A VIEW OF THE 1980'S

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VERSION 3

"To make knowledge work productive will be the great management task of this century just as to make manual work productive was the great management task of the last century. The gap between knowledge work that is managed for productivity and knowledge work that is left unmanaged is probably a great deal wider than was the tremendous difference between manual work before and after the introduction of scientific management."

Peter Drucker, The Age of Discontinuity, Harper & Row, 1969, p.290.

"Industrialism produced a new man--one adapted to the demands of the machine. In contrast, today's emerging consciousness seeks a new knowledge of what it means to be human, in order that the machine, having been built, may now be turned to human ends; in order that man once more can become a creative force, reviewing and creating his own life and thus giving life back to his society."

Charles A. Reich, The Greening of America, Random House, 1970, p.4.

SCOPE OF ANALYSIS

Much that is described herein is based on trends that have evolved in the U.S. economy during the 1960's. Since Xerox is aiming to become a multi-national organization, the question of relevancy of the U.S.A. experience needs to be raised right from the beginning. It seems safe to proceed under the assumption that the existing two to eight year technology lags between the economies of U.S.A., the principal European countries, and Japan will be reduced so that trends observed in the U.S. can be extrapolated to other advanced industrial nations. Since these nations right now represent almost the entire Xerox world market, we will continue this discussion by dealing entirely with opportunities to be found in advanced industrialized countries only. We should realize, however, that emerging during the 1970's will be significant new markets of new industrial nations (Latin America, Middle East, Eastern Europe, etc.) evolving different product needs. A separate assessment forecast should address itself to these environments.

THE U.S. ECONOMY IN THE 1980'S

In projecting our current experiences ten or more years ahead, we must consider that unprecedented social, political, and psychological uncertainties will affect the growth prospects in years to

come. The 1970's contain elements of uncertainty and discontinuity[1] which may accentuate qualitative changes in the mode of our lives in the U.S.A., and possibly in the remainder of the advanced industrial world. This environment then emphasizes the need for long range strategic planning because only through such a process can we consciously evolve alternatives that will make it possible to acquire a sufficient number of options which would be adaptable to rapidly changing needs.

BACKGROUND OF GROWTH TRENDS

Between 1955 and 1968, real gross national product in the U.S.A. increased by 3.8% per year.[2] (Common market growth averaged 6%; Japan, 12%.) Forecasters have extrapolated the growth rate of the last decade to arrive at a 1980 GNP approaching $1,935 billion in the U.S.A.[3] and corresponding extrapolated figures for other industrial societies.

We do have to question these extrapolations because the two critical components of growth (increases in productivity per man-hour and in the total number of people in the labor force) on which past growth has been based and on which all future forecasts

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[1]An excellent treatment of these elements can be found in a current (1971) multi-part series of articles in FORTUNE Magazine, "The U.S. Economy in an Age of Uncertainty."

[2]See Exhibit E.14.

[3]See Exhibit E.15.

ultimately rest[4] can be expected to depart from their long-term trends of the last two decades.

For instance, since 1968 the productivity growth in the U.S.A. private economy has averaged only about 1.6% a year, which is less than one-half of the long-term trend. The projected real economic growth (as measured in constant dollars) for 1970 will be actually close to zero, which is due to a combination of continued low productivity per man-hour and a shrinkage in the labor force growth rate. Yet, to achieve our growth objectives, it will be essential actually to improve our long-term productivity, as measured in GNP/CAPITA, above our experience when the U.S. economy grew the fastest (during 1948-55.)[5] From the standpoint of current events, it is indeed hard to see how these objectives can be attained.

There are many new political, cultural, ethnic, and attitudinal reasons underlying the relative decline in economic growth, and consequently there are many potential exposures that can influence our advanced society. In the long run it will have worldwide consequences. We, at Xerox, should recognize that these trends provide us with unique opportunities to make contributions to society not only in the U.S.A., but also on the global scale, since there is no reason to discern why similar tendencies should not occur in other nations when they approach our stage of industrial development. We will

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[4]See Exhibit E.1 showing the schematic relationship between GNP, Industry Production, Productivity and Employment.

[5]See Exhibit E.14.

also assume that any unique and material contributions to productivity improvements will justify profit margins which otherwise would not become available.

DECLINE IN ECONOMIC PRODUCTIVITY

Even though we have insufficient data to demonstrate (in an econometric[6] sense) the relative contribution of various segments of our work force to overall productivity, Exhibit E.3 illustrates one of the principal factors we have identified in our questioning of continued and extrapolated economic growth rates: the relatively unproductive "white collar" and "service" component of our total work force is becoming the most predominant mode in which people participate in the economy!

Preliminary analysis indicates that the relative growth[7] rates of the various classes of occupational labor also exhibit undesirable trends: the most productive[8] labor element (in agriculture) is declining; highly automated "blue collar" is remaining numerically constant[9] (and hence declining relatively to total labor force growth), whereas the relatively unproductive "white collar" and "services" labor is expanding both absolutely and in its growth rate.

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[6]It is urged that for purposes of long-range planning further studies be made in this field either by devoting the necessary staff time to it or by sponsoring appropriate University Research. Preliminary research indicates that detailed structural information is available only in the agricultural and manufacturing sectors of the economy.

[7]See Exhibit E.4 and E.12 and E.19.

[8]See Exhibit E.11.

[9]See Exhibit E.2 and E.5.

What is even more important than the aggregate numbers is the structural change[10] within each labor category, and specifically within the "white collar" grouping. Even though the estimated 1968 "white collar" employment of 35.5 million far exceeds the total estimated "blue collar" work force of 27.5 million workers, the unskilled "white collar" component[11] is estimated at 12.8 million and expanding rapidly to an estimated number of 17.3 million clerical workers in 1980.

Similarly, the "high growth" Services segment remains almost exclusively an employer of unskilled labor notable for its low productivity and low educational make-up. As a matter of fact, the relatively large output of the nation's universities and colleges is barely adequate to support the demands of the job markets due to growth and replacement, thus leaving the structural divisions within the economy between skilled and unskilled labor not dramatically altered as compared with the late 60's. (See Exhibit E.8 and E.16.)

From a strategic standpoint, we at Xerox must devote significant amounts of attention to the needs of the unskilled, non-production workers for productivity enhancement products since this area is especially suited to the mass economies in production and in global service support which only very few companies are in a position to offer at this point.

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[10] See Exhibit E.12.

[11] Defined as personnel without authority over employees or without authority to commit funds, largely to be found in the "clerical worker" category defined in Exhibit E.13.

Again, inadequate detailed research and information sources exist in this area. Since we are dealing essentially with economic and behavioral problems of human beings operating in offices, schools, factories, etc., it is important that we at Xerox have a much better understanding of these statistical trends so that we could translate economic forecasts into product concepts by means of which our firm could make a productive impact on this environment.

ATTITUDES OF WORK FORCE

It is clear, as noted by Drucker (see page 1) that the problem of making the new numbers of "white collar" and "services" people productive is a formidable one because it confronts us technologically and culturally with a completely new set of tasks of how to organize work. We also have to become increasingly sensitive to the ideas expressed by Reich (see page 2), who suspects that the new jobs cannot be fitted into the pattern which was found to be successful when industrialized production was organized by mechanized means.

The over-riding influence in finding solutions to the problem how to organize the work force for increased productivity cannot be necessarily found in pursuing traditional approaches. The most powerful factor in the next decade will be most likely the dramatic shift in the age distribution of the work population towards the 25-34 old age bracket (see Exhibit E.6 and E.7) who have already demonstrated significant departures in their attitudes towards the generally accepted work ethic.

In a strategic sense this means, however, that a successful innovator and manufacturer of products must be willing (in a cultural sense) to apply much more flexible and innovative product development tactics than tradition and experience may indicate in the short run.

As contrasted with our competitors, management of Xerox believes that it possesses greater strategic and tactical flexibilities than anyone else. Major expected shifts in the attitudes of the work force may thus provide us with unique competitive advantages in the new environment.

THE HUMAN ENVIRONMENT AND PRODUCTIVITY

One of the best understood elements of the "white collar" environment is the relationship between employee turnover and productivity. Even though the average clerical work force turnover is estimated between 25% and 30% per annum,[12] we know of isolated cases of turnover exceeding 50% per annum, particularly where a large number of people are employed in a controlled, well-structured environment such as in mass key-punch installations, or in telephone company operations. We also know that the productivity per unit of labor (as measured in terms of units such as key strokes per hour; number of documents processed; number of inquiries handled) is subject to worker to worker fluctuation exceeding 100%.

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[12]Defined as number of people replaced after one year.

Apart from the cultural (and possibly political) impacts on our society, the current approach to physically concentrating a large segment of our total work force in office environments is increasingly an economical and motivational liability to our overall growth potential.

Short-term productivity increases achieved through standardization and automation (as obtained through automatic processing of punched card unit record documents in mass document handling operations such as in banks, insurance offices, etc.) are offset by dis-economies in other areas (such as in error rates or in frustrating inabilities to process non-standard requests.)

As we project the needs of advanced industrial societies ten to twenty years hence, we can expect that the "white collar" environment will be increasingly receptive to the use of productivity-enhancing devices containing high technology and high capital value, and possessing certain attributes which are especially supportive of the abilities of individuals to enlarge their jobs and thus be of greater economic value.

In the paragraphs that follow, we will discuss the attributes of some of these devices to illustrate how the products of the 1980's would differ from existing products. We have also taken a specific case study (see the attached essay on "The Office of the Future") which illustrates how a large assortment of technological features would cumulatively have impact on the work environment of a highly skilled manager. No radical innovation is necessary to make the fictional aspects of this case study come true--every technology mentioned or implied in this projection can be demonstrated in the

market or laboratory today! As in the case of all prior innovations, the changes in the human environment that will enhance productivity in the next 10-20 years will be evolutionary rather than revolutionary. The speed of progress that will be made will be largely constrained by the capabilities of user organizations to absorb the rate of change (and to finance it) and perhaps--and more importantly--by the presence of a few agressive organizations with the research resources, mass economies of scale in production and market development capabilities of sufficient size to affect the desired structural changes in work environments.

THE WORK STATION AS A COMMUNICATIONS TERMINAL

One of the pervasive characteristics--on a worldwide scale--underlying the growth of "white collar" labor is the systemization of paper-flow in large organizations whether governmental or in private industry. Although much research needs to be done in analyzing the frequency, distribution, and contents of documents, of forms, and of copies throughout the economy, based on available statistics it is becoming apparent that the large government bureau, the large insurance company, the bank, the credit card operation, or the large corporation are the prime sources for generating highly standardized and controlled paper-flows requiring large organized inputs of clerical labor for processing, manipulation, and filing.

The underlying economic force behind this trend is the increasing concentration of production and services in a decreasing number of organizations. It is estimated that perhaps as few as 1,000 organizations may account for more than 75% of the world's GNP.[13]

In contrast with similar paper-flows of the past, the documents that are generated must increasingly fit multi-purpose needs for inter-departmental coordination and must achieve a degree of format and contents standardization on increasing larger scale so as to facilitate the processing of the documents either by machines or by standardized clerical work stations. Thus, during the last twenty years, we have managed to standardize the bank check, airline tickets, certain invoices and receipts, freight bills, etc. in the interest of uniform processing on a national and sometimes international scale. By analogy, we are accomplishing the same standardization as took place during the early 1900's in the production and assembly of standardized machine parts into mass produced industrial goods, when certain components such as screws, bolts, and bearings had to become interchangeable to reduce manufacturing and maintenance costs.

