Porat, Bell, and the Information Society Recondsidered: The Growth of Information Work in the Early Twentieth Century

Jorge Reina Schement

Columbia Institute for Tele-Information
Graduate School of Business
809 Uris Hall
Columbia University
New York, New York 10027
(212) 854-4222

World satellite systems now make distance and time irrelevant. We witness and react to crises simultaneously with their happening. Networks of telephones, telex, radio, and television have exponentially increased the *density* of human contact. More people can be in touch with one another during any single day in the new communications environment than many did in a lifetime in the fourteenth century. The convergence of telecommunications and computing technologies distribute information automation to the limits of the world's communication networks. We are well past the point of having the capability to transform most of human knowledge into electronic form for access at any point on the earth's surface.
Frederick Williams(1982, p201)

As fewer Workers in the rich nations have engaged in physical production, more have been needed to produce ideas, patents, scientific formulae, bills, invoices, reorganization plans, files, dossiers, market research, sales presentations, letters, graphics, legal briefs, engineering specifications, computer programs, and a thousand other forms of data or symbolic output. This rise in white-collar, technical, and administrative activity has been so widely documented in so many countries that we need no statistic here to make the point. Indeed, some sociologists have seized on the increasing abstraction of production as evidence that society has moved into a 'post-industrial' stage.
Alvin Toffler(1980, p186)

Williams and Toffler evoke an image that today is largely taken as fact. The basis for the image rests upon the idea that we are entering a new age characterized by the recent evolution of the information society, which may be observed by following the course of three recent events: the information economy, information technology and information work.

According to this widely held view, interaction among these three events led to a profound socio-economic shift in the history of the United States. Information-oriented activities grew into the primary sector of the economy and information became a major commodity of exchange. Computers and other information technologies, produced by big science, arrived to shape the production and distribution of information, as well as reframing the context of everyday life. Information work spread as the primary form of employment necessary to produce the new devices and transmit the primary commodity. From this convergence of social forces, an information society began to emerge in the United States during the 1950s, '60s and '70s.

Porat's (1977) pioneering work, The Information Economy, is the original source of data for this interpretation of the rise of the information society. His description of the changes in the U.S. work force underlies the majority view on the growth of information work(Bell, 1979; Dizard, 1982; Katz, 1988; Nora and Minc, 1978; Ochai, 1984; Toffler, 1980; Williams, 1982) and is often linked with Bell's (1976) theory of post-industrial society.

Most scholars of the information society accept Porat's premise that information work became the dominant kind of work in the U.S. at about the same time that the information sector of the economy became the largest economic sector. Moreover, they tend to relate these events to the development and diffusion of the computer. Thus, the dominant image in the literature pictures the late twentieth century as an era when the economy and the labor force underwent a profound transformation, probably driven by a revolution in computing technology.

Information work forms a key component in this explanation, because it impacts most directly on daily life and reflects the actual activities of the members of society. Work, the source of sustenance for modern men and women, began to change in the late 1950s from manipulation of materials to manipulation of information, so that the arrival of the

information age was personally felt by individuals confronting changes in the work place -- or so the argument goes according to Porat.

The purpose of this paper is to examine the portion of this explanation that proposes that information work emerged as a dominant sector within the labor force in the 1950s and1960s. In section 1, this paper reviews approaches to the measurement of information work. In section 2, Machlup's interpretation of the existence of a knowledge work force is reviewed, along with Bell's subsequent proposal of a theory of post-industrial society. Section 3 examines and critiques sources of bias in Porat's construction of information occupations for his four sector analysis of the work force. In section 4, a new four sector analysis is presented based on the critique of Porat and data for recent years. The findings of the two studies are compared and contrasted in section 5. Based on the new findings presented here, section 6 suggests that the information work sector grew to prominence in the 1920s, rather than in the 1950s. It is further suggested that the early growth of the information work sector was due to the expansion of American corporate bureaucracies during the heyday of American industrialization.

Only data presented for the twentieth century are incorporated in this paper, although Porat's analysis goes back to 1860. This is because data for the twentieth century are the most relevant to the question asked here. Moreover, data for the nineteenth century are not of sufficient reliability to be of use to the analysis presented in this paper.

1. Approaches to the Conceptualization and Measurement of Information Work

Determining precisely who is an information worker and what is information work presents a severe test to the social scientist. Obviously all human activities require some measure of information processing or manipulation. Every human task, no matter how routine, depends on an intellectual capacity. Indeed, humans continuously process and manipulate information in order to adapt to their social and physical environments. In the case of manual work, the goal of these information activities is to facilitate the performance of a physical task. Thus, the assembly line worker must interpret what he or she sees and depend on an understanding of

management's directives in order to carry out the appropriate task, even if it is no more complicated than fitting a washer onto a bolt.

Machlup(1962), the first to enter this field, sought to define knowledge as an operational concept, in order to establish a systematic basis for constructing his concept of knowledge industries. He required a model of the knowledge work force to answer questions derived from his attempt to redefine the GNP. But he left his model to the last chapter of the study. Not surprisingly, his analysis of the knowledge labor force lacks the thoroughness of his analysis of the knowledge sector of the economy. Nevertheless, his was the first comprehensive attempt. But while his studies of the nature of knowledge and information shed light on these difficult phenomena(Machlup and Mansfield, 1983), his, and subsequent operationalizations of knowledge production continue to be awkward.

For example, the production of "new knowledge", is difficult to operationalize. Machlup identified one kind of new knowledge producer as an "original creator" who,

> although drawing on a rich store of information received in messages of all sorts, adds so much of his own inventive genius and creative imagination, that only relatively weak and indirect connections can be found between what he has received from others and what he communicates. (Machlup, 1962, p33)

In principle, he resisted any interpretation of original creators as limited solely to those in the "upper strata" (his phrase). But, he limited his group of original creators to scientists and engineers, though he acknowledged that the bulk of time spent doing scientific and engineering work involves little original creation in the above sense. Furthermore, he conceded that original creativity could also be present in the work of a newspaper columnist but he could not say exactly how (Machlup, 1962, p349). Machlup (1962, p386) found that knowledge producers constituted 31.6% of the labor force in 1959, and that if one included students ninth grade and up as members of the labor force, the figure increased to 42.8% (see figure 1).

Bell (1976) noted the rise of the service work force and its importance to the shape of a post-industrial society (see figure 2). He sought to describe a new knowledge class, primarily composed of professional and technical workers with a scientific elite at its core (Bell, 1976, pp228-232) According to his theory, they constituted the class of technocrats that would lead post-industrial society. Even more than Machlup, Bell focused on "new knowledge" as the basis for his division of the work force. Bell ignored the possibility that workers outside the elite class might originate, synthesize, and apply information in order to produce "new knowledge." His 1972 prediction that American society would evolve into a technocracy led by an elite class of knowledge creators continues to hold interesting implications. But his exclusive focus on technocrats limited understanding of the extent and content of information work.

Porat was first to break away from the conceptual constraints of operationalizing new knowledge. He did so by introducing the more inclusive term "information" and sought to determine the extent to which the production, processing, and distribution of information goods and services contributed to the U.S. GNP. He specifically steered away from the problem posed by the recognition that information processing is present in all work.

