Chapter 2

Productivity and Employment

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Office automation promises an increase in productivity in all sectors of the U.S. economy, because all industry sectors increasingly depend on information as a major component of products and service. Office automation will significantly reduce the number of jobs required for a given volume of information-handling work. It will also fuel a growing demand for information and information processing.

Thus, it is possible that there will be continuing strong demand for additional office workers. The most likely outcome is, however, slowing growth in the number of office jobs, and eventually, an absolute reduction in the number of jobs in offices from some peak in the 1990s. While the latter outcome is by no means certain, there is sufficient evidence pointing in this direction to justify watchful concern by Congress, and to merit efforts to improve the monitoring of employment trends so that corrective or compensating actions can be taken when and if they are needed. Recent employment forecasts should not lull policy makers into complacency. This is an area fraught with uncertain y.

THE UNCERTAIN OUTLOOK

The first two conclusions—that work required for handling a given volume of information will decrease, and that demand for information will grow-can be made with considerable certainty. Between these two conclusions and the third, that the number of office jobs may ultimately decline, lie several large questions. The most important is, “how much will the total volume of information-handling increase?” Second, what are “information-handling” jobs, and which ones will be affected? Third, if there is a stable or lower demand for white-collar work, are there ways of adjusting without creating structural unemployment ?

This assessment indicates that, with the amazing capability inherent in computer and communications technologies, even the needs of a thoroughly information-driven economy do not, in the long term, assure rising levels of white-collar employment equal to growth of the labor force. That labor force by the year 2015 will be about 142 million people or 35 percent larger than it is now. But the number of people entering the work force each year is declining. If the transition to stable or declining office employment is slow enough then the negative effects would be muted. If there is strong economic growth, then office employment could continue to grow, although more slowly than in the past. Strong continuing economic growth like that of the 1950s and 1960s is not, however, certain in the future.

The overall employment effects of the first phase of office automation, the large computers installed in the 1960s and 1970s, have been hard to detect amid other changes in the economy. But the second phase of office automation, decentralized computing and advanced communication capability, is spreading rapidly. The third phase, the evolution of integrated office systems or networking, will bring about much restructuring of the flow of work in and between offices.

Delayed effects of the first phase and the emerging effects of the second and third phases are overlapping. From this perspective, it is possible to see the latent productivit, enhancing effects of office automation as water building up behind a dam. The dam is made of institutional inertia and the unavoidable transition problems. When that is removed, there could be a flood of work force reductions, unless

workers are channeled into productive new jobs and industries.

Organizations often resist laying off workers when they adopt labor-saving technology, preferring, when possible, to let attrition solve the adjustment problem. This is one example of institutional inertia. But every year some firms go out of business and some new businesses are started. New organizations are likely to use new technology from the beginning, creating fewer jobs than new starts would otherwise create. This is probably already happening; for example, Dun and Bradstreet reported that in 1984 more new firms were started than in 1983, but they employed nearly 5 percent fewer people. In the financial, insurance, and real estate industries, which are the leaders in office automation, the number of workers hired by new organizations declined by over 9 percent. [1] If new organizations tend to create fewer jobs because they make effective use of new technology, then employment effects would tend to accelerate over time.

Which white-collar jobs will be affected? Most directly and strongly, they will be clerical jobs. The number of professional and managerial jobs is apt to be less strongly affected, and professional work may continue to expand indefinitely in an information society. However, even managerial and professional jobs are not immune from the labor-saving effects of office automation.

Businesses are now engaged in strong efforts to reduce labor costs and to increase productivity. *Forbes Magazine* reported that the nation's 500 largest publicly owned companies (which account for about a fifth of all civilian employment) expanded their total sales in 1984 by 4 percent and at the same time shrank the number of people on their payrolls by 4 percent, or 840,000,[2] Sales per employee rose by 10 percent, and assets per employee rose by 11 percent; these are two rough measures of increasing productivity. There are other signals of pressure on employment growth despite continuing job creation. During recent business cycles, unemployment rates in "business recovery years" have remained higher than they were in recession years before the mid-1960s, in spite of the creation of thousands of new jobs. The number of involuntary part-time workers is continuing to grow. These indicators are not tied directly to office automation, yet there is a strong possibility that some of the effects on employment oft wo decades of office automation are now becoming apparent.

