was not so classified.

All data are for 1970, taken from BLS publications.**

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*For full definitions of the labor types, including description of the work, see Bureau of Labor Statistics (BLS) Handbook of Occupational Types, Volumes I and II, Government Printing Office, Washington D. C.

**These are based in turn, on the U. S. Census "Industry by Occupation" Special Report, 1970 Census. Available through the Government Printing Office, Washington D.C.

INFORMATION SECTOR OCCUPATIONS

Occupational Type	Legend	1970 Emp't
AUTHORS	s	26,003
EDITORS AND REPORTERS	s	149,998
PROOFREADERS	s	26,999
RADIO, TV ANNOUNCERS	s	21,000
WRITERS, ARTISTS, ENTERTAIN	s	70,004
LIBRARIANS	s	115,003
LIBRARY ATTENDANTS, ASSISTANT	s	120,008
POSTMASTERS AND MAIL SUPER	s	34,999
NEWSBOYS	s	71,997
MAIL CARRIERS, POST OFFICE	s	267,995
POSTAL CLERKS	s	314,995
TELEGRAPH MESSENGERS	s	2,500
TELEGRAPH OPERATORS	s	12,000
TELEPHONE OPERATORS	s	388,008
ENGINEERS, AERO-ASTRONAUTIC	s	60,999
ENGINEERS, CHEMICAL	s	49,999
ENGINEERS, CIVIL	s	167,003
ENGINEERS, ELECTRICAL	s	280,997
ENGINEERS, INDUSTRIAL	s	159,006
ENGINEERS, MECHANICAL	s	184,995
ENGINEERS, METALLURGICAL	s	15,003
ENGINEERS, MINING	s	5,001
ENGINEERS, PETROLEUM	s	12,000
ENGINEERS, SALES	s	38,998
ENGINEERS, OTHER	s	130,005
AGRICULTURAL SCIENTISTS	s	13,001
ATMOSPHERIC, SPACE SCIENTISTS	s	6,000
BIOLOGICAL SCIENTISTS	s	29,003
CHEMISTS	s	109,004
GEOLOGISTS	s	24,001
MARINE SCIENTISTS	s	3,001
PHYSICISTS AND ASTRONOMERS	s	21,002
LIFE, PHYSICAL SCIENTISTS	s	2,001
ACTUARIES	s	5,000
MATHEMATICIANS	s	8,001
STATISTICIANS	s	21,003
DRAFTSMEN	s	316,007
SURVEYORS	s	59,001
RADIO OPERATORS	s	30,001
TOOL PROGRAMMERS, NUMERICAL	s	3,002
COMPUTER PROGRAMMERS	s	176,506
COMPUTER SYSTEMS ANALYSTS	s	88,103
OTHER COMPUTER SPECIALISTS	s	14,601
ECONOMISTS	s	66,006
POLITICAL SCIENTISTS	s	1,900
PSYCHOLOGISTS	s	30,002
SOCIOLOGISTS	s	1,303
URBAN AND REGIONAL PLANNERS	s	9,000
OTHER SOCIAL SCIENTISTS	s	7,000
ADULT EDUCATION TEACHERS	s	58,003
AGRICULTURE TEACHERS	s	5,000
ART, DRAMA, MUSIC TEACHERS	s	30,001
ATMOSPHERIC, EARTH, MARINE	s	4,500
BIOLOGY TEACHERS	s	21,000
BUSINESS, COMMERCE TEACHERS	s	14,000
CHEMISTRY TEACHERS	s	16,000
ECONOMIC TEACHERS	s	10,000
EDUCATION TEACHERS	s	7,200
ELEMENTARY SCHOOL TEACHERS	s	1,400,040
ENGINEERING TEACHERS	s	17,000
ENGLISH TEACHERS	s	39,001
FOREIGN LANGUAGE TEACHERS	s	20,700
HEALTH SPECIALTIES TEACHERS	s	28,000
HISTORY TEACHERS	s	16,000
HOME ECONOMICS TEACHERS	s	4,200
LAW TEACHERS	s	2,900
MATHEMATICS TEACHERS	s	26,000
PHYSICS TEACHERS	s	14,000
PRESCHOOL, KINDERGARTEN	s	133,004
PSYCHOLOGY TEACHERS	s	13,000
SECONDARY SCHOOL TEACHERS	s	1,037,029
SOCIOLOGY TEACHERS	s	7,000
SOCIAL SCIENCE TEACHERS	s	12,000
MISC COLLEGE AND UNIVERSITY	s	19,000
COLLEGE, UNIVERSITY	s	148,004
THEOLOGY TEACHERS	s	5,000
TRADE, INDUSTRIAL TEACHERS	s	3,000
TEACHERS, EXC COLL, UNIVERSITY	s	209,912
PHOTOGRAPHERS	s	70,196
PUBLIC RELATIONS MEN, WRITERS	s	82,007
ACCOUNTANTS	s	686,015
ARCHITECTS	s	62,002
ARCHIVISTS AND CURATORS	s	6,002
HOME MANAGEMENT ADVISORS	s	5,202