> We are trying to get at a different question: Which occupations are primarily engaged in the production, processing, or distribution of information as the output, and which occupations perform information processing tasks as activities ancillary to the primary function? (Porat, 1977, p105)

Having identified the "information economy", he aggregated the number of "information workers" active in this new sector of the economy (see figures 7 & 8). For this reason, Porat's study was brilliant yet limiting. His re-analysis of the economy uncovered the strength of the contribution of information activities. He altered thinking on the character of the U.S. economy, so that the phrase, "information economy", soon entered the literature and popular speech and the idea of an information sector within the economy has taken firm hold. His focus on "information" rather than "knowledge" avoided

Machlup's conceptual pitfall, and imposed a broader, more realistic framework for measuring the extent of this kind of work. Nevertheless, he continued in the tradition of Machlup. Porat admitted that information work might occur outside of the information sector, in some agricultural occupations for example. But since these were located outside of the information sector, he could not analyze them within his framework. Even given these limitations, he found that information workers earned 53% of all labor income in 1967 (Porat, 1977, pp8, 117).

Machlup's and Porat's economic analysis shed first light on the phenomenon of information work. Yet their economic approach also directed inquiry away from the study of information work as a social phenomenon within the information society.

The Expert Group at OECD attempted to fill in the blanks by constructing a typology of information occupations, utilizing the 1968 International Standard Classification of Occupations (ISCO) as their point of departure. They divided information work into four groups of occupations: 1) information producers; 2) information processors; 3) information distributors; and 4) information infrastructure occupations. Their success led to other studies analyzing information work as occupational behavior wherever it occurs, rather than as an activity present within the information sector of the economy. Because OECD identified information occupations, rather than directly aggregating information workers as did Machlup and Porat, they opened the door for the direct study of information occupations and workers. Moreover, the use of the ISCO classifications provided the opportunity to compare empirical data from numerous countries. Especially valuable, are those studies focusing on less developed countries where information sectors are small, but where information workers are widely distributed throughout the work force. As a result of the Expert Group's breakthrough, researchers have begun to accumulate data on information occupations and work forces in

many countries (Katz, 1988; Singlemann, 1978).[1]

Schement and Lievrouw (1984) focused on the informational content of work. They assumed Porat's given, that "intellectual content is present in every task, no matter how mundane" (Porat, 1977, p105) But beyond the recognition that human workers process information, they observed patterned information activities increasingly integrated into many occupations, even traditional ones. For example, Sears mechanics routinely fill out numerous forms prior to performing any assignment on an automobile brought in for service. Taxi drivers spend significant amounts of time communicating with dispatchers, processing directions, and maintaining logs of their transactions. All occupations, even traditional ones, contain patterned information activities as part of the work task, and some traditional occupations contain surprisingly high levels of information processing. But in information occupations, manipulation of information defines product, task, and worker. Schement and Lievrouw (1984, p235) identified five categories of workers: 1) information producers; 2) information recyclers; 3) information maintainers; 4) information technology producers; and, 5) information technology maintainers.

Their study of the Dictionary of Occupational Titles (DOT), the basic document for describing occupations, reinforced the hypothesis that information work occurs across all sectors of the work force. As one would expect, they found that 96.9% of the DOT's information sector (divisions 00-29) met their definitions of information occupations. Similarly, they determined that 49.6% of those occupations in the service sector (30-38) could be considered informational. But Schement and Lievrouw also found that information occupations comprised 25.1% of the industrial sector (50-99) and 26.1% of the agricultural sector (40-46). Moreover, while the Department of Labor correctly identified an information sector within the labor force, its definitions were excessively narrow since other sectors also contained significant numbers

---

[1] At about this time, Debons, King, Mansfield, and Shirey (1981) were conducting their survey of information professionals. They also followed an occupational approach, but limited their analysis to "professionals" only, that is those whose occupations required them to hold a bachelor's degree or higher. Thus, their analysis shed useful light on the characteristics of information professionals within the labor force, but did not attempt to gain insight into the pattern of distribution of information work.

of information occupations. Of the total number of occupations recognized in the U.S. labor force, 40% were informational.[2] Thus, information occupations were found across all divisions of the 1977 DOT indicating that information work takes place in all areas of the economy.

Social scientists have grappled with the concept of information work since Machlup's first attempt at an economic analysis of the production of knowledge. In the intervening years, a general picture has emerged with some variation depending on the assumptions of the interpreter. As attempts to define information work have evolved, they encompass a basic set of behaviors consistent across all definitions. The following definition summarizes these points.

> **Information work** occurs when the worker's main task involves information processing or manipulation in any form, such as information production, recycling, or maintenance. Moreover, the consequence of information work is more information, whether in the form of new knowledge or repackaged existing forms. Unlike the assembly line worker, an information worker, such as a telephone operator, processes and manipulates information as an end in itself. Information defines the task, the product, and the worker.

2. Earlier Findings and Updates

Machlup focused solely on those workers who produce knowledge as opposed to those who do not. His data indicated a steady growth of knowledge workers throughout the twentieth century. If one assumes the trend identified in figure 1, then knowledge workers will pass the 50% mark

---

[2]Schement, J.R. and Lievrouw, L. (1984), pp330-333. In the DOT for 1977, 55% of all occupations are found in the industrial sector. The preponderance of industrial occupations, in contrast to the actual number of industrial workers, can be attributed to the longer period of time available for industrial occupations to subdivide and specialize, as well as to the pro-industrial bias built into the DOT at its inception during the Depression years. The information work sector was already the largest sector during the Depression. Yet the idea of information work would not arrive for forty years.

around 1980 or soon thereafter. Rubin and Huber, with Taylor, (1986) updated Machlup's 1962 findings, carefully adhering to his classification scheme of occupations. By carying forth a project begun by Machlup and unfinished at the time of his death in 1983, they found all knowledge-producing workers to comprise 41.23% of the total economically active population in 1980 (p196). This falls considerably below Machlup's earlier estimate. Because Machlup's scheme was not as inclusive as Porat's and others, he and his followers consistently give lower figures for the share of information work. Neither Machlup, nor Ruben et al., attempts a breakdown into four work force sectors.

Bell proposed that the growth of the service sector of the work force (see figure 2) had transformed the reality of life for Americans. In post-industrial society individuals engage in work whose product is quality of life; whereas, before they engaged in work whose product was a material good. At the core of the service work force, Bell hypothesized the existence of a scientific elite creating new knowledge and forming the intellectual impetus for post-industrial society. In turn, this elite drew support from an infrastructure of technical workers. His findings indicated that these professional and technical workers comprised 12.2% of the total work force in 1963 (Bell, 1976, p217). Bell's subsequent writings (1979) on the growth of a technocratic elite within post-industrial society, and within the information society, rely on Porat's data.

3. Operationalizations and Sources of Bias in Porat's Information Occupations

Porat identified five groups of information occupations found in three markets for information services. Workers producing or distributing information commodities for sale in the marketplace fell into the first and largest group of information occupations. In the second group, he placed those occupations concerned with the processing, movement, or manipulation of information for purposes of planning, or coordinating activities that result in the sale of goods and services. The last group comprised occupations involved in the operation of information machines, or technologies, for the purpose of supporting the first two groups. (see figure 3)

3.1 Splitting Occupational Categories

Porat made operational decisions regarding the inclusion of a number of occupations which affected the relative sizes of his categories. He addressed the problem of defining those occupations in which some workers primarily manipulate information, but others do not. In particular, he saw that some service occupations (e.g. physicians, registered nurses) underwent rapid changes in the 1960s and '70s, so that they might reasonably be considered informational in the near future. But at the time of Porat's research, he recognized them as occupations in transition, so he attempted to sift out the information work portion and split eighteen occupations, allocating one half of each occupation to the information sector and one half to the service sector (see figure 4) (Porat, 1977, p119).