[1] The 102,329 new starts in 1984 hired 578,838 workers compared to 607,416 new hires for the 100,868 new starts in 1983. See "Dun and Bradstreet Looks at Business, " a Dun and Bradstreet subscriber newsletter, vol. 3, No. 3, May-June 1985.

[2] Forbes *Magazine*, Apr. 29, 1985, p. 231.

The Framework for Analysis

The long range effects of office automation on office employment are pictured, in figure 2-1, as a dynamic interaction between:

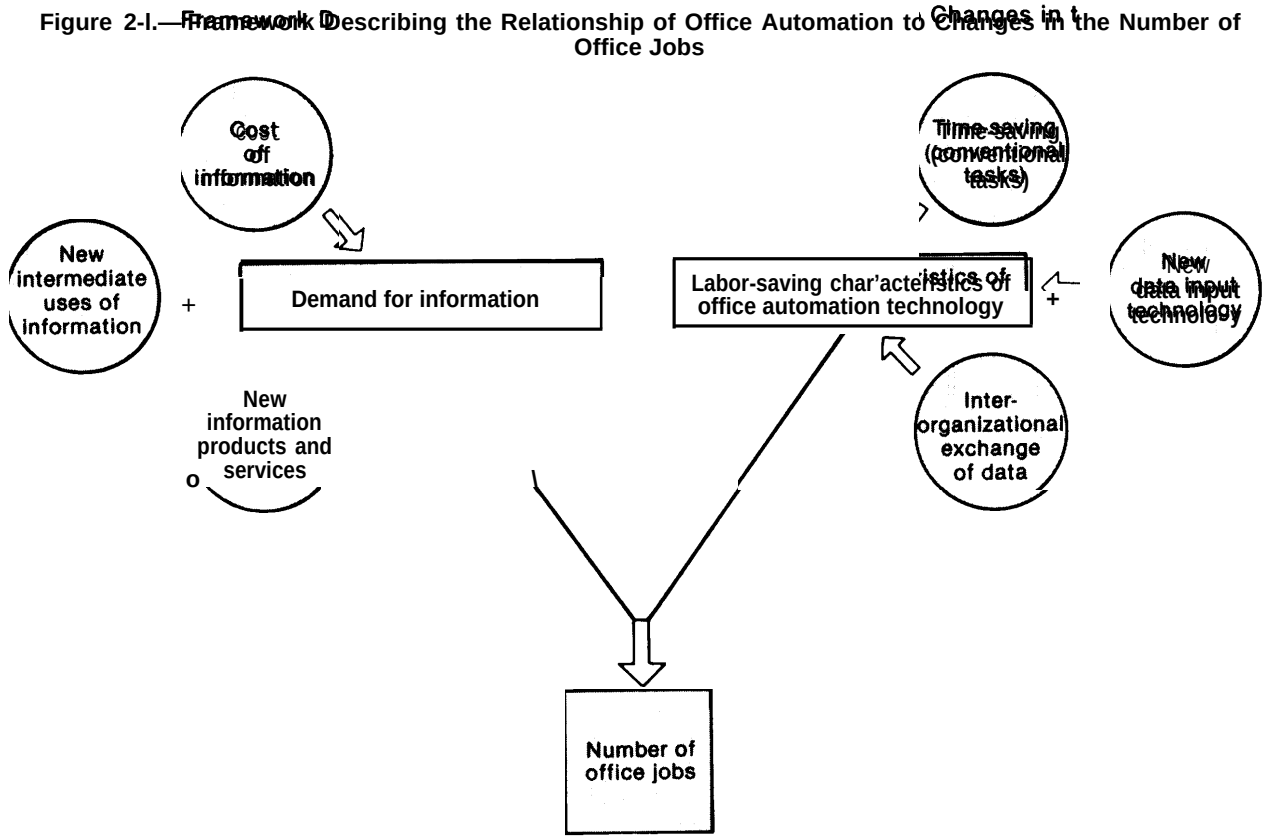
- growth in demand for information, and
- the labor-saving characteristics of office automation technology.