INFORMATION SECTOR OCCUPATIONS (cont.)

Occupational Type	Legend	1970 Emp't
JUDGES	s	13,700
LAWYERS	s	287,013
OPERATIONS, SYSTEMS RESEARCH	s	79,005
PERSONNEL LABOR RELATIONS	s	286,011
RESEARCH WORKERS	s	115,004
SOCIAL WORKERS	s	230,007
VOCATIONAL, ED COUNSELORS	s	112,003
BANK, FINANCIAL MANAGERS	s	398,010
CREDITMEN	s	67,998
BUYERS, SHIPPERS, FARM PROD	s	24,999
BUYERS, WHOLESALE, RETAIL	s	154,998
PURCHASING AGENTS, BUYERS	s	175,006
SALES MANAGER, RETAIL TRADE	s	274,997
SALES MANAGER, EXC RET TRADE	s	263,999
ASSESS, CONTROL, LOC PUB ADMIN	s	30,001
CONSTRUCTION INSPECTOR, PUB	s	21,000
HEALTH ADMINISTRATORS	s	100,003
INSPECTORS, EXC CONSTRUCT PUB	s	89,002
OFFICIALS, ADMINS, PUB	s	263,007
SCHOOL ADMIN, COLLEGE	s	40,002
SCHOOL ADMIN, ELEM, SECONDARY	s	174,004
OFFICE MANAGERS	s	288,007
ADVERTISING AGENTS, SALESMEN	s	63,501
INSURANCE AGENTS, BROKERS, ETC	s	412,007
REAL ESTATE AGENTS, BROKERS	s	316,008
STOCK AND BOND SALESMEN	s	101,802
SALES REPRES, MFG	s	393,992
SALES REPRES, WHOLESALE TRADE	s	634,991
SECRETARIES, LEGAL	s	104,004
SECRETARIES, MEDICAL	s	79,003
SECRETARIES, OTHER	s	2,602,050
STENOGRAPHERS	s	128,005
TYPISTS	s	973,021
BOOKKEEPING, BILLING OPERATORS	s	68,504
CALCULATING MACHINE OPERATORS	s	33,996
COMPUTER, PERIPHERAL EQUIP	s	150,005
DUPLICATING MACHINE OPERATORS	s	19,007
KEYPUNCH OPERATORS	s	300,006
TABULATING MACHINE OPERATORS	s	9,003
OTHER OFFICE MACHINE OPS	s	52,004
BANK TELLERS	s	287,007
BILLING CLERKS	s	123,009
BOOKKEEPERS	s	1,540,027
CASHIERS	s	968,994
CLERICAL ASSIST, SOC WELFARE	s	1,501
CLERICAL SUPERVISORS	s	192,005
COLLECTORS, BILL AND ACCOUNT	s	60,002
DISPATCHER, STARTER, VEHICLE	s	63,999
ENUMERATORS AND INTERVIEWERS	s	65,002
ESTIMATORS, INVESTIGATORS	s	329,007
EXPEDITORS, PROD CONTROLLERS	s	199,995
FILE CLERKS	s	270,009
INSURANCE ADJUST, EXAM	s	105,002
MAIL HANDLER, EXC POST OFFICE	s	130,006
MESSENGERS AND OFFICE BOYS	s	56,004
METER READERS, UTILITIES	s	36,999
PAYROLL, TIME KEEPING CLERKS	s	175,013
REAL ESTATE APPRAISERS	s	24,001
RECEPTIONISTS	s	423,019
SHIPPING, RECEIVING CLERKS	s	437,991
STATISTICAL CLERKS	s	291,006
TEACHERS AIDES, EXC MONITORS	s	150,004
TICKET STATION, EXPRESS AGENTS	s	94,001
WEIGHERS	s	45,996
SIGN PAINTERS AND LETTERS	i	20,001
HEALTH RECORD TECHNOL, TECH	s	12,300
OTHER MGRS, ADMINISTRATORS	s	4,343,956
AUCTIONEERS	s	5,499
PHOTOGRAPHIC PROCESS WORKERS	i	68,999
DATA PROCESSING MACH REPAIR	i	36,001
OFFICE MACHINE REPAIRMEN	i	64,499
RADIO, TELEVISION REPAIRMEN	i	137,002
BOOKBINDERS	i	32,000
COMPOSITORS AND TYPESETTERS	i	169,997
ELECTROTYPERS, STEREOTYPERS	i	7,000
ENGRAVERS, EXC PHOTOENGRAVERS	i	9,297
PHOTOENGRAVERS, LITHOGRAPHERS	i	33,500
PRESSMEN AND PLATE PRINTERS	i	138,998
PRESSMEN APPREN	i	2,800
PRINTING APPREN, EXC PRESS	i	6,000
TELEPHONE INSTALLERS, REPAIRMEN	i	280,004
TELEPHONE LINEMEN, SPLICERS	i	52,001
MOTION PICTURE PROJECTIONISTS	i	16,000