As we project the needs of advanced industrial societies ten to twenty years hence, we cannot pursue this standardization approach along its mechanized analogy. The processes we are

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[13]The trends in concentration of manufacturing capacity, capital investment, and employment are of strategic significance from a marketing standpoint and require further research. See Exhibits E.20 and E.21 for further illustration of this point.

dealing with are information processing experiences where the "product" is completely perishable and ever changing. Hence the current notion of arraying clerks or machines along "work stations" and then "assembling" standard documents into standard outputs contains a fundamental fallacy that information processing or information consumption can be standardized in all of its aspects. It seems that the environment will be increasingly receptive to the consumption of high technology and high capital value devices having some of the following attributes:

A. Capture of Information

Creation of most information today involves large amounts of labor input through operations such as:

- Keying
- Typing
- Transcribing
- Typesetting
- Reproducing and Copying
- Writing and Recording

As a matter of fact, much of the information is created in redundant sequential steps, each requiring a repetitious expenditure of labor such as in the typing, re-typing, typesetting and reproducing sequence. For instance, most of the input into today's technologically advanced computer systems is first written, sometimes transcribed into proper format and only then keyed. Input costs can thus account for as much as 15-20% of total cost for a particular application.

Aside from the costs involved, the manual data capture operation is from a human operator standpoint especially undesirable since it transforms an individual into an automated link within a rigidly defined system.

High technology and high capital value methods for information capture either by direct sensing (mini-computer sensors in processes), or by direct recognition (either optically or through audio methods) become essential elements of the work station of the future. Most importantly, the new work station must have the characteristics of preventing redundant expenditures of labor, by means of the fundamental flexibility of its output medium. It is therefore highly likely that the currently most often used "white collar" work station--the typewriter--will be gradually replaced by a device which captures information in an electronically coded form so that it can be subsequently manipulated much more efficiently into a variety of output formats by more effective electronic methods.

From a strategic standpoint this clearly implies that any major firm wishing to participate in the substitution of technology based capital for inefficient "white collar" labor (which is another way of defining the "architecture of information"), must be able to significantly influence and/or participate in the information capture market segment.

B. Storage of Information

Storage of information today involves a wide diversity of functions such as:

- Filing
- Printing -- books, reference sources
- Libraries
- Encoding on Magnetic Media
- Filming
- Recording on Acoustical or Video Medium

Again, enormous amounts of labor are consumed in these processes which are characterized by redundancies. For example, almost all created information is stored in multiple sources or locations (such as in the case of filing of correspondence.) When one considers the cost of supplies, space occupied, and associated manipulation or coding, we find that in most cases the cost of information storage exceeds the cost of capture of information.

From a human labor standpoint, there is very little "value added" in the storage process itself, especially if the storage activity involves handling masses of paper. Hence in terms of motivation as well as economics, information storage is an especially attractive candidate for electronically automated storage processes whether the storage is digital or optical; analog or binary.

Since a wide variety of technologies known today will permit storage costs of the early 1980's to range from 10^{-5} cents per bit (for 1-10 second access) to 10^{-2} cents per bit (for microsecond access) for digital memories and even lower for optical memories, electronic storage of data ought to emerge clearly as the preferred storage medium for all high-value information during the 1980's,

especially as access constraints (in communications, in terminals, in retrieval logic) become simultaneously removed.

Consequently, strategic placement of Xerox in the electronically accessible information storage technology is a prerequisite for a significant participation in any systems sales.

C. Retrieval of Information

The economics of retrieval of information today is entirely dictated by its storage technology, even though we are just now at the threshold of file-independent information systems in certain advanced computer data bases.

The basic problem of information retrieval in large organizations is being solved today by a combination of schemes, the most prevalent being information broadcasting by means of the copying/reproducing process which is basically deficient in its inability to contribute to the subsequent ease of retrieval or search except by providing for more convenient filing..

Since information retrieval has the highest "value added" from all of the various information manipulation processes and from the standpoint of its automation is most difficult to achieve (since it requires the execution of complex and non-standard functions), its human operator value as in terms of work experience is of the highest order.

The strategic implication for Xerox is then to "architect" its work station products in a manner which facilitates the highest possible degree of human operator intervention and

participation in the retrieval processes--essentially endowing the work station with characteristics of a device suitable for "learning"--rather than imposing a hierarchical or structured query sequence as is currently the case in many primitive inquiry systems.

Incidentally, this strategy gives relief from the extremely costly and ineffective need for heavy software investments which so far have been essential to equip any computer system with a capability to retrieve information from files. This strategy also implies: a need for decentralized file manipulation processors, the availability of communication accesses to multiple files, and the absolute prerequisite for "systems sales" wherein information capture, information storage, and information retrieval technologies can become installed in a modular, evolutionary, and technologically adaptive sequence.

The work station of the 1980's will then act as a communications terminal between people engaged in solving the complex problems of coordinating the logistics of the service industries. This would be made possible by the lowering of the costs of information capture and information storage, thus providing the technological basis for the high payoff interactive retrieval functions. Such work stations will also permit production industries to carry out existing administrative and clerical functions without a need to increase the costs of such staffs, as was not the case during the late 60's. The increased productivity of the remaining staffs will thus aid in the maintenance of profit margins

which otherwise would become eroded even further than indicated by current trends.

The net result of such processes will lead to the gradual altering of the function of the non-skilled clerical worker as well as of certain non-skilled service workers from performing standardized and specialized "assembly line" functions to becoming active and individual participants in the information processing functions themselves. In this fashion, we will be able to provide for our new (and differently motivated generation) workers with a work environment where it is technically possible--and indeed desirable--for each worker to seek an enlargement of his work contents. This is made feasible by the perfectly flexible and asynchronous nature of his work station wherein the worker can, subject to certain agreements with management, instantly enlarge the scope of functions executed, or, instantly extend the range of his tasks. Such an environment had previously existed only during the handi-craft era and had to be eliminated when the discipline of synchronized manufacturing physical processes dictated the establishment of a rigidly controlled work environment.

Whatever has been said above naturally applies already to the work performed by professionals, technical experts, managers, officials, and proprietors. The new technology will also enhance their capability and productivity in:

-- handling inquiries

-- being interpreters of information

-- acting as modifiers in the information processing functions.

In these processes, large amounts of capital and technology will be consumed to meet needs to be discussed further.

DOCUMENT AND FILE CONTROL

While the human needs and productivity requirements make it desirable to evolve new technologies and new devices, the needs of the large organizations (which will have to fund the investments in these technologies) appear to be evolving along parallel paths.

While aggregate clerical turnover figures are extremely high (by "blue collar" standards), they still do not convey the full story in terms of performance reliability at each information processing work station.[14] In addition to the basic turnover probability, there are vacations, absenteeism, work-station shifts, and relief operators. Depending on the nature of the information processing function performed, the probability of having the same work station occupied by the identical worker to process a set of functions requested by one person (such as a given customer) becomes very small indeed. Consequently large organizations find it essential to extend control over all files, documents, correspondence, etc. entering the system since each element of paper becomes increasingly relevant in the ability of

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[14]An industrial "hard goods" product--once assembled from standardized components--has a pre-determined service reliability once we assume a given level of maintenance. The reliability of an information processing system is much more perishable; it depends on human performance at any instance of time.

the organization to respond to external requirements with tolerable reliability.

In projecting needs ten to twenty years ahead, we have to increasingly visualize a hierarchy of information, data and document storage devices that lend themselves to a high degree of centralized procedural control and decentralized inquiry (and manipulation) capability. These devices and high technology equipment components will offer a variety of options to effect a compromise between cost, controlled accessibility, response time to inquiry, operational complexity, and general ease with which the machine will communicate with the human operator in a "tutorial" mode. To illustrate the last point: One of the factors that militate against job enlargement, lead to position specialization and result in cumbersome procedural manuals--all of which are resulting in low productivity--arises from the need to construct jobs that can be learned by an average candidate in a reasonable time. Hence individuals become "pigeonholed" in jobs, develop vested job interests and a built-in resistance to change. The work station we are projecting into the 1980's will have the important attribute of being operable either in an automatic "tutorial mode"--not unlike in current Computer Assisted Instruction Sequences--or, in an optional supervisory "assist mode"--wherein a supervisor can connect directly into a work station to share, in a teacher-pupil relationship, in the solution of a non-standard situation.

The implications of such work station arrangements go far beyond the economical, efficiency or productivity factors discussed so far. Live experimental installations will be needed before we fully understand the real performance character of these technologies.

LIMITATIONS OF DIGITAL COMPUTERS

To date, the principal tool for substituting a "capital intensive" technology for clerical labor has been the digital computer. The total installed value of this equipment is estimated at $25 billion, or about $1,500 worth per clerical worker and half of that amount per "white collar" worker. When compared with average assets invested per "blue collar" employee of about $14,000 to $18,000, the disparity between the use of capital in these two labor categories can be noted.

Actually, only a small portion of information handling clerical jobs are as yet affected by computers. The greatest impact to date has been found in those areas where well-defined and formatted information has to be manipulated. For instance, the productivity of computers in handling checking accounts, invoices, standardized accounting data, and periodic expense records has resulted in a significant reduction in unit costs per transaction. But the use of computers has been quite limited in a vast number of applications that can be categorized as information retrieval management. The existing digital "bit"

memories providing systems storage capabilities of up to 10^8 - 10^9 characters have been simply inadequate to provide access to information records possessing archival attributes, because even small archival files have 10^{10} characters or more. Besides, when the physical limits of the existing digital storage "hardware" is tested, the "software" problems of managing this quantity of data invariably produce systems breakdowns. Furthermore, the entire digital computer technology still suffers from major technical inadequancies in the processing of inputs and outputs (in terminals).

For instance, one of the most sophisticated information retrieval applications now in operation can be found in airline reservations systems. Only the expenditure of many tens of millions of dollars on software, almost equalling the cost of individual hardware systems, makes it possible for these systems to operate at all. When examining the operation of such a reservation system, we have to bear in mind that it operates in a highly stylized and predetermined environment, performing only a limited number of functions at a time; whereas most retrieval problems we encounter in offices are much less structured. On account of problems with terminals, document processing, and validation, the expensive and costly ticketing function also remains unintegrated into the entire processing system.

In view of these experiences with digital computers, how can we expect to satisfy the ever changing needs for mechanized

information retrieval where multi-million dollar investments in software are simply too expensive?

How can we serve the information storage needs of most enterprises, when the information currently embodied in reference catalogues, letters from customers, inter-office communications, directories, etc. easily exceeds 10^{10} characters for small firms and 10^{12} characters for medium sized firms?

How can we utilize the digital computer which ultimately has to rely on a key stroke or a hand-lettered alphanumeric character if the cost of encoding information runs at $5 to $7 for only 10^4 characters?

Considering these limitations of the existing digital (von Neumann) machines, we must conclude that an architecture possessing decidedly different attributes will have to become dominant in the 1980's. Even if we allow for 1000-fold increases in processing speeds of computers, for 1000-fold decreases in unit storage costs and for similar improvement in other factors, the fundamental limitations of the digitally-oriented computer systems will be remaining with us; the most important being our inability to generate sufficient amounts of software logic needed to operate such systems. Even with the availability of general purpose application "packages," the logic needed to express the needs of an enterprise beyond its most rudimentary processing of elementary transactions represents a simply staggering requirement for software investments.

Therefore, it is highly probable that both information retrieval and information analysis uses will have to fall back increasingly on the built-in "software" of the human mind, which still remains the most easily programmable associative information machine. In other words, man-machine, inter-active systems placing the least understood and most ill-structured portions of a "program" outside of the computing machine are essential to overcome the inherent software limitations of existing systems.

To achieve this coupling between the mind and the system, the technology will have to accommodate itself to the inter-active mode by providing information in the form of easily scannable images, pictures, graphs instead of the media in which it currently operates--in the form of a typical computer tabular listing print-out. In some respect, this will mean going back to formats pre-dating the computer age, that is, forms with variable type-fonts (for discrimination); images with color (for contrast and highlighting); pictures (for high information contents); and unsymmetrical images (for sub-dividing a complex image into separate elements.)