Information handling and communication play a larger and larger role in all economic activities. This is what is meant by an "information society. " Computers whet the appetite for information. More kinds of information can be collected. It can be analyzed in more ways, thereby producing still more information. All of this data can be used in new ways and easily communicated to more people.

Organizations are likely to find more internal or intermediate uses for information, and to produce new information-intensive services or products as office automation technology makes it possible to combine, package, and distribute information in innovative ways. Consumer expenditures appear to be shifting from hard goods to soft goods and services, as evidenced by the growth in service industries and in particular by the proliferation of new financial services in recent years.

Because information-handling costs have always been primarily labor costs, and because office automation technology is labor-saving, it is assumed that the cost of information-handling will decrease. This should, accord-

Figure 2-l.—Framework Describing the Relationship of Office Automation to Changes in the Number of Office Jobs



SOURCE Off Ice of Technology Assessment

ing to standard economic theory, tend to further increase the market for information.

Office automation is adopted for many reasons, and often reduction of the work force is not one of the objectives. But it is, by nature, labor saving, even when that is not a primary motivation for its adoption. This argues for a significant reduction in the labor necessary for handling a given volume of information.

The statements made above are hypotheses or arguments often heard in discussions about whether office automation will lead to an increase or a decrease in office jobs. The purpose of this chapter is to examine these propositions in more detail. They provide a basic framework for discussing the long-range effects of office automation on future office employment. But there are several levels of complexity that must be considered. Many of these propositions involve, or conceal, definitional or logical difficulties. The interactions between them are not well understood. There are other factors and forces acting on white-collar employment—and intermediate steps in these relationships —that are ignored in the simple diagram shown in figure 2-1.

Estimates of the relative magnitude of these competing forces are judgment calls. Those who see an increasing demand for information producing an expanding need for information-handlers, and those who anticipate new industries or new occupations to create jobs for displaced office workers can not, in the nature of things, offer a valid description of what those future products, industries, and jobs might be. They are therefore often accused of optimism based on ungrounded faith. Those who see disturbing signals of future job loss can point only to fragmentary and widely dispersed evidence that is difficult to compare or aggregate, and are equally subject to charges of ungrounded pessimism.

Employment data is notoriously difficult to work with because job categories and occupational titles are not standardized and change over time. Projection of trend lines is not very helpful in discussions of significant technological change, and arguments from analogy to automation in the past are not convincing because the surrounding social and economic environment has radically changed.

These caveats do not mean that analysis is useless; they only warn of the degree of uncertainty necessarily involved. It is the task of policy analysts to advance conclusions in spite of incomplete evidence, as it is the task of policymakers to make decisions under conditions of uncertainty.

What Follows

Since OTA's conclusions about the possible employment effects of office automation are less optimistic than some recent long-range employment projections, these will be reviewed to point out forces and factors that are usually not adequately accommodated by econometric models and that strongly affected the conclusions of this assessment. These considerations have to do with the way in which technological change erodes the validity of conventional assumptions, disrupts long-term trend lines, and changes the meaning of established categories of occupations and industry boundaries.

The conclusion that the number of office jobs may, between 1985 and 2000, tend to stabilize and possibly begin to decline, rests on the following points:

- Computers represent a fundamental technological change rather than a marginal improvement; their adoption will resemble that of the telephone and the typewriter rather than that of the industrial robot. Office automation will be pervasive.
- Recent technology/employment forecasts are flawed and probably understate the employment effects of office automation. (See "Recent Labor Force Projections.")
- The potential productivity benefits of office automation are larger than are generally recognized; they have been and will be masked during a transition period because of technical and managerial problems, and institutional inertia in adapting to technological change. (See "Productivity and the Nature of White Collar Work.")
- Office automation will reduce the need for labor by sharply reducing the need for both primary and secondary data entry; time saving in analytical, computational, and communication-related tasks; direct substitution for labor in many tasks; eliminating intermediate and preparatory steps or tasks; and transferring tasks from highly paid to lower paid employees (see "How Office Automation Affects Work").
- Specialized occupations with narrowly defined tasks will be most directly and immediately affected (see "Emerging Occupational Shifts' '). Automation will eliminate or reduce the need for tasks characteristic of some "generic" clerical occupations (i.e., those common to most or all industry sectors). Growth of some categories of management occupations may be sharply constrained or even reversed because of time savings in information collection, analysis, and formatting; time savings in communications; increases in scope of supervisory attention and monitoring capability; and reduction in the number of workers to be supervised.
- There are already possible indicators of constrained employment growth from office automation, including declining unit labor costs in the heavily automated financial, insurance, and real estate (FIRE) industries (see "Technology and Recent Trends in White Collar Employment").
- Office automation could also encourage conversion of employees to part-time, temporary, or independent contractor status, with a reduction in the number of full-time, permanent jobs (see "Part-Time and Temporary Employment").
- Off-shore sourcing of clerical work, now small in volume, could increase significantly in the next decade (see chapter 8).
- Office automation may have more significant or more highly visible impacts than

earlier waves of mechanization and automation in the United States because the economy will not be growing as rapidly, it will affect more occupations, and it will cut across industry sectors (see "Analogies From Past Waves of Automation"). There are, in many cases, some signs that technology has contributed to rising unemployment rates since the end of World WarII.

The remainder of this chapter discusses these points in more detail, beginning with a review of recent employment forecasts. It ends with a brief discussion of labor force growth, possible adjustment mechanisms, and some policy implications.

RECENT LABOR FORCE PROJECTIONS

The Bureau of Labor Statistics (BLS) expects employment in managerial, technical and professional, and clerical occupations to increase by about 28 percent by 1995.[3] Most job growth is projected to be in the service producing industries (transportation, communications, utilities, trade, finance, insurance, real estate, government, and "other services"), which BLS expects to account for 75 percent of all new jobs, or 18.7 million by 1995. Since these industries are the ones in which office automation could have major effects, the BLS reasoning should be examined closely.

BLS expects that a quarter of all employment growth, 31 million jobs, through 1995 will be in the category of "other services. Within this category the largest industry is business services, which includes a variety of things from business consultants to janitorial services, and is projected to grow by 5.3 percent per year, with employment growth of 3.9 percent per year. Professional services (legal, engineering, accounting, etc.) are expected to add another 850,000 jobs. Financial and banking services are projected to have strong growth but "modest" gains of employment of 1.9 percent per year or 21 percent increase in 10 years.

The BLS projection assumes: 1) full recovery from the 1982 recession and stable economic growth through 1995, 2) continuing decline in the average weekly work hours per worker, *3)* productivity growth at the rates of the late 1960s and early 1970s, and 4) some shifts in employment, namely that "new labor-saving technologies will cause shifts to occur among industries, with many of the old-line factory jobs giving way to new industries and occupations. Factory automation and office automation will displace some workers but they will have an opportunity to move into other jobs; what new industries and occupations will be created is not specified.

BLS expects that jobs requiring college or specialized technical training will increase significantly, as will some less skilled jobs; for example, nursing aides and orderlies. The BLS analysts recognize that "employment growth in many occupations will be affected by technological change . . . " and that among these are typists. Nevertheless, they expect many office occupations to grow, as shown in table 2-1.

BLS projections show three alternative growth rates, which are based on alternative assumptions about the overall rate of economic growth. The BLS employment projection process links a labor force model, an aggregate macroeconomic model, an industry activity model, a labor demand model, and an occupational demand model. Under different assumptions

[3]George T. Silt' estri, John M. Lukasiewicz, and Marcus E. Einstein, "Occupational Employment Projections Through 1995, " *Employment Rejections for 1995*, U.S. Department of Labor, Bureau of Labor Statistics, Bulletin 219'7, March 1984, p. 44.