INDUSTRY SECTOR OCCUPATIONS

Occupational Type	Legend	1970 Emp't
CARPENTERS		984,985
CARPENTERS APPRENTICES		8,900
BRICKMASONS AND STONEMASONS		171,997
BRICK, STONEMASON APPREN		4,499
BULLDOZER OPERATORS		99,998
CEMENT AND CONCRETE FINISHERS		64,999
ELECTRICIANS		449,993
ELECTRICIANS APPREN		21,300
EXCAVATING, GRADING, MACH OPS		279,995
FLOOR LAYERS, EXC TILE SETTERS		23,499
PAINTERS, CONTRUCTION, MAINT		399,995
PAINTER APPREN		1,600
PAPERHANGERS		10,000
PLASTERERS		28,000
PLASTERER APPREN		500
PLUMBERS AND PIPEFITTERS		354,995
PLUMBERS, PIPEFITTERS APPREN		14,000
ROOFER AND SLATERS		62,998
STRUCTURAL METAL CRAFT		78,999
TILESETTERS		31,999
BLACKSMITHS		9,999
BOILERMAKERS		29,998
HEAT TREATERS, ANNEALERS, ETC		22,997
FORGEMEN AND HAMMERMEN		17,999
JOB AND DIE SETTERS, METAL		99,997
MACHINISTS		360,992
MACHINIST APPREN		9,998
MILLWRIGHTS		80,997
MOLDERS, METAL		54,999
MOLDERS APPREN		799
PATTERN AND MODEL MAKERS		41,996
ROLLERS AND FINISHERS, METAL		23,000
SHEET METAL WORKERS, TINSMITHS		154,996
SHEET METAL APPREN		5,999
TOOL, DIEMAKERS		167,996
TOOL, DIEMAKER APPREN		9,999
AIR COND, HEATING, REFRIG		129,998
AIRCRAFTS		119,999
AUTO ACCESSORIES INSTALLERS		5,998
AUTO BODY REPAIRMEN		158,997
AUTO MECHANICS		836,985
AUTO MECHANICS APPREN		2,599
FARM IMPLEMENT		46,300
HEAVY EQUIP MECH, INCL DEISEL		686,987
HOUSEHOLD APPLIANCE MECHANICS		119,999
LOOM FIXERS		18,000
RAILROAD, CAR SHOP REPAIRMEN		53,999
MECHANICS EXC AUTO APPREN		7,007
OTHER MECHNICS AND REPAIRMEN		224,004
ELECTRIC POWER LINEMEN		100,002
LOCOMOTIVE ENGINEERS		37,500
LOCOMOTIVE FIREMEN		18,000
POWER STATION OPERATORS		17,301
BAKERS		124,998
CABINETMAKERS		74,996
CARPET INSTALLERS		46,999
CRANEMEN, DERRICKMEN, HOISTMEN		169,993
DECORATORS, WINDOW DRESSERS		69,998
DENTAL LABORATORY TECH		30,001
FURNITURE AND WOOD FINISH		22,999
FURRIERS		2,599
GLAZIERS		24,999
INSPECTORS, LOG AND LUMBER		17,000
INSPECTORS, OTHER		128,002
JEWELERS AND WATCHMAKERS		41,498
MILLERS, GRAIN, FLOUR, FEED		8,800
PIANO, ORGAN TUNERS, REPAIRMEN		7,000
SHIPFITTERS		11,000
SHOE REPAIRMEN		30,998
STATIONARY ENGINEERS		178,006
STONE CUTTERS, STONE CARVERS		7,000
TAILORS		67,997
UPHOLSTERERS		67,998
CRAFTSMEN, KINDRED WORKERS		79,997
FORMER ARMED FORCES MEMBERS		500
CRAFT APPREN		10,698
DRILL PRESS OPERATIVES		75,998
FURNACEMEN, SMELTERMEN, POURERS		74,399
GRINDING MACHINE OPERATIVES		144,998
HEATERS, METAL		7,499