We therefore have to conclude that in the 1980's a new category of information processing devices will evolve which will extend the limited input/output functions currently performed exclusively by alphanumeric displays. Based on our current knowledge, this extension of capabilities will be performed by means of computer-aided manipulation of text and images, under the guidance of a human operator as contrasted with the existing approach wherein small records or "fields" of data

are manipulated entirely under the complete control of a 100% pre-determinable and programmed routine.

In terms of technology development, this certainly implies an increased wedding of micro-imaging systems to existing digital processing machines. The current COM/COMP devices are just a beginning of this development. The use of micro-imaging and optical memories--with storage densities currently 10^2 to 10^4 times greater (per cubic inch) than existing magnetic discrete memories--is a most cost/effective extension of existing concepts into archival or low cost working information storage. In selected application situations it is also probable that new video recording methods (such as miniaturized film or high density magnetic tape or plastic recording or holographic tape) may be integrated into information processing systems. This situation is bound to happen when extended uses of these recording media in mass consumer markets will result in sufficiently low unit costs to make such devices especially attractive.

To make the existing digital computer even more effective as a work station, it must also adapt to handling of audio communications. This development will most likely come about as a consequence of the high communications costs involved in any interactive work station. The audio function (such as currently performed by dictating machines) will thus be time-sharing many existing facilities so as to yield overall lower average costs.

The most likely consequence of such a development would be to integrate the circuits and devices even further so as to incorporate all communications tasks, inclusive that of a telephone and picture phone (video).

The aggregate evolutionary trend then leads us to conclude that by the late 1980's the meaning of the term "architecture of information" results in a flexible and modular integration of all information technologies that currently appear as separate and isolated methods for processing information. Because of the functional inter-dependencies between:

- computing
- telephone
- video
- dictating equipment
- message switching
- facsimile
- micro-graphics
- copying
- duplicating
- printing
- data entry devices
- terminals

and so forth, Xerox must have the strategic capability to carefully assess the competitive and profitability implications in pursuing various steps (or sequences) leading to capture of any portion of this huge market.

OPPORTUNITIES OF THE 1980'S

When trying to make an assessment of opportunities, projected output growth rates become a good starting point. Out of 82 industry sectors identified for the purposes of input-output analysis of the U.S. economy, the highest ranking increases can be found in categories related to information processing.[14] Just as a matter of interest, we are also including the ten bottom ranked industries[15]--note that they have the highest productivity of labor, yet are known for lowest profitability.[16]

In term of market size, these growth rates are most relevant when translated into sales volume[17] in the durable equipment sector of the U.S. economy.[18] By 1980 the industrial category "Office, Computing and Accounting Machinery" clearly becomes the second largest durable equipment purchase category with estimated sales in the $21 billion range per annum.

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[14]See Exhibit E.9A and E.10.

[15]See Exhibit E.9B.

[16]A separate paper will attempt to reconcile this apparent paradox. From a strategy standpoint, however, it is very important to realize that high economic growth rates and high profits are only generated where the current effectiveness is low, or where dramatic performance improvements are possible to meet previously unfulfilled needs. Consequently, innovative strategies either in marketing and/or technological progress are the only ones that generate high growth or profits. Entry into mature, established, highly competitive and relatively efficient industry segments are generally not conducive to growth and profit.

[17]See Exhibit E.17.

[18]Figures for worldwide economy are not available, but a safe bet is to take the 1980 U.S.A. figure and multiply it by three.

Another way of viewing the U.S.A. market size is by examining the projected cumulative value of the investment in capital stocks (gross value, without depreciation).[19] Here, "Office, Computing and Accounting Machinery" becomes the fifth largest durable equipment purchase category, because the cumulative value of other equipment had accrued over a much longer time period. The depreciated 1980 value of this cumulative investment of $102.3 billion (in 1958 terms; in current terms about twice that amount) nets out to only $42.9 billion, thus providing this industrial category one of the most advantageous cash flow and tax-free investment resource capability in the U.S. economy.

CONCLUSION

"A View of the 1980's" has examined some of the unstated assumptions implied in the "architecture of information" concept.

It has confirmed that a major opportunity exists, in fact, wherein Xerox can potentially play a significant role which would fit in with its prevailing beliefs and desires.

It has broadly identified some of the critical areas and has laid the ground for further analysis.

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[19]See Exhibit E.18.

APPENDIX

Reference to Statistical Sources Quoted:

Exhibit

E.1	-	Bulletin 1672, Bureau of Labor Statistics (1970), p.54
E.2	-	Bulletin 1673, Bureau of Labor Statistics (1970), p.18
E.3	-	Bulletin 1673, p.23
E.4	-	Bulletin 1673, p.23
E.5	-	Bulletin 1673, p.25
E.6	-	Bulletin 1673, p.27
E.7	-	Bulletin 1673, p.28
E.8	-	Bulletin 1673, p.35
E.9	-	Bulletin 1673, p.47
E.10	-	Bulletin 1672, p.33
E.11	-	Bulletin 1673, p.8
E.12	-	Bulletin 1673, p.57
E.13	-	Bulletin 1673, p.58
E.14	-	National Planning Association, Report 70-N-1 (1970) p.S.14
E.15	-	NPA 70-N-1, p.S2-3
E.16	-	Bulletin 1673, p.42
E.17	-	NPA 70-N-1, p.S49
E.18	-	NPA 70-N-1 p.S53

Interrelationship of Potential Gross National Product, Final Demand, Industry Production, Productivity, and Employment

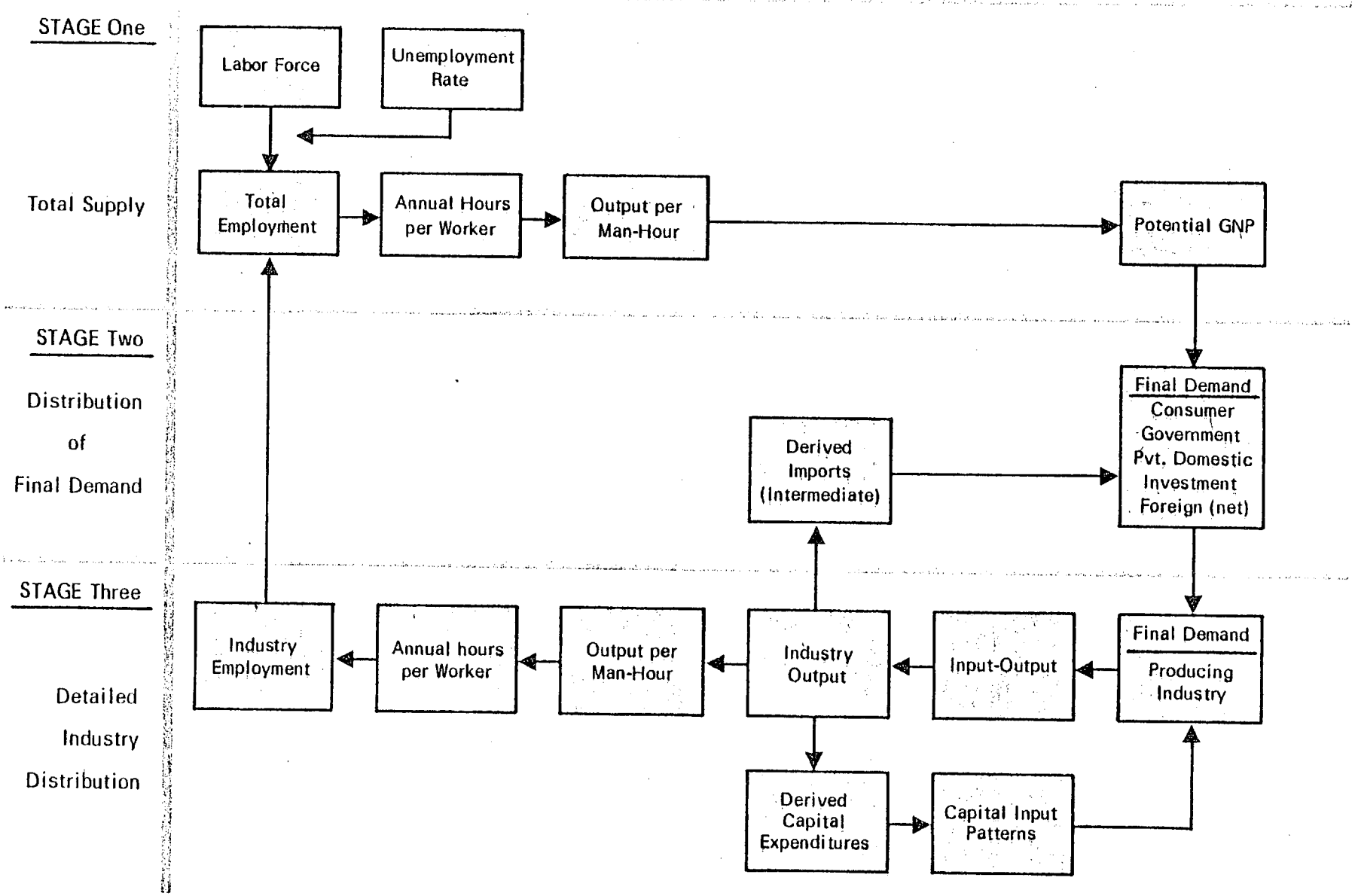
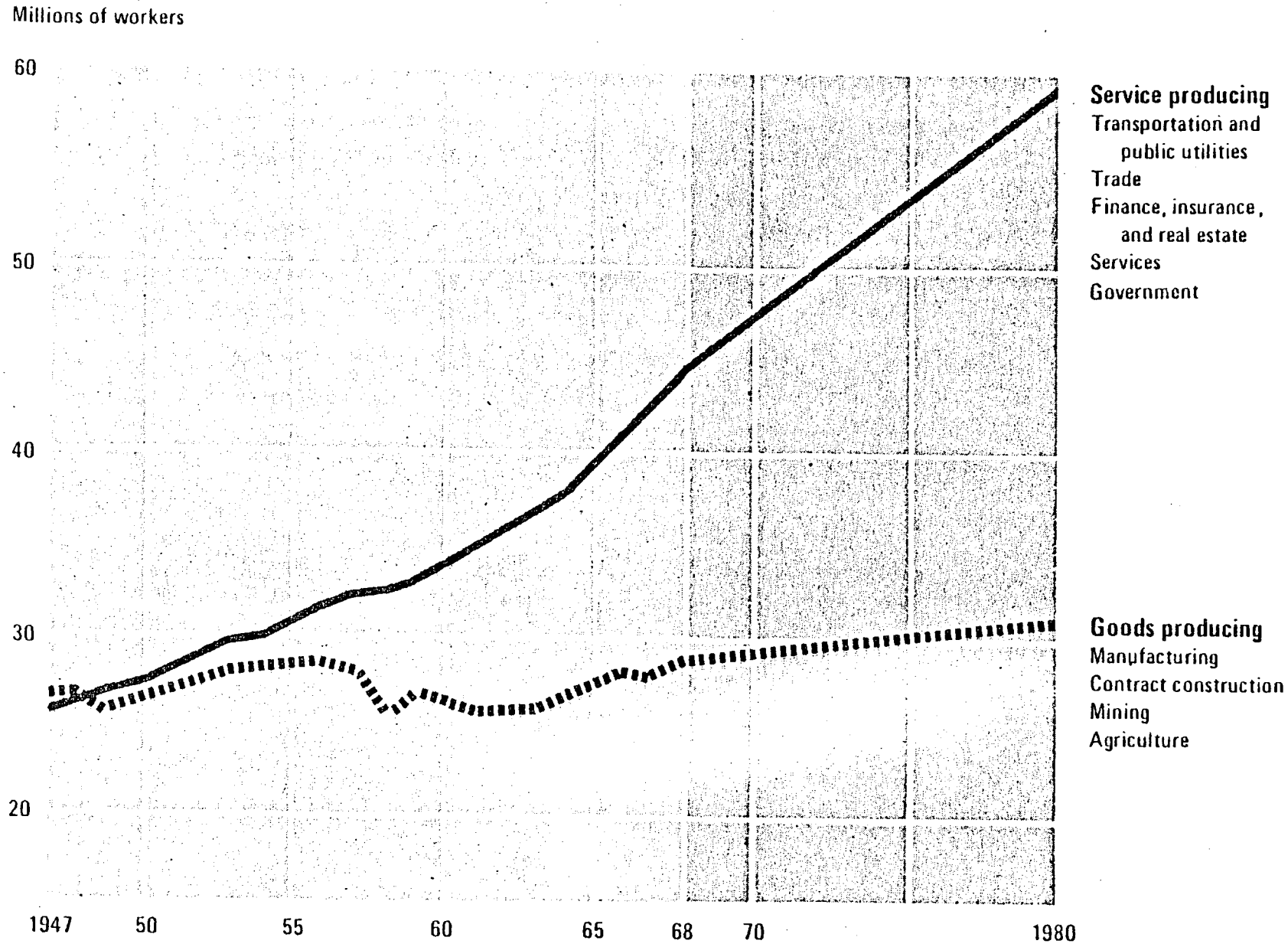