[4]Manufacturing employment. which has declined from 25 percent of all jobs in 1959 to under 19 percent, is projected to hold this share through 1995. This means that manufacturing would have to create about 4.3 million additional j ohs, or one-sixth of all new jobs.

Table 2-1.– Growth in Selected Occupations as Projected by the Bureau of Labor Statistics, 1982-95

Occupations	Projected growth[a] Low	Moderate	High	Range of jobs added[b] (thousands)
Total : all occupations	23°/0	250/o	28%	23,336-28,392
Total: professional, technical, managerial, and clerical	26	28	31	11,921-14,165
All professional, technical, and related occupations	30	31	35	4,961-5,741
Accountants, auditors	38	40	44	325-373
Computer specialists	79	81	84	414-439
Economists	29	27	30	9-9
Managers, officials, and proprietors	26	28	31	2,476-2,935
All clerical workers	24	26	29	4,484-5,489
File clerks	O	2	5	21-34
General clerks	7	9	12	642-765
Office machine operators	26	28	30	243-284
Computer operator personnel	25	27	30	147-172
Data entry operators	–12	–11	–9	–38--28
Secretaries, stenographers	24	26	29	644-787
Typists	15	16	19	146-185
Telephone operators	6	8	10	19-31

[a]Projections were made for low, moderate, and high occupational growth scenarios with associated variation by industry
[b]The range represents the low to high estimates

SOURCE George T Silvestri, John M Lukasiewicz, and Marcus E Einstein, "Occupational Employment Projections Through 1995," *Employment Projections for 1995*, US Department of Labor, Bureau of Labor Statistics, Bulletin 2197, March 1984, p 44

about economic growth, industry sectors grow at differentiates. If an industry is expected to grow, occupations concentrated in that industry are projected to grow proportionately, with marginal adjustments made to accommodate anticipated technological changes. The tying of occupational growth to growth in specific industries accounts for some curious outcomes to be noted in table 2-1, which is abstracted from much larger tables in the BLS projection. For example, demand for economists increases less under the moderate growth scenario than under either the low or high growth scenarios, presumably because economists are concentrated in industries that would expand least in a period of moderate economic growth.

Some occupations that declined from 1979 to 1982 are nevertheless projected to grow in the future, because the decline is attributed to the business recession and it is assumed that with recovery, past trends in occupational growth will be resumed. The model does not separate change due to business cycles from technological change. For example, drafters decreased by l.6 percent from 1979 to1982, but are projected to increase from 2 to 8 percent. Cost estimators declined 2 percent but growth of 41 to 48 percent is projected. Bookkeepers (hand) declined by 3.9 percent but 13 to 18 percent growth is projected. General clerks declined by l.2 percent but 27 to 33percent growth is projected.

This mechanical linking of occupational growth to industry growth suggests that BLS may underestimate the effect of technological change (and office automation in particular) even though the text accompanying its projection acknowledges that:

> Most office clerical occupations are expected to grow more slowly during 1982-95 than in the 1970s because of office automation. . . Secretaries will increasingly use advanced office equipment in the future, thereby becoming more productive. This in turn will dampen demand for the occupation. Nevertheless, seeretaries are projected to grow at a rate that is about average because of the growth of industries in which they are concentrated.[5]

Anticipated growth in demand for goods and services, generated through the BLS macroeconomic model, is translated into a projection of industry activity (e.g., growth rates) through the use of input/output analysis. As a commentary on the BLS methodology notes:

> (Input/output modeling) . . . assumes, for example, fixed coefficient production; that is,

[5]Silvestri, Lukasiewicz, and Einstein, op. cit., p. 44.
"John A. Hansen, *Bureau of Labor Statistics Methodology for Occupational Forecasts,* a contractor report for the Office of Technology Assessment, April 1984. p. 13.

> that there is a single production process that must be used in the production of each good. No substitutions are permitted between the various inputs to the production process . . . (U)nless a new input/output table is constructed for each time period, technological change cannot be incorporated into analyses based on input/output tables. The use of input) output tables therefore naturally makes it difficult to incorporate technological change into occupational forecasting.