INDUSTRY SECTOR OCCUPATIONS (cont.)

Occupational Type	Legend	1970 Emp't
LATHE, MILLING MACH OPERATIVES		154,997
METAL PLATERS		35,999
OTHER PRECISION MACH OPR		76,499
PUNCH STAMPING PRESS OPR		179,995
SOLDERERS		42,399
WELDERS AND FLAME CUTTERS		537,992
CARDING, LAPPING, COMBING		17,800
KNITTERS, LOOPERS, AND TOPPERS		34,599
SPINNERS, TWISTERS, WINDERS		149,996
WEAVERS		45,999
OTHER TEXTILE OPERATIVES		189,994
CHECKERS, EXAMINERS, ETC, MFG		689,989
GRADERS AND SORTERS, MFG		45,298
MEAT WRAPPERS, RETAIL TRADE		46,500
PACKER, EX MEAT, PRODUCE		648,984
PROD GRDR, PACKER		25,400
ASBESTOS, INSULATION WORKERS		27,000
ASSEMBLERS		943,982
BLASTERS AND POWDERMEN		7,099
BOTTLING, CANNING OPERATIVES		59,997
CHAINMEN, RODMEN, SURVEYING		11,001
CLOTHING IRONERS AND PRESSERS		199,998
CUTTING OPERATIVES		238,992
DRESSMAKER, SEAMSTRESS		109,998
DRILLERS, EARTH		57,498
DRY WALL INSTALLERS, LATHES		47,000
DYERS		27,998
MISC MACH OPERATIVES		1,306,970
OPERATIVES		1,131,381