EXHIBIT .1

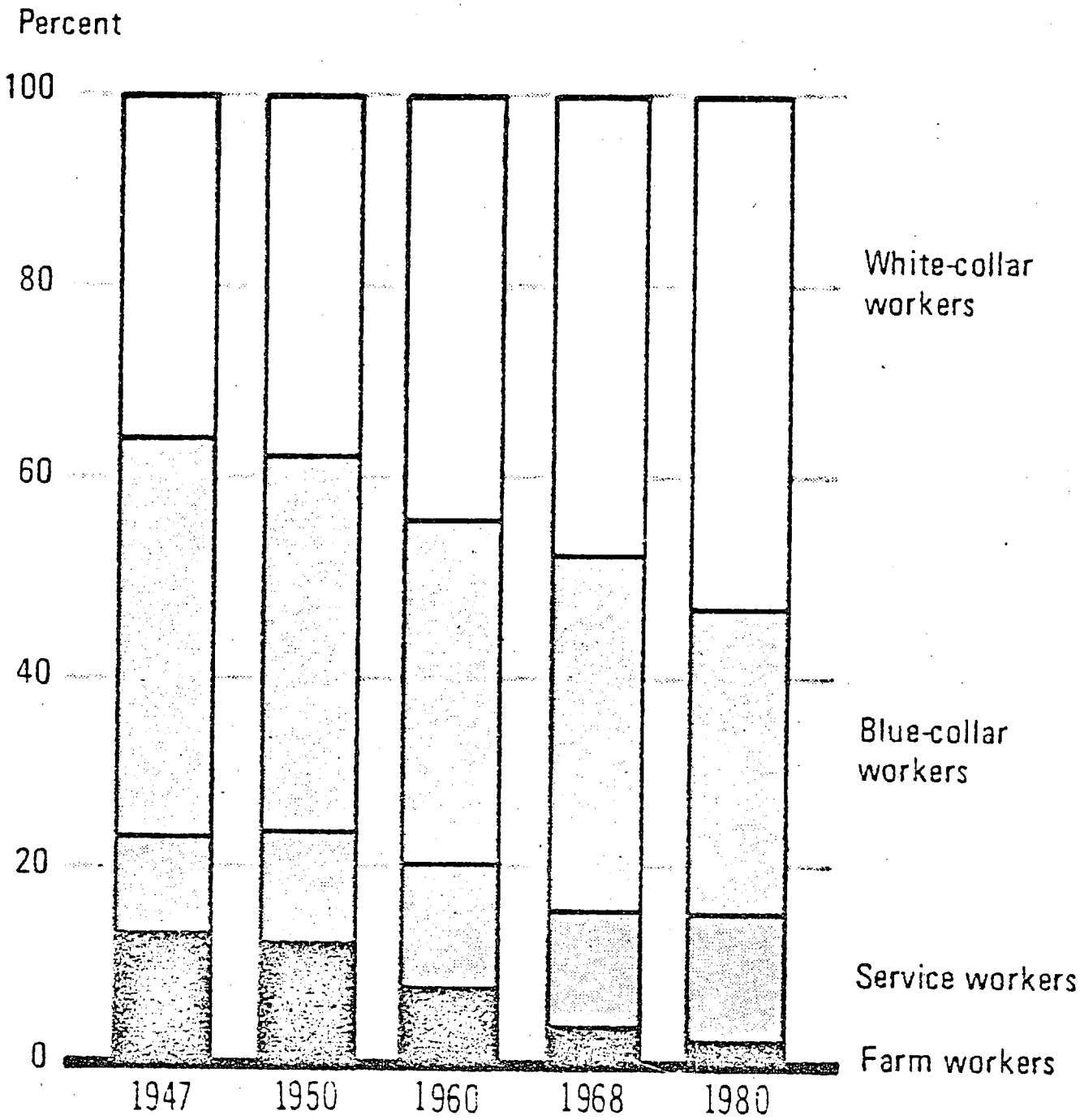
Employment [1] trends in goods-producing and services-producing industries, 1947–68 (actual) and 1968–80



[1] Wage and salary workers only, except in agriculture, which includes self-employed and unpaid family workers.

EXHIBIT .2

Employment trends among major occupational categories,[1] 1947–68 (actual) and 1980



[1] Farm workers include farm managers.

EXHIBIT E.3

Average annual rate of employment change, by major occupational group, 1960–68 (actual) and 1968–80

Occupational group	1960–68	1968–80
Total	1.8	1.9
White-collar workers	2.8	2.6
Professional, technical, and kindred	4.1	3.4
Managers, officials, and proprietors	1.2	1.7
Clerical	3.5	2.5
Sales	1.2	2.2
Blue-collar workers	1.7	1.0
Craftsmen and foremen	2.0	1.7
Operatives	2.0	0.8
Nonfarm laborers	----------	−0.1
Service workers	2.0	2.8
Farm workers	−5.1	−3.4

EXHIBIT E.4

Employment in major occupational groups, 1968 (actual) and 1980

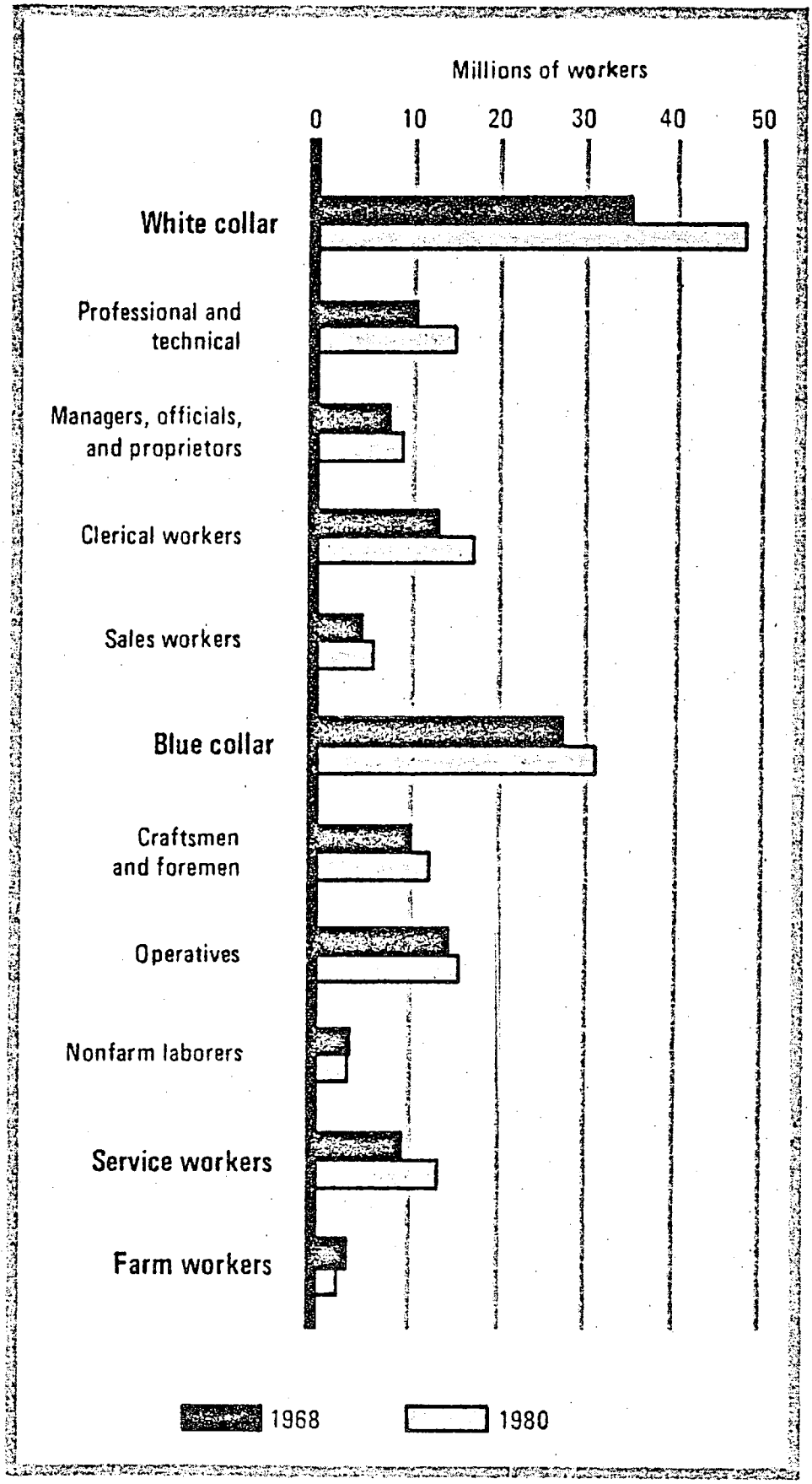


EXHIBIT E.5

Major changes in the labor force, 1960's (estimated) and 1970's (projected)