By splitting the occupational categories identified by the available census data, Porat questioned the utility of traditional definitions and opened for consideration, the possibility that information work might occur in occupations that did not conform to intuitive definitions. He argued that lumping together foremen who were information workers, with foremen who were industrial workers, confused occupational labels, thus implicitly challenging Bell's (1976) identification of the knowledge work force. Other researchers, such as Schement and Lievrouw (1984), pursued this line of questioning by studying the extent to which information work behavior had penetrated the entire work force.

Porat's decision partially solved the problem of recognizing occupations in transition, but created a systematic bias inflating the size of the information work sector for the early decades of the century. Medical doctors provide an example of why the operational decision to split occupations between information work and noninformation work is misleading. For the 1970s and '80s, an excellent claim can be made for classifying general practitioner (GP) physicians as information workers. Typically, a GP meets the patient and elicits information about the suspected illness in a clinical setting. Then the GP diagnoses the illness and prescribes treatment. The patient takes the prescription to a pharmacist who interprets the physician's instructions and physically dispenses the medication. The patient then performs self treatment by ingesting the medication. The pharmacist and the patient perform the physical aspects of the treatment. The

physician performs the informational components of data collection and diagnosis. Indeed, diagnosis stands at the core of the medical profession's definition of itself. Thus, Porat's claim considering GPs information workers is valid for recent decades. However, in the first half of the century, GPs performed surgery, dispensed medication, gave injections, and took blood samples, in addition to performing diagnoses. Thus, it is unlikely that even 50% of all GPs were information workers prior to the 1960s, the decade when doctors quit making house calls and providing individual treatment.

Porat faced the same problem with some industrial occupations. Foremen, for example, have increasingly assumed tasks of coordinating activities and disseminating information. Moreover, throughout the twentieth century, automation and unionization resulted in converting foremen from industrial workers into information workers. However, this transformation did not occur at a uniform rate for all foremen. Some, especially those in small construction businesses, continue to play the role of lead worker. Porat also split workers in these occupations between the industrial and information sectors (see figure 5).

In the above cases, Porat recognized these occupations as containing a significant amount of information work. But his decision to allocate half of their numbers as information workers gave the false impression that, in the first half of the century, these occupations contained large numbers of information workers. It would have been more accurate to judge the presence of information work on a decade-by-decade basis. That way, he would have allowed for the uneven rate of change. To be fair, such detailed analysis would have been virtually impossible for reasons outlined in section 4.1.

3.2 Assigning Occupations from the Service Sector to the Industrial Sector.

Of more profound effect on Porat's four sector analysis was his decision to shift some occupations from the service sector to the industrial sector (see figure 6). He chose to redefine these occupations as industrial occupations reasoning that, since some of these workers (plumbers and glazers) manipulated physical objects, their occupations should be considered industrial. Furthermore, he also reallocated some transportation occupations on the premise that, "transportation

of bulk commodities is an essential feature of an industrial economy" (Porat, 1977, p117). With these seemingly innocuous changes, Porat effectively redefined the meaning of "industry" and "service", and by doing so, increased the number of occupations in the industrial sector at the expense of the service sector.

This operational decision left a source of confusion greater than splitting occupations between two sectors. Changing the grouping of the occupations but leaving the traditional labels, in effect led to the assumption that the industrial sector contained only those occupations conventionally thought of as industrial. Certainly, this was not Porat's intention. Porat wrote The Information Economy as his dissertation and probably performed the reassignment of occupations in response to suggestions from committee members seeking a more rational basis for differentiating occupations in the industrial sector from those in the service and information sectors.[3] But since the main purpose of the report was to measure the extent of information activity in the U.S. economy, the discussion of the work force is supplementary and limited to chapter seven. The brief explanation on operationalizing occupations within the industrial sector is buried in the text, not likely to be noticed (Porat, 1977, p117).

Therefore, one reason for the high percentage of industrial workers in Porat's data is that he included a variety of service jobs as industrial occupations. Moreover, since many of these groups have been less susceptible to mechanization, they represent large numbers in the work force. By locating plumbers, glazers, railroad brakemen, truck drivers, and all skilled crafts (whether factory-based or not) in the category of industrial work, he inflated the industrial work force while deflating the service work force, thus contributing to the illusion that industrial workers dominated well into the 1950s.

4. Porat's Findings and the Interpretations Based on These Findings.

Porat (1977) took Machlup (1962) as his point of departure, and expanded the division of the labor force from two sectors to four sectors (see figures 1, 7 & 8). Like Machlup,

---

[3]Personal communication recorded in 1977.

he found information workers approaching 50% of the work force in 1980. In his analysis, information workers overtook service workers in 1920, and surpassed agricultural workers at the end of the same decade. But they did not reach parity with industrial workers until 1955. Thus, according to Porat, information workers did not come into their own as the primary work force group until the late fifties. The timing of the trend line for information workers coincides with the period when computers were growing in visibility, the late fifties and early sixties. Porat interpreted the coincidence of these two trends as reflecting the coming of an information society. Similarly, Bell's (1976) theory of post-industrial society was premised on the seemingly recent growth of the service sector. In a later review of Porat's research, Bell (1979, pp180-186) supported Porat's interpretation equating post-industrial society with the information society. Their main point is that the information society is a post-industrial society precisely because the explosion in information technology and the rise of the information sector of the work force are recent. The recency of these two developments demonstrates the passing of the old industrial society of the late nineteenth and early twentieth centuries. However, one basis for this interpretation, the rise of the information sector of the work force, may not be so recent.

5. An analysis of the Four Sectors of the Work Force With Corrections for Biases Identified in Section 3.

An analysis of the U.S. work force in the twentieth century was conducted in order to determine the relative sizes of the four sectors and to test Porat's data. In order to reduce the systemic bias in Porat's earlier approach, two changes were introduced departing from his organization of the four sectors of the work force. First, the census data were reevaluated in an attempt to accurately measure the representation of information workers in those composite occupation groups which include information and noninformation workers, and which evolved a greater information orientation between 1900 and 1980 (see figures 4 and 5). Second, Porat's reassignment of service occupations to the industrial sector was reversed (see figure 6), so that conventional groupings of occupations were maintained.

5.1 Measurement of Numbers of Workers in Composite Occupations

The gross nature of occupational statistics gathered by the census presents a major difficulty for this type of analysis. For one thing, the census combined or divided occupational categories in 1910, 1920, 1950, 1960, and 1970 making it difficult to calculate the numbers of information workers within the affected categories. For example, *Express messengers and railway mail clerks*, suddenly appear in 1910 in large numbers, as do *Foremen, construction* ; and, *Motion picture projectionists.* These insertions give the impression that groups of information occupations came into existence suddenly, where none existed before. On the other hand, *Musicians and music teachers* disappear as a separate group beginning with the 1970 census, their numbers being subsumed within the total for *Professional, technical, and kindred workers.*.

As mentioned above, foremen pose daunting problems when trying to separate information from noninformation workers. For the 1940 census, foremen in nonrailway transportation industries were divided into *Foremen, transportation, except railroad* ; and, *Foremen, telecommunications, utilities, & sanitary services.* Then in the 1970 census, they were recombined into one group to also include *Foremen, railroads and railway express service.* Knowing the numbers of foremen in separate industries will contribute to our understanding of how the information work sector grew. But the answer cannot be teased from the census data.