BLS analysts are acutely aware of this problem. Adjustments to take into account technological change are made at several points in the BLS process. Technological change will effect the forecast output of the economy as a whole, and the allocation of final demand into the 156 categories used in the model. A technological development that affected the distribution of demand for transport of freight between the trucking and air transport industries would require changing coefficients at many points in the model, for example, those governing the relationships between demand for transportation, energy, and perhaps steel and rubber.

Industry outputs must then be translated into demand for labor—and number of jobs. The econometric model that does this is based on a constant elasticity of substitution production function, that is, a basic formula that interprets the substitutability of one input for another, for example, capital for labor. It includes a technology variable that governs the total output-to-capital ratio for the economy as a whole. This variable is given a different weight for each industry. When the output-to-capital ratio is changing significantly (as it has been in office-oriented industries) this weight must obviously be adjusted. Some adjustments are also made in translating labor demand into number of jobs, to accommodate trends in length of workweek and work year.

Such adjustments are made, in the BLS procedures, by the analysts using their own knowledge of and assumptions about current and anticipated technological developments. They are, in other words, made on the basis of judgment and can only be evaluated in that light. However, the rationale for making these adjustments, and the precise changes that are made, are difficult for outsiders to track and examine.[7] BLS is, however, notably conservative in making such adjustments, relying heavily on past trends.

In a recent General Accounting Office (GAO) publication,[8] BLS stated its assumptions for some "growth occupations. They were very simple, brief, and generalized. For example, for accountants and auditors, the only technological assumption was:

> It was assumed that there will be no technological changes or developments that will affect employment in this occupation.

For bookkeepers (hand), the relevant assumptions were as follows:

> Computerization has had a significant effect on employment in this occupation by slowing down the rate of growth. This trend will continue, causing the employment of bookkeepers to grow more slowly than average.
>
> Computerization will continue to develop, but its adverse effect will be offset by the rapid increase in the volume of business.
>
> Computerization will continue to spread between 1982 and 1995. There will be further evolution of labor-saving technologies and continued diffusion throughout the economy, resulting in higher productivity and a slower-

Ibid., See also Timothy I,. I Hunt and H, Allen Hunt, of the W.E. Upjohn Institute for Employment Research. "An Assessment of Data Sources to Study the Employ merit Effects of Technological Change, a paper submitted to the National A cademy of Sciences Committee on Women's Employment *and* Related Social Issues, October 1984. They comment:

> Technological change actually enters into the (f31.S) system in at least three places (T)echnological change will have specific effects on some occupations. it will have an overall impact on the product ivity of workers, and it will affect the demand for good \ and services generally
>
> I t is worthy of note that t his system involves a considerable amount of judgment, especially in anticipating the effects of technological change. There are no simple equations that pr('diet changes in staffing pat terns w it hin an industry. I n fact, t he BLS staff has found that trends in industry employment levels can be predicted more accurately than the changes in occupa it ional employment This is due in large part to the difficulty of pro jecting specific occupational impacts of technological change

[8] U.S. (General Accounting Office, *Specific Technological Assumptions A ffecting the Bureau of Labor Statistics 1995 Employment Projections*, Report to the Hon. Berkley Bedell, (1, S. House of Represent atives, GAO OCE-85-2, May 20, 1985.

than-average rate of growth for this occupation,

The occupational forecast is made by disaggregating the labor demand further; that is, the 156 industry sectors used in the other models is spread apart into 360 industries and the total number of jobs is allocated between them. For each of the 360 industries, BLS considers the historical staffing pattern—obtained from the Occupational Employment Survey and carried out by State Departments of Employment Security.[8] The jobs that it is assumed the industry will provide are distributed among the occupations according to the ratios that have been obtained in the past, with some qualitative adjustment. In preparing the occupational projections for 1995, the BLS procedure assumes that all workers will be in occupations that not only exist now, but have existed long enough that employers begin listing them as separate categories.[10]

BLS uses several kinds of sensitivity analyses in preparing its forecasts; the analysts lay out three different scenarios or trend lines for economic growth, and also make varying assumptions about labor productivity. These, however, would not capture fundamental changes in production processes and capital-to-output ratios. No sensitivity analyses are performed to test the effect on staffing patterns of technological change.