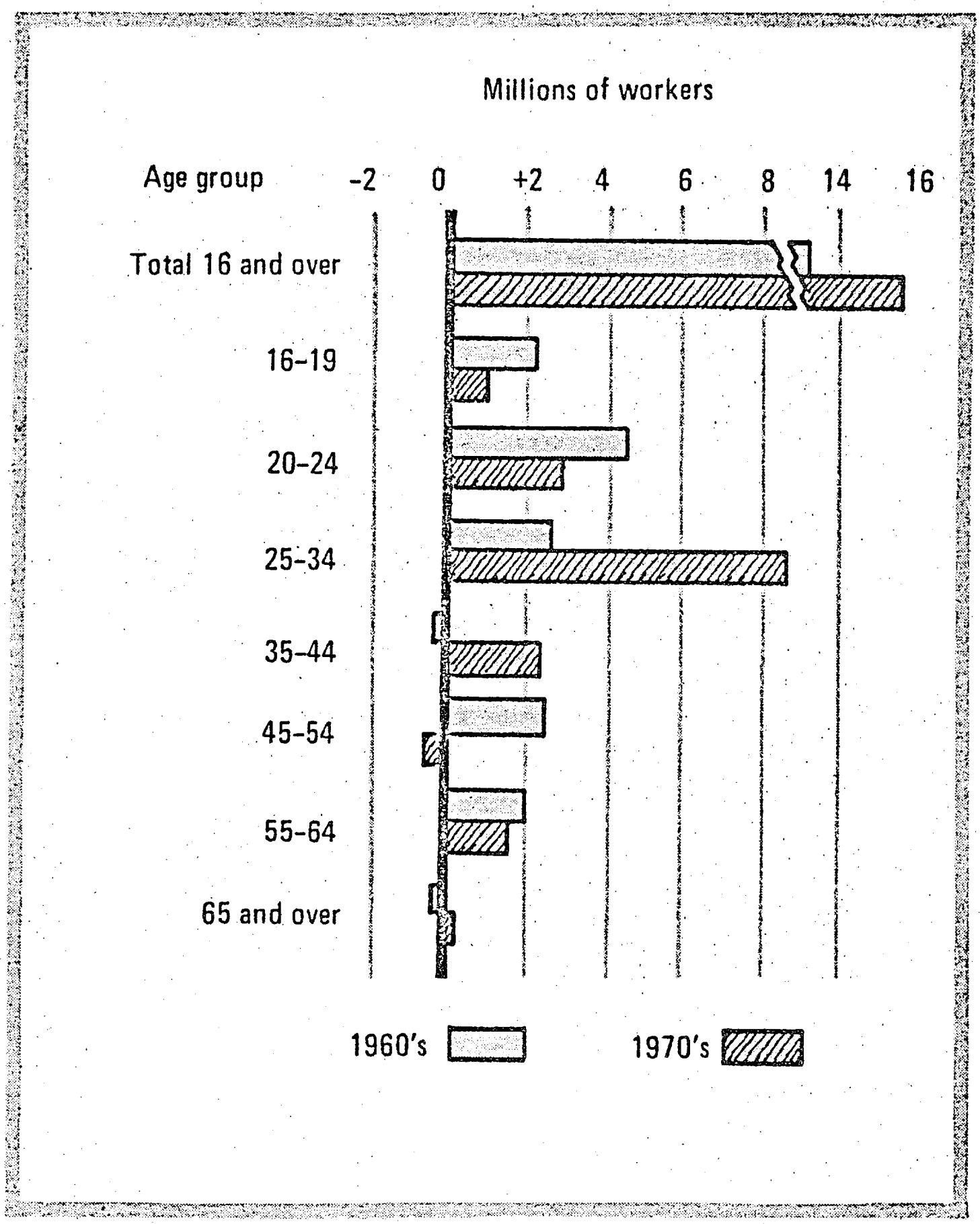


EXHIBIT E.6

The shape of the labor force, 1968 (actual) and 1980 (projected)

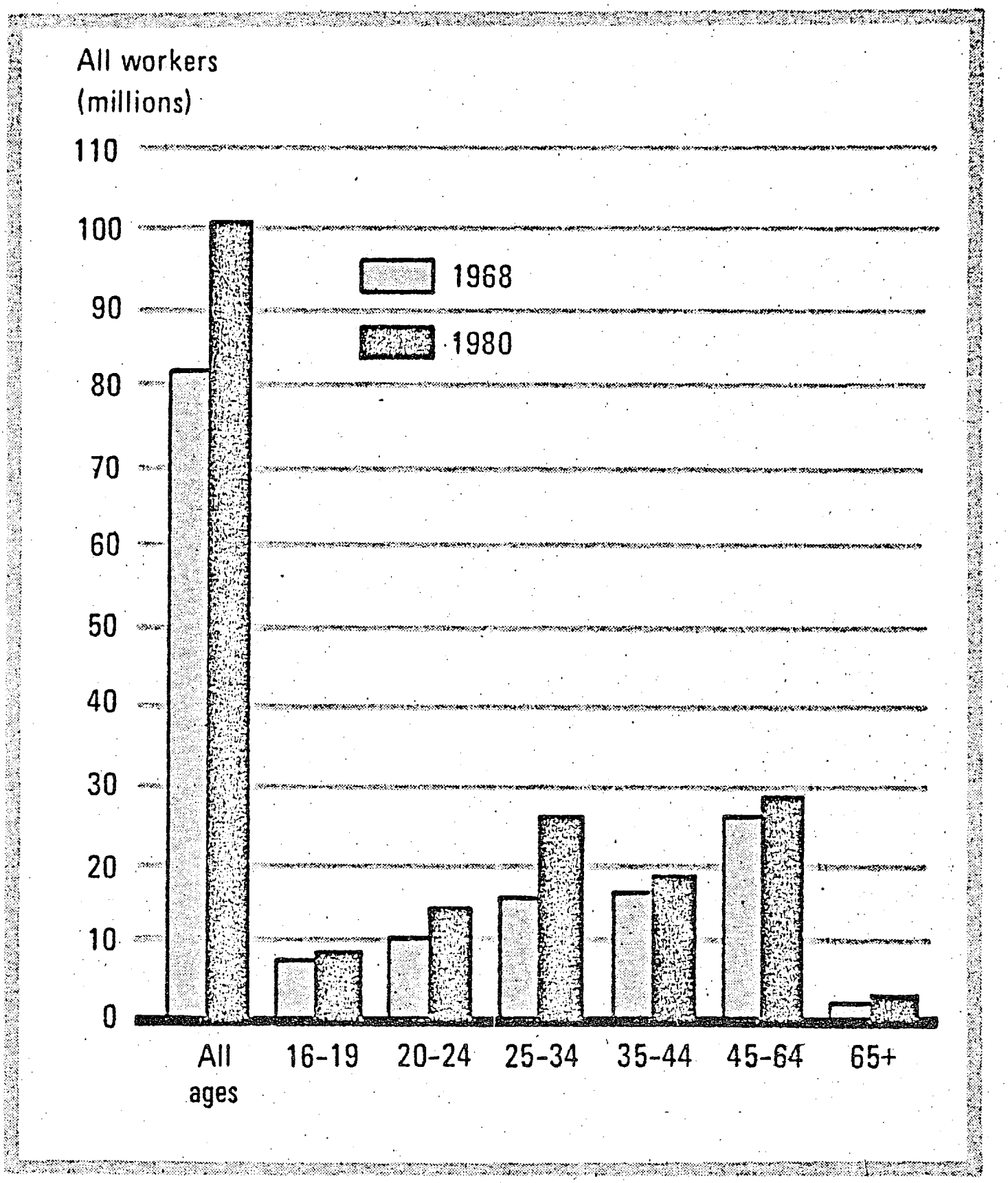


EXHIBIT E.7

Distribution of college graduates by major occupational field, 1968 and 1980

Occupational group	1968			1980		
	Total employment [1] (thousands)	College graduates [2] (thousands)	Percent, graduates to total	Total employment [1] (thousands)	College graduates [2] (thousands)	Percent, graduates to total
All occupational groups	75,920	9,229	12.3	95,100	15,342	16.1
Professional and technical	10,325	6,182	59.9	15,500	10,230	66.0
Managers, officials, and proprietors	7,776	1,562	20.0	9,500	2,850	30.0
Sales	4,647	463	10.1	6,000	780	13.0
Clerical	12,803	583	4.6	17,300	779	4.5
All other	40,369	439	1.1	46,800	703	1.5

[1] 16 years of age and over.
[2] Data include persons 18 years of age and over having 4 years of college or more.

EXHIBIT E.8

Ten selected industries projected to grow rapidly in real output,[1] 1965–80

Industry name and number	Rank	Average annual rate of growth [2]
SERVICES ECONOMY		
51. Office, computing and accounting machines	1	10.3
63. Optical, ophthalmic and photographic equipment	2	8.8
57. Electronic components and accessories	3	8.4
66. Communications; except broadcasting	4	7.0
28. Plastics and synthetic materials	5	6.8
68. Electric, gas, water and sanitary services	6	6.7
52. Service industry machines	7	6.5
32. Rubber and miscellaneous plastics	8–9	6.3
73. Business services	8–9	6.3
56. Radio, television and communication equipment	10	6.2

EXHIBIT .9A

Ten selected industries projected to grow slowly in real output,[1] 1965–80

Industry name and number	Rank	Average annual rate of growth [2]
SERVICES ECONOMY		
33. Leather tanning and industrial leather products	1	−0.3
34. Footwear and other leather products	2	1.4
4. Agricultural, forestry, and fishery services	3	1.5
7. Coal mining	4	1.8
37. Primary iron and steel manufacturing	5	1.9
3. Forestry and fishery products	6	2.0
15. Tobacco manufacturers	7	2.3
5. Iron and ferro-alloy ores mining	8	2.5
1. Livestock and livestock products	9	2.8
2. Agricultural products except livestock	10	3.0