Some groups of information workers were combined in occupations so that the information workers could not be separated from the noninformation workers. For example, *Jewelers, watchmakers, goldsmiths and silversmiths* ; *Fruit, nut, and vegetable graders and packers, excluding factory* ; and, *Airplane pilots and navigators*, include both information and noninformation workers. The case of jewelers and watchmakers is difficult because watchmakers produce information devices. Similarly, vegetable graders generate information but packers do not. In both cases, cycles of automation and foreign trade have affected information and noninformation workers differentially making it difficult to determine the proper ratio for one census period, much less nine. In the case of the commercial airline industry, it have

produced a stable ratio of around 2 pilots to 1 navigator since 1920, but even this cannot be determined without resorting to numerous outside sources. Therefore, while one suspects that the ratio of information to noninformation workers is significant in these occupation groups (especially for recent decades), no simple ratio can be applied.

Lastly, the 1950, 1960, and 1970 censuses show discrepancies between the numbers of workers in the occupations listed and the subtotals for occupation groupings. For example, when one adds the number of workers listed in the 1970 census for all occupations comprising *Professional, technical, and kindred workers*, the sum is 7,897,000. But the total given by the census is 11,561,000. Three million six hundred and sixty-four thousand workers were "lost" because the census total included persons for whom occupations were not reported. In the case of the subtotals for these years, some also included occupations not shown separately. Undoubtedly, information occupations fell within these unspecified catch-all categories. I encountered insurmountable difficulties in deciding how to classify these hidden groups of workers and occupations, as did Machlup and Porat. The task was akin to attempting a portrait with a house painter's brush.

Upon review of the operational possibilities for resolving the problems inherent in the census data, no solution promised greater accuracy in determining the number of information workers. Ultimately, all attempts to accurately measure the numbers of information workers hidden in suspected occupations were equally defeated. Given its implicit bias, Porat's operational decision to split occupational groups on a 50/50 basis offers no advantage in terms of accuracy. Since one goal of this study is to test Porat's 4 sector construction of the work force, a conservative approach was chosen. In selecting occupations to be included in the information sector, I only included occupations which easily fell within the dimensions of information work outlined in section 1. Of those composite occupations listed in figures 4 and 5, only *Managers* ; *Checkers, examiners, inspectors (manufacturing)* ; and, *Graders and sorters (manufacturing)*, were included as information workers.

5.2 Allocation of Occupations to the Industrial and Service Sectors

In keeping with a conservative approach to this test of Porat's study, all occupations identified in figure 6, were placed within the service sector. In so doing, conventional assumptions were maintained regarding the "industrial nature" or "service nature" of an occupation. Accordingly, the revised industrial and service sectors avoided the systematic bias which exaggerated the size of Porat's industrial sector.

6. Comparison of Findings From all of the Studies

6.1 Similarities

The data from all of the studies (including Machlup's) show an increase in the percentage of information workers in the work force. Porat (1977) and the data collected for this paper show information workers overtaking agricultural workers during the 1920s. All three studies indicate that information occupations experienced little growth during the depression years. Porat found a diminished rate of growth for information workers, from 1960 to 1970, and the findings in the reanalysis support him. All of the studies show information workers approaching 50% of the work force in the 1980s.

6.2 Differences

Porat's data (figures 7 & 8) indicate that the percent of information workers reached a level higher than the percent of industrial workers in the 1950s, while the service sector increased beyond the industrial sector in the mid 1970s. However, the data gathered for this paper show that the information work sector overtook the industrial work sector by 1930, and that the service work sector intersected the industrial work sector during the 1940s.

By correcting for the systematic biases in Porat's work categories, the data in figures 9 & 10 show important work force shifts occurring during the 1920s and 1930s. They show the information work sector rising to primacy by 1930, stalled during the depression, and continuing to grow after 1940. The crucial decades for the emergence of the information work force seem to be 1920-1940. In this period, the United States passed the threshold into a work force where information workers formed the single largest group. At the same time,

service workers reached near parity with industrial workers, and farm workers finally fell below the other major groups. Throughout the post World War II era, the industrial work sector placed third and diminished steadily. Information workers surpassed 50% after 1980, becoming the majority of the work force.

Based on the growth trend between his 1960 and 1970 data, Porat forecast a leveling off of the information work force after 1970. He implied that information work might reach a point of saturation as it approached 50% of the work force. Collected twelve years later, the data in figures 9 & 10 show no actual leveling. During the seventies, the growth rate of the information sector approximated that of the booming fifties. From 1980 to 1986, growth slowed to a rate similar to that of the sixties. As of 1986, the information portion of the labor force continued to gain against other sectors and stood at 52.6% of the total work force. While no leveling off has been observed, there can be no doubt that the information work sector will eventually peak at a point somewhere beyond 50%.[4]

The differences are significant because Porat's data show the information work sector reaching primacy in the years after World War II and the industrial work sector succumbing to the service work sector more recently. Taken at face value, his body of data provide evidence for a recent shift into a work force dominated by information workers thereby reinforcing a view of the information society as taking the place of industrial society. After Porat's study was published, Bell endorsed Porat's position in an important review article. Bell retranslated Porat's data within the context of his own theory of post-industrial society (Bell, 1979). When reinforced by Porat's data, Bell's theory projects a seemingly potent interpretation tying the growth of the information work force to post World War II developments in science and technology.

In contrast, the data presented in this paper pose a paradox, since they suggest that the information work sector

---

[4]A further note on the transformation of the work force since 1980: The 1981 recession represents a good confidence test of the analysis presented in this article. This period saw massive layoffs of industrial workers and the growth of low paying jobs in the service sector. Some of these new jobs went to unemployed industrial workers. Figure 9 shows a decline in the percent of industrial workers and an increase in the percent of service workers from 1980 to 1986, indicating that the data reflect actual labor displacement which occurred in the economy.

surpassed the other work sectors by the end of the third decade of the century. Thus, the post-industrial interpretation is flawed. Furthermore, although the rise of post war science and the computer certainly affected the development of the information work force and influenced the direction of the information society, they cannot be considered a primary cause, since the pattern of information work was set decades before the emergence of the first or the diffusion of the second. The rise of the information work force needs to be understood within the context of the history which shaped industrial society in the United States, rather than as part of a post-industrial transformation. Indeed, the pattern of information work can best be seen as a manifestation of the forces that created industrial society.

7. Modern Management and the Growth of Information Work in the Early Twentieth Century as an Alternative Explanation

The powerful forces that propelled information work to the forefront of the American economy converged in the earliest decades of the century, during the height of the "industrial" period. They did so in response to the problems which industrialization itself posed for managers.

By the middle decades of the nineteenth century, entrepreneurs began to realize the tremendous profit potential of industrial production. Their key insight recognized that the advantage of the industrial system lay in its capacity for sustained growth. When entrepreneurs increased the numbers of units produced in their factories, they drove down the cost per unit of production. Nineteenth century industrial entrepreneurs discovered economies of scale and built empires on this principle (Chandler, 1977, pp240-244; Heilbroner and Singer,1984, pp175-176).

However, the very size of the empires presented immense problems of control for their directors. Styles of management, typical of the entrepreneurs who rose to become captains of industry, collapsed when companies reached sizes that prevented personal attention to each factory, warehouse, and railroad yard owned by the firm. As each new industry -- the railroads, steel, oil, meat packing, chemicals, automobiles -- grew, it encountered the same problems of size and control. The solution, first discovered by managers of railroads, required the creation of an entirely new system of supervision

(Beniger, 1986, pp219-287; Chandler, 1977, pp81-187; Heilbroner and Singer, 1984, pp143-167; Schement, 1989, pp41-44).