SERVICE SECTOR OCCUPATIONS

Occupational Type	Legend	1970 Emp't
BOATMEN AND CANALMEN		5,999
BUS DRIVERS		228,999
CONDUCTORS, MOTORMEN, RAIL		8,400
DELIVERY AND ROUTEMEN		816,987
FORK LIFT, TWO MOTOR OPR		280,992
MOTORMEN, MINE, FACT, LOGGING		10,000
PARKING ATTENDANTS		30,500
RAILROAD BRAKEMEN		48,999
RAILROAD SWITCHMEN		52,999
TAXICAB DRIVERS, CHAUFFEURS		150,009
TRUCK DRIVERS		1,377,976
CHAMBERMAID, MAID, EXC PRIV		218,505
CLEANERS AND CHARWOMEN		611,016
JANITORS AND SEXTONS		1,163,028
BARTENDERS		189,004
BUSBOYS		110,003
COOKS, EXC PRIVATE		821,019
DISHWASHERS		207,005
FOOD COUNTER, FOUNTAIN WORKERS		282,007
WAITERS		1,096,023
FOOD WORKERS, EXC PRIVATE		389,010
DENTAL ASSISTANTS		100,007
HEALTH AIDES, EXCEPT NURSING		133,004
HEALTH TRAINEES		19,000
LAY MIDWIVES		801
NURSES AIDES, ORDERLIES		834,026
PRACTICAL NURSES		370,013
AIRLINE STEWARDESSES		34,200
ATTEN, RECREATION, AMUSEMENT		80,002
ATTEN, PERSONAL SERVICE		61,996
BAGGAGE PORTERS AND BELLHOPS		21,000
BARBERS		157,998
BOARDING, LODGING HOUSEKEEPERS		9,600
BOOTBLACKS		3,199
CHILD CARE WORKERS		339,009
ELEVATOR OPERATORS		39,001
HAIRDRESSERS, COSMETOLOGISTS		479,999
HOUSEKEEPERS, EXC PRIVATE		111,003
PERSONAL SERVICE APPREN		1,000
SCHOOL MONITORS		26,501
USHERS, RECREATION, AMUSEMENT		16,300
WELFARE SERVICE AIDES	*	18,001
CROSSING GUARD, BRIDGETENDERS		46,001
FIREMEN, FIRE PROTECTION		181,004
GUARDS AND WATCHMEN		386,014
MARSHALS AND CONSTABLES		5,900
POLICEMEN AND DETECTIVES		388,011
SHERIFFS AND BAILIFFS		40,001
CHILD CARE WORKERS		517,015
COOKS, PRIVATE		36,001
HOUSEKEEPERS, PRIVATE		107,003
LAUNDRESSES, PRIVATE		12,000
MAIDS, SERVANTS, PRIVATE		696,020
ANIMAL CARETAKERS, EXC FARM		71,002
CARPENTERS, HELPERS		116,998
CONSTR LABOR		804,987
FISHERMEN AND OYSTERMEN		33,985
FREIGHT, MATERIAL HANDLERS		747,983
GARBAGE COLLECTORS		83,999
GARDENRS, GROUNDKEEPR, EXC FARM		537,016
LONGSHOREMEN AND STEVEDORES		55,996
LUMBERMEN, WOODCHOPPERS		81,997
STOCK HANDLERS		717,993
TEAMSTERS		6,999
VEHICLE WASHR, EQUIP CLEANERS		175,997
WAREHOUSEMEN		149,007
OTHER LABORERS		590,993
CHIROPRACTORS		16,026
DENTISTS		94,111
DIETITIANS	*	30,001
OPTOMETRISTS		18,003
PHARMACISTS		128,798
PHYSICIANS, MD OSTEOPATHS	*	289,810
PODIATRISTS		7,001
REGISTERED NURSES	*	680,021
THERAPISTS		81,603
VETERINARIANS		22,601
OTHER MEDICAL AND HEALTH		1,000
CLINICAL LAB TECHNOL, TECH		130,004
DENTAL HYGIENISTS		16,001

SERVICE SECTOR OCCUPATIONS (cont.)