EXHIBIT .9B

Average Annual Growth Rates of Fastest Growing Industries, 1965-80

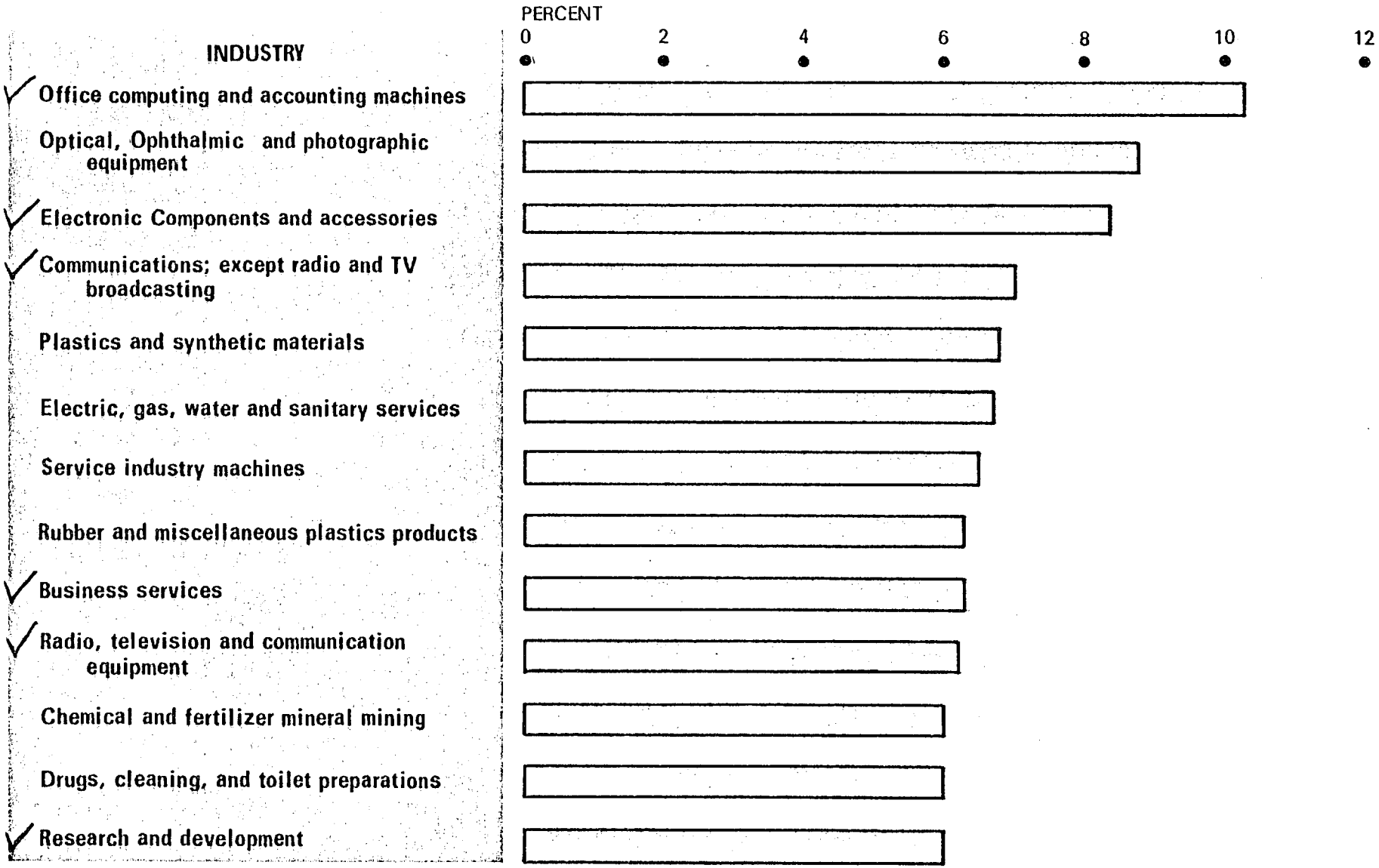


EXHIBIT .10

Projected productivity, by major sector, private economy, 1968–80

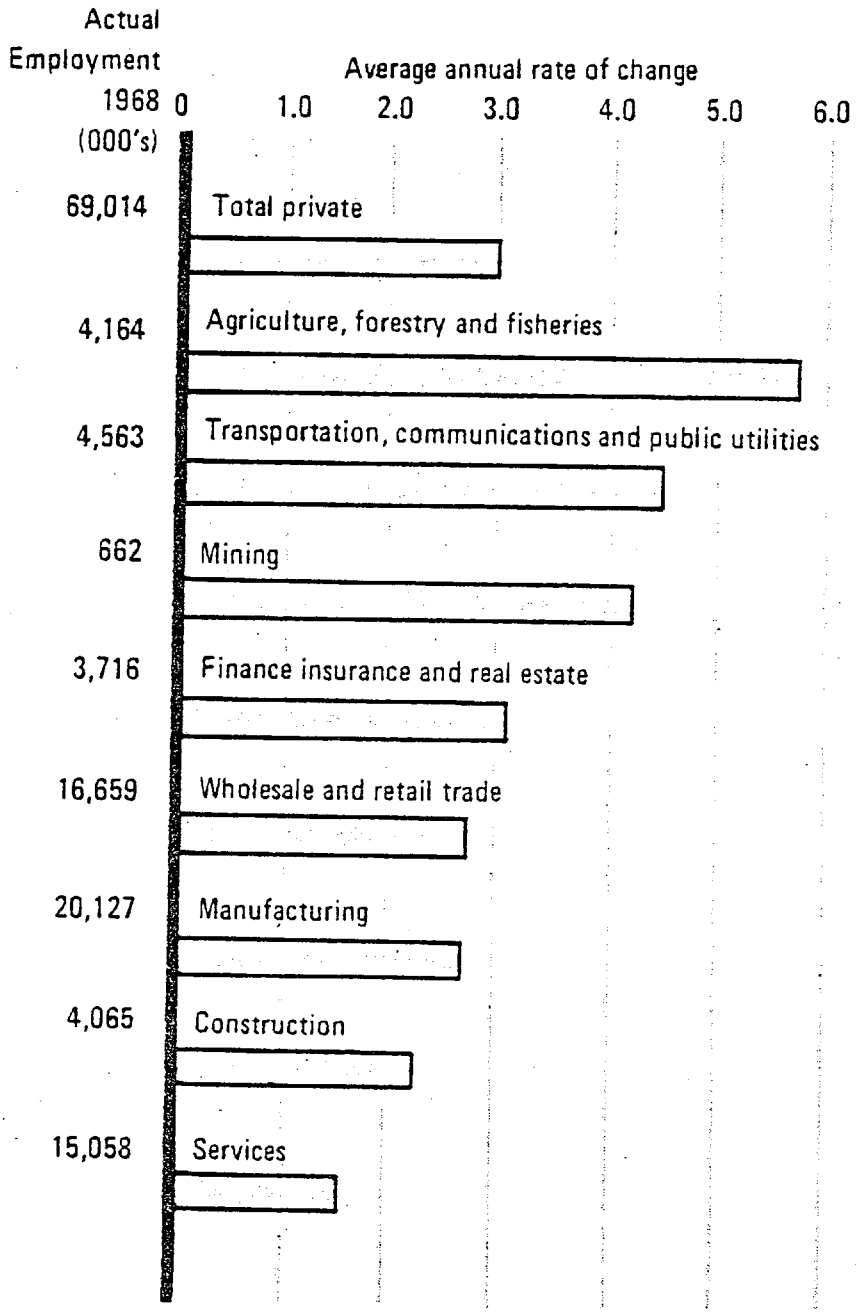


EXHIBIT E.11

Employment by major occupational group, 1968 and projected 1980 requirements

[In thousands]

Occupational group	1968 employment		Projected 1980 requirements		Change 1968-80	
	Number	Percent	Number	Percent	Number	Percent
Total	75,920	100.0	95,100	100.0	19,180	25.0
White-collar workers	35,551	46.8	48,300	50.8	12,749	35.9
Professional and technical	10,325	13.6	15,500	16.3	5,175	50.1
Managers, officials, and proprietors	7,776	10.2	9,500	10.0	1,724	22.2
Clerical workers	12,803	16.9	17,300	18.2	4,497	35.1
Sales workers	4,647	6.1	6,000	6.3	1,353	29.1
Blue-collar workers	27,525	36.3	31,100	32.7	3,575	13.0
Craftsmen and foremen	10,015	13.2	12,200	12.8	2,185	21.8
Operatives	13,955	18.4	15,400	16.2	1,445	10.4
Nonfarm laborers	3,555	4.7	3,500	3.7	−55	−1.5
Service workers	9,381	12.4	13,100	13.8	3,719	39.6
Farm workers	3,464	4.6	2,600	2.7	−864	−33.2

EXHIBIT .12

Employment and average annual openings in selected occupations, 1968 and projected 1980 requirements

Occupations	Employment 1968	Requirements 1980	Percent change 1968–80	Average annual openings 1968–80 [2]
Total	75,920,000	95,100,000	25	3,990,000
PROFESSIONAL, TECHNICAL AND RELATED WORKERS	10,325,000	15,500,000	50	777,000
Business administration and related professions				
Accountant	500,000	720,000	43	33,000
Personnel worker	110,000	155,000	43	6,900
Public relations worker	100,000	165,000	64	8,800
Engineering	1,100,000	1,500,000	40	53,000
Health service occupations				
Dentist	100,000	130,000	30	4,900
Dental hygienist	16,000	33,500	109	2,400
Medical laboratory workers [1]	100,000	190,000	90	12,800
Physician (M.D.'s and D.O.'s)	307,000	469,000	53	20,900
Radiologic technologist	75,000	120,000	60	7,300
Registered nurse	660,000	1,000,000	52	65,000
Speech pathologist and audiologist	18,000	33,000	83	2,300
Natural scientists				
Chemist	130,000	200,000	56	8,800
Physicist	45,000	75,000	64	3,200
Life scientist	170,000	245,000	41	9,900
Oceanographer	5,200	9,700	85	500
Teachers				
Elementary school teachers	1,230,000	1,270,000	3.3	56,300
Secondary school teachers	940,000	1,065,000	14	40,000
College and university teachers	286,000	395,000	38	17,000
Technician occupations				
Engineering and science	620,000	890,000	43	31,000
Draftsmen	295,000	435,000	48	15,300
Other professional and related workers				
Lawyer	270,000	335,000	23	14,500
Librarians	106,000	135,000	29	8,200
Mathmetician	65,000	110,000	60	4,600
Pilot and copilot	52,000	114,000	117	1,800
Programer	175,000	400,000	129	23,000
Social worker	160,000	270,000	67	16,700
Systems analyst	150,000	425,000	183	27,000
MANAGERS, OFFICIALS AND PROPRIETORS	7,776,000	9,500,000	22	380,000
CLERICAL WORKERS	12,803,000	17,300,000	35	911,000
Bank clerks	400,000	512,000	29	29,500
Bank tellers	230,000	337,000	46	20,000
Bookkeeping workers	1,200,000	1,500,000	19	78,000
Cashiers	730,000	1,110,000	51	69,000
Dental assistant	100,000	150,000	50	9,000
Electronic computer operating personnel	175,000	400,000	129	20,400
Office machine operators	325,000	460,000	39	25,000
Receptionists	240,000	400,000	66	30,000
Shipping and receiving clerks	370,000	465,000	25	15,400
Stenographers and secretaries	2,650,000	3,650,000	37	237,000
Telephone operators	400,000	480,000	21	28,000
Typists	700,000	930,000	37	63,000
SALES WORKERS	4,647,000	6,000,000	29	263,000
Automobile salesmen	120,000	145,000	21	4,400
Insurance agents and brokers	410,000	480,000	17	16,200
Manufacturers' salesmen	500,000	735,000	47	32,000
Real estate salesmen and brokers	225,000	270,000	20	14,200
SALES WORKERS—Continued				
Retail trade salesworkers	2,800,000	3,460,000	24	150,000
Security salesmen	135,000	170,000	24	7,400
Wholesale trade salesworkers	530,000	695,000	30	25,200
CRAFTSMEN, FOREMEN AND KINDRED WORKERS	10,015,000	12,200,000	22	396,000
Building trades				
Bricklayers	175,000	230,000	31	7,600
Carpenters	869,000	1,075,000	24	39,300
Electricians (maintenance and construction)	430,000	575,000	34	20,400
Excavating, grading and road machinery operators	285,000	425,000	49	16,200
Painters and paperhangers	430,000	560,000	30	23,200
Plumbers and pipefitters [3]	330,000	475,000	44	19,500
Mechanics and repairmen				
Air conditioning, refrigeration and heating mechanics	100,000	140,000	40	5,000
Airplane mechanics	135,000	230,000	70	9,700
Appliance servicemen	205,000	260,000	27	8,600
Business machine servicemen	115,000	200,000	74	8,500
Industrial machinery repairmen	175,000	220,000	26	7,550
Motor vehicle mechanics	825,000	1,000,000	21	26,500
Television and radio service technicians	125,000	145,000	16	3,000
Printing				
Compositors and typesetters [4]	190,000	180,000	−5	3,200
OPERATIVES	13,955,000	15,400,000	10	426,000
Driving Occupations				
Local truckdrivers	1,200,000	1,450,000	22	37,000
Over-the-road truckdrivers	640,000	800,000	25	21,600
Other manual occupations				
Assemblers	785,000	850,000	8	26,000
Gasoline service station attendants	400,000	475,000	16	10,900
Inspectors (manufacturing)	585,000	635,000	9	19,200
Welders and oxygen and arc cutters	480,000	675,000	41	23,000
NONFARM LABORERS	3,555,000	3,500,000	−2	60,000
SERVICE WORKERS	9,381,000	13,100,000	40	752,000
Private household workers	1,700,000	1,980,000		121,000
Food service workers				
Cooks and chefs	670,000	900,000	33	48,000
Waiters and waitresses	960,000	1,240,000	28	67,000
Health service workers				
Hospital attendants	800,000	1,500,000	88	100,000
Licensed practical nurses	320,000	600,000	88	48,000
Personal service workers				
Barbers	210,000	260,000	24	12,800
Cosmetologists	475,000	685,000	43	38,000
Protective service workers				
Firefighters	180,000	245,000	34	7,700
Municipal police officers	285,000	360,000	28	15,000
Other service workers				
Building custodians	1,100,000	1,460,000	33	80,000
FARM WORKERS	3,464,000	2,600,000	−33	25,000

[1] Includes medical technologist, technician, and assistant.
[2] Growth and replacement openings, does not include transfers.
[3] Also called—operating engineer (construction machinery operations).
[4] Also called—composing room occupations.

Note: Percent increase based on unrounded estimates.