The new system of administrative management demanded that managers, first, believe in the superiority of systematic decisions arrived at rationally, and, second, that they invent ways and means for supplying managers with information. The rational management systems necessary for bringing order from the chaos of sprawling industrial empires relied on information as the foundation resource.

So when Alfred P. Sloan Jr. conducted an organization study of General Motors, in 1920, and recommended that each GM division develop statistics for determining the relation between net return and invested capital in order to assist senior management in deciding the allocation of resources to each division, he set in motion the building of a vast information infrastructure within the corporation (Sloan, 1963, pp53-54). In 1921, before the implementation of Sloan's organization study, GM contained 40 separate corporate staffs and 14 manufacturing divisions each with its own staffs (Sloan, 1963, p56). By 1925, with the reorganization of GM well under way, there were 41 corporate staffs and 32 manufacturing divisions with staffs organic to their operations (Sloan, 1963, p115). Furthermore, the invention of organizations based on the flow of information occurred in every corporate sphere. As of 1902, the directors of the United States Rubber Company received information from 36 corporate level staffs and 51 divisions (Chandler, 1977, pp436-437). The directors of Armour & Company, in 1907, reported 23 corporate staffs, and 9 divisions containing 71 separate staffs (Chandler, 1977, pp394-395). American managers like Sloan had discovered that the profitability of large corporations depended on efficient management, and that efficient management depended on information.

As a result, the number of information workers employed by large corporations grew rapidly in the first decades of the twentieth century [see figure 11]. For example, clerical and kindred workers increased by nearly 500% between 1900 and 1930; whereas, their numbers increased by 220% between 1930 and 1960. The numbers of professional, technical and kindred workers increased by nearly 270% from 1900 to 1930;

between 1930 and 1960, their numbers increased by 220% (Machlup and Kronwinkler, 1975, pp754-755).[5]

However, one might reasonably argue that in order to judge the relative importance of corporate bureaucracies in creating the information work force, it is necessary to know something of the extent to which the rise of information work was influenced by the growth of government civil service. Total federal government employees [including non information workers] increased by 360% between 1900 and 1930; whereas, their numbers increased by 400% between 1930 and 1960. Nevertheless, during the first decades of the century, the percentage of federal government employees shrank in comparison to all clerical, professional, technical and kindred workers as the growth of corporate bureaucracies outdistanced the growth of the federal government [see figure 11].[6] In 1900, federal civil servants made up 11.3% of all clerical, professional, technical and kindred workers. In 1930, the first census year to record the primacy of the information work sector, their share dropped to 7.8%. In 1960, in the wake of government growth due to World War II and the Cold War, federal civil servants rose to 14.1%. The inclusion of givernment non information workers means that the actual numbers of government information workers is somewhat less than these figures. Moreover, the total for all information workers is larger than the number of clerical, professional, technical and kindred workers. Therefore, one can see that government information workers were not the major source of growth for the information work force in the first decades of the century.

The creation of an information work force in the early twentieth century resulted from efforts to more efficiently exploit the productivity of industrial workers. That the growing ranks of information workers were interdependent with the industrial work force can be seen in figures 9 and 10.

---

[5]For an excellent treatment of the social and political dynamics affecting the 19th and 20th century growth of the professional work force, see Abbott (1988).

[6]State and local government employment figures were either incomplete or unreliable for 1900-1930; most state, and territorial governments [Oklahoma, Arizona, and New Mexico], were small in numbers of employees. The inclusion of federal government employees who were not information workers appears to be a reasonable compensation for the absence of figures on state and local government employees.

During the Great Depression, the effect of shutting down factories was felt by both industrial and information workers. Industrial workers lost jobs directly from the factory floor. But, less obviously, information workers lost jobs since they also figured into the calculus of corporate profitability. Thus, both the industrial and information work forces stagnated between 1930 and 1940. The point is that the information work force of 1930 was the direct result of industrial production. Moreover, continued demand for information workers of increasing specialization fulfilled the needs of the new corporate bureaucracies coming into existence and formed the technostructure of the new industrial state (Galbraith, 1967).

On the other hand, the information work force of 1980 contained a source of production in its own right -- the producers of information commodities. Therefore, the recession of 1981-1983 did not duplicate the trend lines of 1930. In 1981-83, the information work force continued to grow, while the industrial work force declined.

What is counterintuitive in this alternative explanation is that the image of the information worker is a recent one associated with the 1980s, not the 1930s. The stereotype of the information worker sitting at a desk with a personal computer resonates because it entered the public imagination along with the idea of the information society. No comparable image from the pencil-and-paper era of the '20s and '30s seems fitting. Yet the evidence seems to indicate otherwise.

The theory of post-industrial society/information society proposed by Bell, based on Porat, and generally followed in the literature, is grounded in an interpretation of the growth of the information work force as part of social and technological changes that occured in the U. S. after World War II. Moreover, the concept of the recent rise of information work is integral to the idea of the information society as a post-industrial society. Thus, once information work is shown to have arisen prior to World War II, one of the three conceptual legs of the theory is removed.

If new studies reinforce the interpretation that information work rose to primacy in the 1920s, then new hypotheses must be sought to explain the timing of its emergence and, consequently, the relationship between industrial society and the information society. That is not to say that important economic and technological changes did not

occur over the last 30 years. It is simply to say that any theory of the information society must accept a more complex view and explain the growth of the information work force in the '20s and '30s, along with changes that occured in the '60s, '70s, and '80s. From this perspective, post-industrial explanations appear invalid.

8. Conclusion

In contrast to the visibility of material technologies like the railroad, the automobile, or the computer, the diffusion of the technology of modern management took place with less public notice. The gradualness of pace meant that today we see it in the background rather than in the foreground of history. But what is not seen clearly may have profound effects.

We know little of the underlying dynamics that stimulated the proliferation of new information occupations in the first half of the century. Although, as expressed by Adam Smith, the reasons for this proliferation are clear enough.

> The greatest improvement in the productive powers of labor, and the greater part of the skill, dexterity, and judgement with which it is anywhere directed, or applied, seems to have been the effects of the division of labor. (Smith, 1776/1902, p43)

Smith is equally clear on the significance of work to the modern state,

> The annual labor of every nation is the fund which originally supplies it with all the necessaries and conveniences of life which it annually consumes, and which consist always either in the immediate produce of that labor, or in what is purchased with that produce from other nations.
>
> According, therefore, as this produce, or what is purchased with it, bears a greater or smaller proportion to the number of those who are to consume it, the nation will be better or worse supplied with all the

> necessaries and conveniences for which it has occasion.
> (Smith, 1776/1902, p39)

As to gaining a fuller picture of the dynamics of information work, there are limits to what we can know along the line of inquiry pursued in this paper. It is one thing to statistically analyze the presence of information work as a historic pattern in the distribution of the work force. It is another thing to understand what it means to labor as an information worker at an information job in an information age.

In the case of the United States today, "the immediate produce of this labor" is information. Moreover, it is through information work that the majority of the members of society have and will experience the information age in a form of direct significance to their lives. The image of a computer programmer of the eighties working at Fairchild Electronics is indelibly etched on the public memory of the age. But the image of a 1920s distribution clerk routing crates of apricots picked on land that now houses Fairchild Electronics does not come to mind as easily. Explanations of the information society should encompass both.