Occupational Type	Legend	1970 Emp't
RADIOLOGIC TECHNOL, TECH	*	52,002
THERAPY ASSISTANTS		3,501
OTHER HEALTH TECHNOL, TECH		60,003
AIRPLANE PILOTS		49,000
AIR TRAFFIC CONTROLLERS	*	25,001
EMBALMERS		5,000
ACTORS		10,700
ATHLETES AND KINDRED WORKERS		55,702
DANCERS		6,000
DESIGNERS	*	119,997
MUSICIANS AND COMPOSERS	*	105,002
PAINTERS AND SCULPTORS		105,004
FUNERAL DIRECTORS		39,998
OFFICRS, PILOTS, PURSERS, SHIP	*	31,997
OFFICIALS OF LODGES, UNIONS		65,002
RAILROAD CONDUCTORS	*	39,999
RESTAURANT, CAFE, BAR MGRS		463,001
DEMONSTRATORS	*	54,996
HUCKSTERS AND PEDDLERS	*	209,998
OPTICIANS, LENS GRINDR, POLISHR		27,000

Occupational Type	Legend	1970 Emp't
AGRI, BIOLOG TECH EXC HEALTH		36,002
CHEMICAL TECHNICIANS	*	76,998
ELECTRICAL, ELECTRONIC TECH	*	154,002
INDUSTRIAL ENGINEERING TECH	*	20,004
MATHEMATICAL TECHN	*	1,001
MECHANICAL ENGINEERING TECH	*	12,002
ENGINEERING, SCIENCE TECH	*	190,008
FLIGHT ENGINEERS		6,000
OTHER TECHNICIANS EXC HEALTH	*	37,003
COACHES, PHYS ED TEACHERS	*	17,000
CLERGYMEN		228,006
RELIGIOUS, EXC CLERGYMEN		43,001
RECREATION WORKERS		60,002
MGRS, SUPERINTENDANTS, BLDG		100,002
SALES CLERKS, RETAIL TRADE		2,189,973
SALESMEN, RETAIL TRADE	*	406,993
SALESMEN, SERV AND CONSTR	*	151,195
COUNTER CLERKS, EXC FOOD	*	308,998
STOCK CLERKS, STORE KEEPERS	*	495,998
MISC CLERICAL WORKERS	*	1,206,525

AGRICULTURE SECTOR OCCUPATIONS

Occupational Type	Legend	1970 Emp't	Occupational Type	Legend	1970 Emp't
FARMERS (OWNERS AND TENANTS)		1,690,003	FARM LABORERS, UNPAID FAMILY		474,001
FARM MANAGERS		33,000	FARM LABORERS, SELF-EMPL		4,000
FARM FOREMEN		31,000	FARM MANGEMENT ADVISORS	*	7,000
FARM LABORERS, WAGE WRKRS		897,013	FORESTERS, CONSERVATIONISTS		43,002

APPENDIX B

Supporting Data for Figure 1

Figure 1: PROPORTION OF U. S. LABOR FORCE IN THREE SECTORS

	AGRICULTURE	INDUSTRY	SERVICES
1860	-	-	-
1900	.35	.36	.29
1940	-	-	-
1950	.12	.62	.26
1960	.06	.57	.37
1970	-	-	-
1980	.02	.38	.60

Supporting Data for Figure 2

Figure 2 : PROPORTION OF U. S. LABOR FORCE IN FOUR SECTORS

	INFORMATION	AGRICULTURE	SERVICES	INDUSTRY
1860	.05	-	-	-
1900	.10	.35	.19	.36
1940	-	-	-	-
1950	.16	.12	.10	.62
1960	.27	.06	.10	.57
1970	.48	-	-	-
1980	.51	.02	.09	.38

Supporting Data for Figure 3

FIGURE 3: PROPORTION OF U. S. LABOR FORCE IN INFORMATION OCCUPATIONS

	INFORMATION	NON-INFORMATION
1860	.05	.95
1900	.10	.90
1910	-	-
1920	-	-
1930	-	-
1940	-	-
1950	.16	.84
1960	.27	.73
1970	.48	.52
1980	.51	.49

Supporting Data for Figure 4

FIGURE 4: PROPORTION OF U. S. LABOR FORCE IN INFORMATON OCCUPATIONS

(High and Low Estimates, 1960-1980)

		INFORMATION	NON-INFORMATION
1960	(lo)	.21	.79
	(hi)	.27	.73
1970	(lo)	.44	.55
	(hi)	.48	.52
1980	(lo)	.48	.52
	(hi)	.51	.49