EXHIBIT .13

AVERAGE ANNUAL GROWTH RATES - USA

(% - In Constant Dollars)

	1948 - 55	1955 - 68	ESTIMATED 1968 - 73	ESTIMATED 1973 - 80
GNP	4.4	3.8	4.0	4.4
GNP/MANHOUR	3.7	2.6	2.5	2.9
GNP/CAPITA	2.6	2.2	2.7	2.9
POPULATION	1.7	1.5	1.2	1.4
EMPLOYMENT	1.2	1.5	1.6	1.8
TOTAL MANHOURS	0.7	1.2	1.5	1.4
AVERAGE WEEKLY HOURS	-0.5	-0.3	-0.1	-0.1

EXHIBIT E.14

GROSS NATIONAL PRODUCT - USA

(BILLIONS, CURRENT DOLLARS)

	YEAR	GNP
	1950	285
	1955	398
	1960	504
	1965	685
	1969	932
ESTIMATES	1973	1224
ESTIMATES	1975	1398
ESTIMATES	1978	1698
ESTIMATES	1980	1935

EXHIBIT E.15

Educational attainment of the civilian labor force 25 years old and over by color, average 1967–69, and projected 1980

Years of school completed	Total		White		Negro and other races	
	1967–69 average	1980	1967–69 average	1980	1967–69 average	1980
	Number (thousands of persons 25 years old and over)					
Total	63,618	76,327	56,824	67,631	6,794	8,696
Less than 4 years of high school	24,723	21,846	20,578	18,027	4,145	3,819
Elementary: less than 8 years	6,551	4,366	4,675	3,141	1,876	1,225
8 years	6,967	4,679	6,225	4,099	742	580
High school: 1 to 3 years	11,205	12,801	9,678	10,787	1,527	2,014
4 years of high school or more	38,895	54,481	36,246	49,601	2,649	4,880
High school: 4 years	23,135	32,375	21,452	29,217	1,683	3,158
College: 1 year or more	15,760	22,106	14,794	20,384	966	1,722
1 to 3 years	7,024	9,185	6,548	8,376	476	809
4 years or more	8,736	12,921	8,246	12,008	490	913
	Percent distribution					
Total	100.0	100.0	100.0	100.0	100.0	100.0
Less than 4 years of high school	38.9	28.7	36.2	26.8	61.0	44.0
Elementary: less than 8 years	10.3	5.8	8.2	4.7	27.6	14.1
8 years	11.0	6.1	11.0	6.1	10.9	6.7
High school: 1 to 3 years	17.6	16.8	17.0	16.0	22.5	23.2
4 years of high school or more	61.1	71.3	63.8	73.4	39.0	56.1
High school: 4 years	36.4	42.4	37.8	43.2	24.8	36.3
College: 1 year or more	24.7	28.9	26.0	30.2	14.2	19.8
1 to 3 years	11.0	12.0	11.5	12.4	7.0	9.3
4 years or more	13.7	16.9	14.5	17.8	7.2	10.5

EXHIBIT .16

PURCHASES OF PRODUCERS' DURABLE EQUIPMENT BY TYPE
SELECTED YEARS, 1948 - 1980 (BILLIONS OF CURRENT DOLLARS)

TYPE OF EQUIPMENT OR STRUCTURE	1955	1960	1968	1975	1980
TURNITURE + FIXTURES	1.17	1.55	2.48	4.29	6.29
FABRICATED METAL PRODUCTS	0.82	0.98	1.71	2.71	3.45
ENGINES + TURBINES	0.42	0.60	1.08	1.96	2.72
TRACTORS	0.89	0.68	1.60	2.21	2.66
AGR. MACHINERY, EXC. TRACTORS	1.00	1.11	1.98	2.66	3.11
CONSTRUCTION MACHINERY	0.74	0.94	1.91	3.29	4.81
MINING + OILFIELD MACHINERY	0.56	0.50	0.65	0.94	1.11
METALWORKING MACHINERY	1.42	1.67	3.29	5.79	7.94
SPECIAL-INDUSTRY MACHINERY, N.E.C.	1.53	2.13	4.19	5.93	7.44
GENERAL INDUSTRIAL MACHINERY	1.50	1.91	3.17	5.74	8.10
OFFICE, COMPUTING + ACCOUNTING MACHINERY	0.91	1.66	6.42	13.60	21.21
SERVICE-INDUSTRY MACHINES	1.22	1.48	2.56	3.75	4.66
ELECTRICAL MACHINERY	2.95	4.42	6.47	10.93	15.57
TRUCKS, BUSES + TRUCK TRAILERS	2.90	3.64	7.28	9.61	12.08
PASSENGER CARS	3.36	3.09	5.32	5.76	6.35
AIRCRAFT	0.16	0.83	3.54	7.82	14.13
SHIPS + BOATS	0.28	0.45	0.47	0.81	1.11
RAILROAD EQUIPMENT	0.68	0.75	0.77	1.05	1.39
INSTRUMENTS	0.74	1.07	3.26	6.25	9.24
MISCELLANEOUS EQUIPMENT	0.68	0.89	1.43	2.24	2.91
SCRAP	-0.12	-0.07	-0.09	-0.13	-0.16
INDUSTRIAL BUILDINGS	2.26	2.85	5.59	8.98	12.45
COMMERCIAL BUILDINGS	3.04	4.18	8.33	16.08	23.16
HOSPITAL AND INSTITUTIONAL BUILDINGS	0.33	0.61	1.57	3.63	6.31
ELECTRIC LIGHT AND POWER	1.49	2.03	3.41	5.59	7.33
GAS	0.87	1.10	1.80	2.86	3.59
ALL OTHER	6.30	7.36	8.59	13.21	17.63
TOTAL EQUIPMENT	38.10	48.41	88.78	147.56	206.59

EXHIBIT E.17

GROSS AND NET CAPITAL STOCKS BY TYPE
SELECTED YEARS, 1948 - 1980 (1958 BILLION DOLLARS)

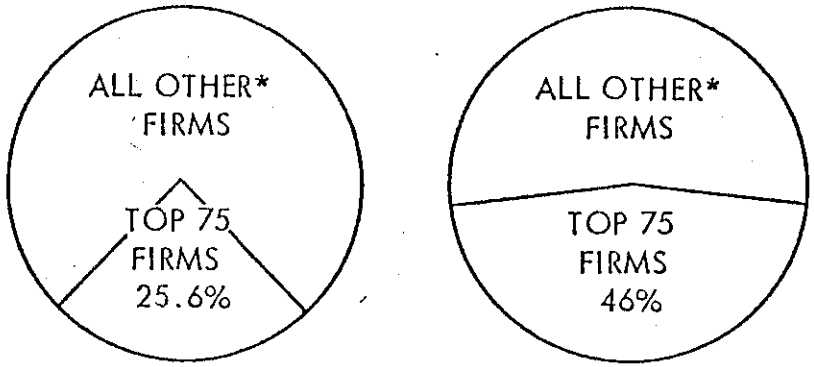
GROSS STOCK - EQUIPMENT & STRUCTURES	1955	1960	1968	1975	1980
FURNITURE + FIXTURES	12.4	16.2	24.9	34.5	43.8
FABRICATED METAL PRODUCTS	10.5	13.9	19.0	25.3	30.0
ENGINES + TURBINES	5.8	8.2	11.7	17.5	22.1
TRACTORS	9.7	10.3	11.3	13.8	14.4
AGR. MACHINERY, EXC. TRACTORS	15.1	17.7	20.8	24.2	26.5
CONSTRUCTION MACHINERY	6.9	7.3	10.1	13.5	15.8
MINING + OILFIELD MACHINERY	5.6	5.5	5.4	5.6	5.2
METALWORKING MACHINERY	20.9	25.0	31.6	40.5	47.9
SPECIAL-INDUSTRY MACHINERY, N.E.C.	22.5	27.1	35.5	45.2	52.3
GENERAL INDUSTRIAL MACHINERY	20.0	22.8	29.2	39.0	46.8
OFFICE, COMPUTING + ACCOUNTING MACHINERY	6.4	9.3	26.5	66.6	102.3
SERVICE-INDUSTRY MACHINES	10.3	12.6	18.6	26.6	32.7
ELECTRICAL MACHINERY	31.2	44.7	66.6	94.1	121.4
TRUCKS, BUSES + TRUCK TRAILERS	27.6	28.1	45.7	58.1	65.9
PASSENGER CARS	13.9	13.1	20.1	22.1	23.4
AIRCRAFT	1.6	3.7	12.0	31.4	53.8
SHIPS + BOATS	8.3	9.2	8.9	9.8	11.1
RAILROAD EQUIPMENT	21.9	22.5	22.9	20.6	19.9
INSTRUMENTS	6.9	9.0	17.6	34.2	48.8
MISCELLANEOUS EQUIPMENT	5.4	7.4	12.2	17.9	22.9
SCRAP	-.6	-.8	-.9	-1.1	-1.2
INDUSTRIAL	43.8	51.2	71.7	94.8	115.9
COMMERCIAL AND MISCELLANEOUS	58.5	68.9	97.7	147.5	196.1
INSTITUTIONAL (EXC. SOCIAL + RECR.)	29.9	37.9	54.2	73.1	93.5
SOCIAL AND RECREATIONAL	8.7	9.2	11.6	12.9	14.5
RAILROAD, LOCAL TRANSIT + PIPELINES	51.6	44.6	35.1	29.2	26.2
TELEPHONE AND TELEGRAPH	8.9	12.6	18.5	24.8	30.3
OTHER PUBLIC UTILITIES	47.2	57.2	75.4	97.7	113.5
PETROLEUM + NATL GAS WELL DRILL + EXPL	24.7	31.5	34.5	30.4	27.1
ALL OTHER PRIVATE	3.3	3.3	4.8	7.8	10.9
FARM NONRESIDENTIAL	17.0	18.6	20.9	22.3	22.3
TOTAL	555.9	647.8	874.1	1179.9	1456.1

PRODUCTIVITY GROWTHS BY INDUSTRY

INDUSTRY	ANNUAL GROWTH (%)		
	1948-1960	1960-1969	1969-1980
AGRICULTURE	4.8	4.8	5.4
MINING	4.6	4.0	4.4
NONDURABLE MANUFACTURING	3.1	3.2	3.4
CHEMICALS	4.9	4.2	5.3
PRINTING & PUBLISHING	1.3	2.2	1.6
DURABLE MANUFACTURING	2.3	3.4	3.4
UTILITIES	6.4	4.6	4.8
FINANCE & INSURANCE	-0.5	0.1	1.0
SERVICES	0.8	0.9	1.0
FEDERAL GOVERNMENT	-0.3	-0.3	-0.2
STATE & LOCAL GOVERNMENT	-0.3	0.1	0.3

EXHIBIT E.19

DISTRIBUTION OF OUTPUT AMONG
TOP 75 INDUSTRIAL FIRMS (1970)



*1,800,000 FIRMS

EXHIBIT E.20

THE OFFICE OF THE FUTURE

(An Exploratory Probe)

Paul A. Strassmann

June 15, 1971

THE OFFICE OF THE FUTURE

(An Exploratory Probe)

Paul A. Strassmann

June 15, 1971

When Jack N. got out of his helicopter at corporate headquarters of Worldwide Amalgamated Enterprises (WAE) in suburban Westchester on Tuesday morning at 9:15 A.M., his suspicions were confirmed. His portable communicator[1] was emitting a slightly audible beeping sound in the high "A" range. Because Jack N. was a highly respected troubleshooter, he always travelled with his two communicator audio option switches tuned to react to communication network paging messages from his boss, Dave R. (a high "A") or his wife (a low "E").