ΩΩΩΩΩΩΩΩΩΩΩΩΩΩΩΩΩΩΩΩΩΩΩΩΩΩΩΩΩΩΩΩΩΩΩΩΩ

References

(1975). Series D 233-682. Detailed occupation of the economically active population: 1900 to 1970. Historical statistics of the United States, colonial times to 1970. Washington DC: GPO.

(1975). Series Y 308-317. Paid civilian employment of the federal government 1816 to 1970. U.S. Bureau of the Census. Historical Statistics of the United States, colonial times to 1970. Washington DC: GPO.

(1981). Table 675. Employed persons by sex, race, and occupation: 1972 and 1980. Statistical abstract of the united states: 1981. Washington DC: U.S. Bureau of the Census.

(1987). Table 627. Employed persons, by sex, race, and occupation: 1986. Statistical abstract of the united states: 1988. Washington DC: Bureau of the Census.

Abbott, A. D. (1988). The system of professions: An essay on the division of expert labor. Chicago, IL: University of Chicago.

Bell, D. (1976). The coming of post-industrial society. New York: Basic Books.

Bell, D. (1979). The social framework of the information society. In M. L. Dertouzos & J. Moss (Ed.), The computer age: A twenty-year view (pp. 163-211). Cambridge, MA: MIT Press.

Beniger, J. R. (1986). The control revolution. Cambridge, MA: Harvard University Press.

Chandler, A. D. Jr. (1977). The visible hand: The managerial revolution in American business. Cambridge, MA: Harvard University Press.

Debons, A., King, D. W., Mansfield, U., & Shirey, D. L. (1981). The information professional: Survey of an emerging field. New York: Marcel Dekker, Inc.

Dizard, W. P. J. (1982). The coming information age: An overview of technology, economics, and politics. New York: Longman.

Galbraith, J. K. (1967). The new industrial state. New York: The New American Library.

Heilbroner, R. L., Singer, A., & . (1984). The economic transformation of America: 1600 to the Present .(2nd ed.). New York : Harcourt Brace Jovanovich.

Katz, R. L. (1988). The Information Society. New York: Praeger.

Machlup, F. (1962). The production and distribution of knowledge in the United States. Princeton, NJ: Princeton University Press.

Machlup, F., & Kronwinkler, T. (1975). Workers who produce knowledge: a steady increase, 1900 to 1970. Weltwirtschaftliches Archiv., 111(4), 752-759.

Machlup, F., & Mansfield, U. (1983). The study of information: Interdisciplinary messages. New York: John Wiley & Sons.

Nora, S., & Minc, A. (1978). L'Informatisation de la societe. La Documentation Francaise.

Ochai, A. (1984). The emerging information society. International Library Review, 16(4), 367-372.

Porat, M. U. (1977). Information economy: Definition and measurement (OT Special Publication 77-12 (1)). Washington DC: Department of Commerce/Office of Telecommunications.

Rubin, M.R. and Huber, M.T., with Taylor, E.L. (198????). The knowledge industry in the United States 1960-1980. Princeton, NJ: Princeton University Press.

Schement, J. R. (1989). The Origins of the Information Society in the United States: Competing Visions. In J. Salvaggio (Ed.), The Information Society (pp. 29-50). New York: Lawrence Erlhbaum.

Schement, J. R., & Lievrouw, L. A. (1984). A behavioural measure of information work. Telecommunications Policy, 8(4), 321-334.

Singlemann, J. (1978). From Agriculture to Services. Beverly Hills, CA: Sage.

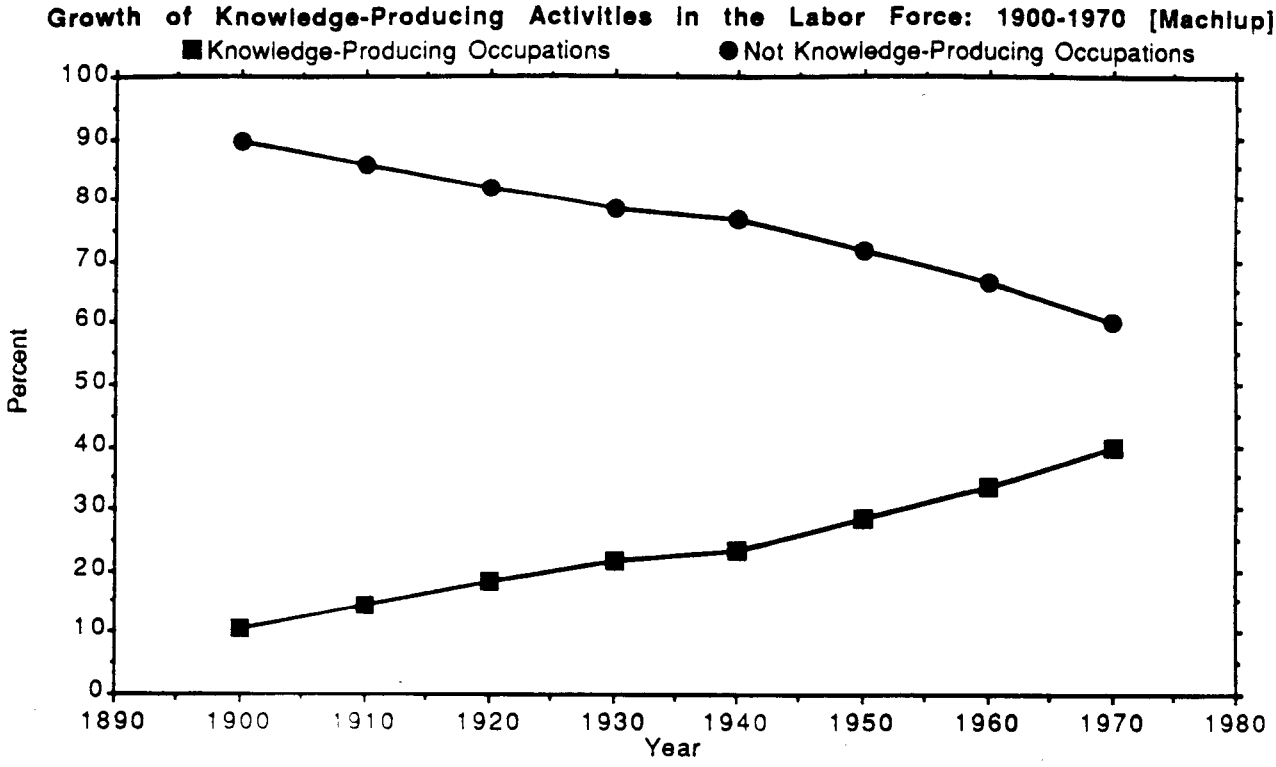
Sloan, A. P. J. (1963). My years with General Motors. New York: Doubleday.

Smith, A. (1776/1902). An inquiry into the nature and causes of the wealth of nations. New York: American Home Library.

Toffler, A. (1980). The third wave. New York: William Morrow.

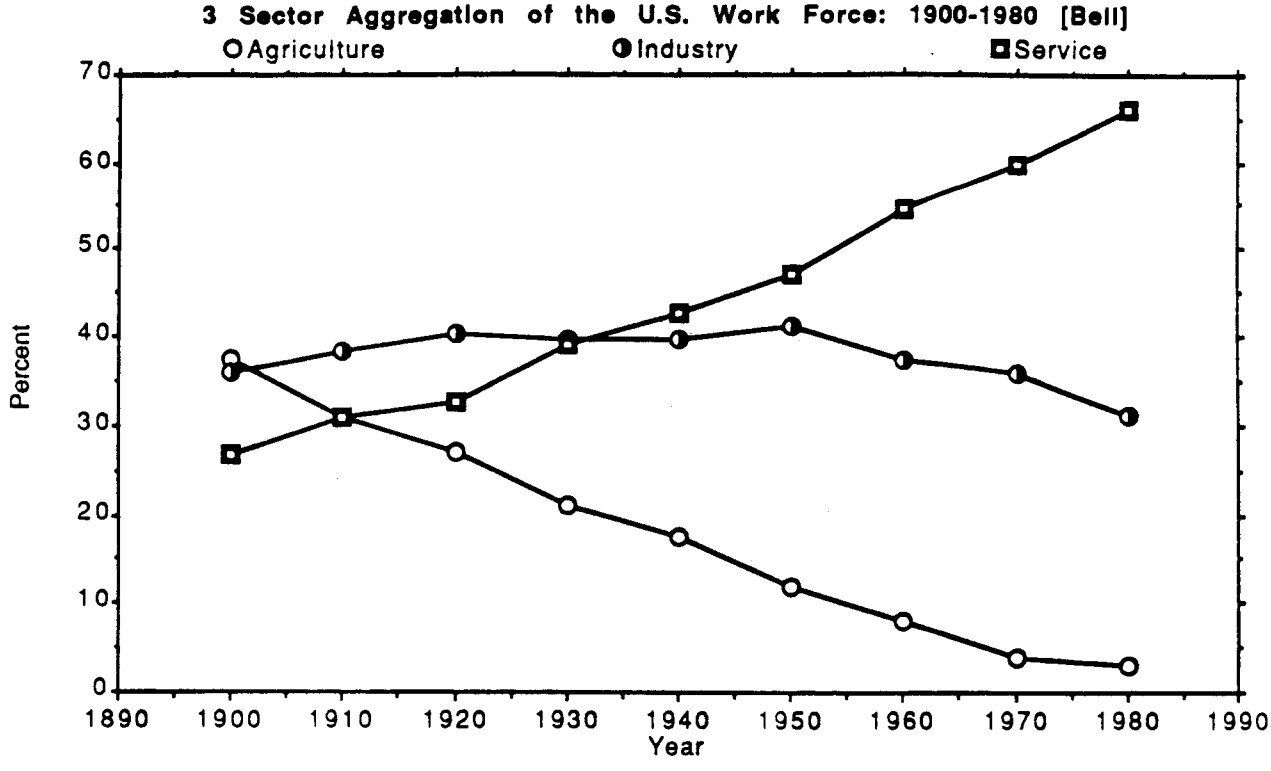
Williams, F. (1982). The communications revolution. Beverly Hills, CA: Sage.

Figure 1



Source: Machlup F. and Kronwinkler T. (1975). Workers who produce knowledge: a steady increase, 1900 to 1970. Weltwirtschaftliches Archiv, 37. pp752-759. Their source: 1900-1950: Historical Statistics of the United States. pp 75-78.

Figure 2



Source: Bell, D. (1976) The coming of post-industrial society. New York: Basic Books, pp134, 137.

Figure 3

Porat's (1977) Typology of Information Workers

Markets for Information

1. Knowledge producers (scientific and technical, producers of private information services).
2. Knowledge distributors (educators, public information disseminators, communication workers).

Information in Markets

3. Market search and coordination specialists (information gatherers, search and coordination specialists, planning and control workers).
4. Information processors (non-electronic based, electronic based).

Information Infrastructure

5. Information machine workers (non-electronic machine operators, electronic machine operators, telecommunication workers).

Figure 4

Occupations Allocated 50% to Service and 50% to Information (Porat, 1977, p119)

Physicians
Registered Nurses
Dietitians
Health Record Technologies
Salary
Radiological Technologies

Counter Clerks, exc. food

Officers, Pilots, Pursers
on Ships
Officials of Lodges,
Societies, Unions
Demonstrators

Hucksters
Sales Clerks, Retail Trades
Misc. Clerical Workers
Managers, Retail Trade,

Managers, Personal Services
Salaried
Managers, Personal Services
Self-Employed
Managers, Business Services,
Salaried
Managers, Business and

Services, Self-Employed
Receptionists

Figure 5

Occupations Allocated 50% to Industry and 50% to Information (Porat, 1977)

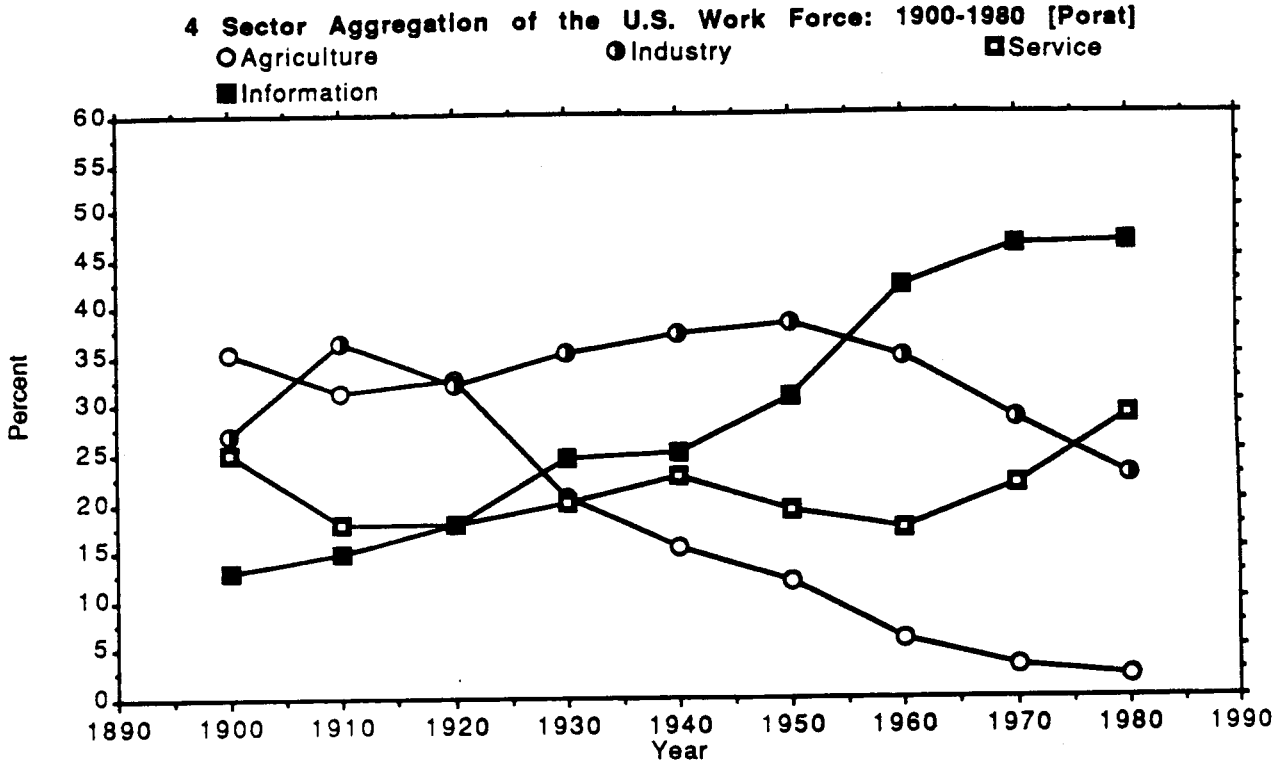
Foreman, NEC
Inspectors, Scalers, Graders, Lumber
Chainmen, Rodmen (Surveying)
Checkers, Examiners, Inspectors (Manufacturing)
Graders and Sorters (Manufacturing)

Figure 6

Service Occupations Allocated to Industry (Porat, 1977, p117)

Railroad Brakemen
Barge Captains
Plumbers
Truck Drivers
Glazers
All skilled crafts whether based in factories or not.
All occupations involved in the transport of bulk commodities.