Jack quickly walked across the parking lot separating the heliport from the rambling office building which served temporarily as world headquarters of WAE. In passing Jack muttered to himself his dissatisfaction with the difficult access to his office; only six weeks ago WAE had decided to move its HQ from Zurich where access was much more convenient. Just prior to entering the building, Jack quickly flipped open the functional key switch lid of his portable communicator and placed the audio monitoring switch into an "off" position. This action got quickly recognized in the communications network[2] as a "message received" signal and entered into the message waiting queue of Dave R.'s office communicator. Jack noted with pleasure how quickly the green "Message Received" Key lit up--the time could not have been more than 1/4 of a

second. The bandwidth response in Westchester certainly seemed to be superior to anything he had been used to before!

Jack ran up an escalator and entered a traditionally furnished room which reminded him of the den of his home in Switzerland. The surroundings were a reflection of his personal taste; and if it were not for a multiple screen communicator[3] next to the coffee table, one would not be able to guess that this was the office of Jack N., W.A.E.'s Director of Strategic Market Planning.

Jack walked over to his favorite chair, pulled the communicator[4] device closer along the coffee table and depressed the green "ON" Key. Screen #1 lit up with a crisp "Identification Please" message in the middle and a round target symbol in the "functional execution area"[5] of the screen.

Jack pulled out of the pocket of his jacket his personal optical pencil[6] and applied its tip to the round target. The screen cleared and displayed in the "functional execution area" the following standard initializing commands:

- (•) Incoming messages queue
- (•) Outgoing messages queue
- (•) Follow-up actions queue
- (•) Reference Information
- (•) Entertainment
- (•) Message Origination

Jack impatiently ticked off the "incoming message queue" line and saw to his amazement all of Screen #1 fill out with message headers overflowing into about half of Screen #2. This is going to be a busy day! The messages were neatly arranged on the screen listing message source, message medium (audio, video, fax text)--buffer location (personal computer; working storage; archival storage)--time of message receipt and message priority.

Dave's telecon-video message was on line number three of the first screen. Since it was bound to require a recipient's positive identification, Jack could not use the more convenient light cursor "bug" signal which could be easily moved across the screen either by tapping the alphanumeric keyboard attached

to the communicator or by proper positioning of a "joystick" toggle beneath the screen. Therefore Jack positioned again his optical pencil near the beginning of the third line. Instantly, Screen #3 lit up and printed out message header describing relevant data (message identification code, time when message sent, location where sent from, message distribution, message security status, and where message buffered or stored). Beneath the header appeared a copy of a newspaper clipping[7] from the Tuesday morning edition of the London Financial Times, plus a copy of Dave's memorandum[8] summarizing his assessment of the situation. Dave, Corporate Staff Vice President for Marketing was in London where he entered his urgent message to Jack five hours earlier. As Jack was scanning the disturbing newspaper news about the imminent strike of all Common Market wideband installers personnel, Dave's voice came out of the communicator. Dave was instructing Jack to translate the potential impact on W.A.E.'s third and fourth quarter earnings as well as assess major changes in production schedule that may be necessary if network enhancements currently underway in Common Market countries were to be deferred by three, five or seven months. Most importantly, in view of Jack's prior involvement with the Installer's Association, Dave wished to find out an expression of Corporate Legal position on alternative actions to be considered by Dave's Common Market Group counterpart.

Jack promptly depressed the "START" Key under Screen #1, keyed in the message "Please review and be ready for comments--Jack N.", and ticked off the "Message Origination" command. By checking off standard commands appearing on two successive frames, he caused Dave's message plus his note to be copied[9] into the "Incoming Message Queues" of three important corporate staffers--one in Legal, one in Financial Analysis, and one in Marketing. These actions automatically caused "incoming message queues" for each of these men to be loaded with a priority waiting message.

Next Jack depressed "START" on Screen #2, ticked off "Message Origination" command first, "Audio-Video" contact next, "Headquarters" next and "Jonas B." last. Jonas was W.A.E.'s legal expert on certain aspects of Common Market Law and had previously negotiated agreements with the Installers. While a ringing audio sound was confirming that Jonas' communicator was open and available, Jack depressed a yellow key "In conference--Messages to Queue." He thus caused his personal computer to actuate a standard voice response, in Jack's own words, indicating that he would not be available soon, thus requesting his caller to leave the caller's return code, audio message or written message in Jack's personal computer. Jack thought that such action would be a smart measure since Jonas was well known for his time consuming yet thorough approach to any conceivable subject.

Instantly, Jonas' friendly face popped up on the screen with great clarity.[10] Jonas was standing next to a long counter which was the sole item of furniture in his office except for a good size personal computer cabinet in matching color with the pure white on the counter and the walls. Among his other pecularities, Jonas liked to walk around while working and concentrating. Hence the office arrangement.

After brief pleasantries, Jack asked Jonas to get Dave's message out of his message queue on another screen and asked him to read it. While Jack was watching Jonas' eyebrows go up about the contents of the message, Jack got back to Screen #3 which still contained the original message. He moved the keyboard control cursor into the "functional execution area" next to the command stating "Keywords." He then depressed the Key "Execute" and moved the cursor to the words "Strike", "Common Market", "Installers Association", "Potential Impact on W.A.E." and pushed the red button "End of Execute." He thus indexed Dave's message for any future information retrieval purposes.[11]

Jonas told Jack that the situation need not be as alarming as conveyed in the tone of the message received. He wanted Jack to get for him certain detailed data concerning W.A.E. major enhancement contracts, by customer and by country.

Second, he was also curious about the potential financial impact of a strike. Meanwhile, Jonas would look up relevant information concerning prior agreements between W.A.E. and the installers.

At this point, Jack decided that the situation was sufficiently complex to call for the aid of his assistant, Marilyn J. who was located in an area shared by assistants of all Key marketing executives. Marilyn's skills were especially in high demand on account of her experience in the area of data base information retrieval. Marilyn's initial training as a linguist and programmer made it possible for her to browse through largely incompatible data base directories located in various W.A.E. computing centers and somehow come up with a composite answer to a non-standard request for data. In a three way conference (Jack to Jonas--video; Jack and Jonas to Marilyn--display text), they agreed on a format and data definition descriptors for column and line headings. Both Jack and Jonas confirmed the display by placing their respective pulse coded pencils along the "confirm" command that would be stored on this new message. Marilyn also reminded Jack that she needed a "link" identification between her data gathering and the original request. Jack promptly moved his cursor to the "link" command in the "functional execution area" and then to "Keywords." All of the supporting information would now be permanently classified

as being associated with Dave's request. Marilyn actuated the "Print" command on her communicator and the combined fax-printing device (FPD) time shared among the other assistants in the room printed out[12] a single copy of the form to be used by Marilyn as a trial worksheet.

With Marilyn and Jonas off in their pursuits, Jack called up Financial Analysis and presented them with his need for a quick Profit Plan model analysis. In a conversational mode not unlike the one pursued with regard to contract information, Jack and Financial Analysis agreed on a format and definition of information sought, "confirmed" their understanding and "linked" the request keywords.

The time was now 9:45 and Jack had spent twenty-five minutes tackling Dave's request. He was now ready to go to other business. He quickly reviewed the status of the entire inquiry by linking in his personal computer the original message from Dave with the keywords just created. Since the incoming message from Dave would be permanently stored on a high density non-erasable optically recorded film casette along with the associated "key pointers" to the indexed message, Jack had essentially created: 1) on a fraction[13] of available "active memory" in W.A.E. HQ central files a special "file" dealing with his particular situation, 2) on portions of the file provided for further expansion by others

by means of linked pointers; 3) a common understanding what needs to be done; 4) disposable printouts of portions of the "active memory" file to be used as worksheets, memoranda of understanding or reminders to individuals of job assignments to be done. The printouts would also serve as memory "joggers" how to get back to the original file without a need to do too much searching.

Let us now follow the activities of Marilyn, Jonas, and Mikasake Y. from Financial Analysis.

Marilyn pursued her inquiry by connecting through the W.A.E. HQ communications controller to the W.A.E. American network using leased 400,000 cps (digitally) pulse modulated circuits. On account of the ultimate European destination of the messages the W.A.E. network passed the discrete message elements to W.A.E.'s Eastern interconnect with several alternate traffic routings to Europe. A special inter-connect switching computer examined the message stream to determine the least cost method for interconnection to any available channel.

Marilyn's high security clearance allowed her to access data base directories at several computer sites, but did not permit her to modify the data bases themselves, only to extract information. Soon she discovered that W.A.E.'s

European Headquarters were pursuing a similar line of inquiry but defined in slightly different terms. After a few bilateral reviews of data definitions aided by auxiliary video displays, agreement was reached to accumulate the data along comparable lines.

Jonas' pursuit was more complex. His reference data was well over a year old and was placed in the HQ inactive and slow, magnetically encoded video files with storage densities of only 10^6 bits per square inch and multi-second access time. His biggest problem, however, was indexing. He could not always associate the precise spelling of a keyword with a specific case, even though he could always remember well the time when a particular event had happened. His assistant, therefore, developed the habit of sending at the end of each month the contents of his transaction logging casette from his personal computer through a COSM (Computer Output Super-Microfiche) device to produce cartridges containing key reference words. A quick walk to his assistant just a few doors away provided him with the necessary leads to prior correspondence and work papers. His assistant gave him xerographic copies of some of the key frames from the super-microfiche reader. After that, retrieving the old files, browsing through them on the communicator viewer and generating "copies" of key sections

in the "active memory" was quite easy. One key document showing an old memorandum of understanding with initialed amendments to the text was copied both electronically as well as physically be means of an old xerographic process just in case physical evidence would have to be produced.

In his search Jonas had the need to access also reference library material not kept in W.A.E. files. The International Commerce Legal Research Institute in Washington, D.C. allowed retrieval from its patented-access data base via a specially coded data channel to protect its royalty revenues from individual inquiries. This superior, even though expensive service, had eliminated the need for legal publishing in the field of international commerce altogether. Jonas "copied" a key exhibit from ICLRI into Jack's rapidly growing working "file" and had the rest of the material printed out on his assistant's FCD device to be held for a few days "just in case" and then discarded.

Mikasake's job turned out to be the toughest. A first attempt through the HQ aggregated PPM (Profit Plan Model) turned out to give answers which contradicted the judgment of several analysts who switched in their communicators to make an assessment of the final results. Due to shortages of certain components and a long term competitive impact of slowed down installations, the potential strike had actually a number of favorable impacts.

Not trusting the aggregated simulation Mikasake switched the HQ model to actuate a detailed large scale PPM run at W.A.E.'s central data center in Minnesota. Format problems and the monthly spare-parts re-balancing runs delayed run execution by one hour.

When Jack came back from the scheduled personnel resource appraisal review at 11:15 his first thought went to the status of this morning's inquiry from Dave.

Queued messages waiting from Jonas and Marilyn gave him exactly what he wanted. He had to call Dave before the end of the business day.

He let Dave see the excellent results and back-up staff work from Jonas and Marilyn. Despite Mikasake's protests, Dave insisted on seeing the dubious results from the aggregated PPM. Subject to receipt of contradictory results from the detailed PPM, the staff was unanimous what action needed to be taken.

Dave was pleased to see the analysis that had been accumulated for him and could appreciate, (even though not entirely) the huge information processing job that was performed since he asked for it in the morning. He thanked Jack profusely and hit the EOT (End of Transmission) button.

Four hours earlier he and W.A.E.'s European President by chance shared a table with the international President of the Installers Association at the Common Market Anniversary luncheon and had agreed in principle to a course of action now recommended by his staff. At least he would be able to sleep better. As Dave walked out of the front doors of W.A.E.'s London Headquarters, he thought to himself that someday there would be an information system that really could aid in executive decision-making!