Figure 7



Source: Porat, M. U. (1977) The Information Economy: Definition and Measurement. (OT Special Publication 77-12 (1)). Washington DC: Office of Telecommunications, U.S. Department of Commerce. p 121

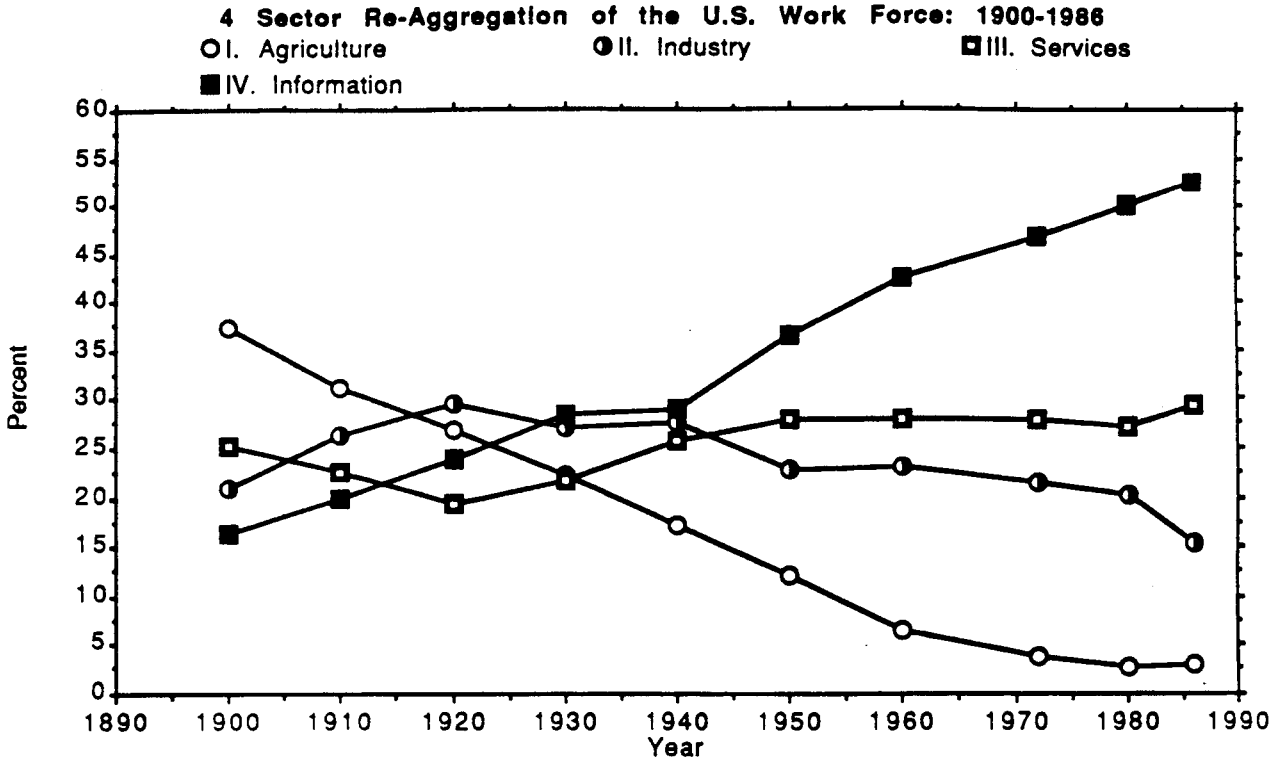
Figure 8

Percentages of the United States Work Force by Sector(Porat, Bell): 1900-1980

Year	Agriculture	Industry	Service	Information
1900	35.3	26.8	25.1	12.8
1910	31.1	36.3	17.7	14.9
1920	32.5	32	17.8	17.7
1930	20.4	35.3	19.8	24.5
1940	15.4	37.2	22.5	24.9
1950	11.9	38.3	19	30.8
1960	6	34.8	17.2	42
1970	3.1	28.6	21.9	46.4
1980	2.1	22.5	28.8	46.6

Source: Bell, D. (1979). "The Social Framework of the Information Society," in M.L. Dertouzos and J. Moss (Ed.s). The Computer Age: A Twenty-Year View. (pp. 163-211). Cambridge, MA: MIT Press.

Figure 9



Compiled from: Table 627. Employed Persons, by Sex, Race, and Occupation: 1986. U.S. Bureau of the Census. Statistical Abstract of the United States: 1988. (108th Ed.). Washington DC, 1987. Table 675. Employed Persons by Sex, Race, and Occupation: 1972 and 1980. U.S. Bureau of the Census. Statistical Abstract of the United States: 1981. (102nd Ed.). Washington DC, 1981. Series D 233-682. Detailed Occupation of the Economically Active Population: 1900 to 1970. U.S. Bureau of the Census. Historical Statistics of the United States, Colonial Times to 1970. (Bicentennial Ed.). Part 1. Washington DC, 1975.

Figure 10

Percentages of the United States Work Force by Sector(Schement): 1900-1980

Year	Agriculture	Industry	Service	Information
1900	37.5	20.9	25.3	16.4
1910	31.1	26.4	22.5	20
1920	26.9	29.6	19.5	24
1930	22.4	27.1	21.9	28.6
1940	17.3	27.6	25.9	29.1
1950	12.2	23	28.1	36.7
1960	6.6	23.1	27.9	42.4
1972	3.7	21.5	28	46.8
1980	2.8	20.2	27.1	50
1986	2.9	15.2	29.3	52.6

Compiled from: Table 627. Employed Persons, by Sex, Race, and Occupation: 1986. U.S. Bureau of the Census. Statistical Abstract of the United States: 1988. (108th Ed.). Washington DC, 1987. Table 675. Employed Persons by Sex, Race, and Occupation: 1972 and 1980. U.S. Bureau of the Census. Statistical Abstract of the United States: 1981. (102nd Ed.). Washington DC, 1981. Series D 233-682. Detailed Occupation of the Economically Active Population: 1900 to 1970. U.S. Bureau of the Census. Historical Statistics of the United States, Colonial Times to 1970. (Bicentennial Ed.). Part 1. Washington DC, 1975.

Figure 11

Comparison of Selected Information Workers to Selected Government Information Workers [in thousands]: 1900, 1930, 1960

	1	2	3	4	5
Yr.	Clerical*	Professional**	Total[1+2]	Government†	Gvt. % [4÷3]
1900:	877	1,234	2,111	239	11.3%
1930:	4,336	3,311	7,647	601	7.8%
1960:	9,617	7,336	16,953	2,398	14.1%

Compiled from: Machlup, F., & Kronwinkler, T. (1975). Workers who produce knowledge: a steady increase, 1900 to 1970. Weltwirtschaftliches Archiv., 111(4), 752-759. Series Y 308-317. Paid Civilian Employment of the Federal Government 1816 to 1970. U.S. Bureau of the Census. Historical Statistics of the United States, Colonial Times to 1970. (Bicentennial Ed.). Part 1. Washington DC, 1975.

*Clerical = Clerical and kindred workers.
**Professional = Professional, technical and kindred workers.
†Government = Total federal government employees [including non information workers].