In summary, the strong link in BLS forecast methodology between industry growth and projected occupational growth, together with reliance on traditional industry staffing patterns and occupational distributions, tends to greatly underestimate the effects of fundamental technological change. This forecast cannot be assumed to capture reliably the potential effects of office automation.

The Leontief-Duchin Forecast, "The Impacts of Automation on Employment, 1963-2000,"[11] also used input-output analysis. To deal with the problem of incorporating the effects of technological change into the model, however, Leontief and Duchin allowed the coefficients in the matrix to change over time, adjusting these coefficients on the basis of qualitative judgments.

Four scenarios were developed. Scenario 1 assumed no further automation or any other technological change after 1980; it is clearly a highly unlikely scenario and is used as a reference or benchmark for the others. Scenarios 2 and 3 project an increasing use of computers in all sectors for specific information processing and machine control tasks and their integration. Of these two, Scenario 3 assumes faster technological progress and more rapid adoption of available technologies, including more powerful software. Scenario 4 is identical to Scenario 3 except that it uses different final demand assumptions. The study concluded that the intensive use of automation:

> . . . will make it possible to achieve over the next 20 years significant economies in labor relative to the production of the same bills of goods with the mix of technologies currently in use. *Over 11 million fewer workers are required in 1990 and over 20 million fewer in 2000, under Scenario 3 as compared to Scenario 1:* this represents a saving of 8.5 percent and 11.7 percent respectively of the reference scenario labor requirements.[12] (Emphasis added.)

The differences by 1990 between Scenario 1 (no further automation) and Scenario 3 for major categories of workers are: [13]

- 5.5 percent more professionals,
- 13.9 percent fewer managers,
- 32.4 percent fewer clerical workers, and
- 8.4 percent fewer jobs in all categories in the national economy.

[8] The survey covers 500,000 businesses, one-third of which are covered each year, and 1,500 occupations found within those businesses,

[10] Hansen, op. cit., p. 18.

[11] Prepared by the Institute for Economic Analysis, New York University, for the National Science Foundation, April 1984, Wassily Leontief and Faye Duchin, Principal Investigators.

[12] Leontief and Duchin, op. cit., p. 1.15. There is a slight discrepancy between the percentages given in the authors' text quoted here and those given below and computed from their tables (p. 1.16 of the report cited); the difference is minor and perhaps was caused by rounding errors.

[13] This includes all private sector employment plus public education and health, but does not include public administration, the armed forces, or household employees.

By 2000, the changes are greater:

- 21.5 percent more professionals,
  41 percent fewer managers,
  45 percent fewer clerical workers, and
- 11.4 percent fewer jobs in all categories in the national economy.

Note, however, that "fewer" here means only fewer than there would be without any further automation—not fewer workers than there are now. As compared to the real figures in 1978 (the base year), total employment will grow by 49 percent under Scenario 3 as compared to 53 percent growth under Scenario l—no further automation. By 2000, it will increase 76 percent over 1978 employment in Scenario 3, as compared to 98 percent increase in Scenario 1.

Under Scenario 3, the proportion of professional jobs to all jobs rises from 15.6 percent in 1978 to 19.8 percent in 2000; managers' jobs decline from 9.5 to 7.2 percent, and clerical jobs from 17.8 to 11.4 percent. Sales workers decline slightly relative to total employment, while the proportion of craftsmen, operatives, service workers, laborers, and farmers each increases. The increases in professional jobs, under Scenario 3, are mainly in demand for computer specialists and engineers.

The good news in the Leontief-Duchin forecast is that if their projections were correct, the labor requirements for Scenario 3, in 2000, would exceed the projected available labor force of 157.4 million (after allowance is made for public administration, household workers, and some multiple job holders). This means, however, that the rate of growth in final demand that they assumed could not be achieved without still greater technological change.

This problem reveals a serious weakness in the model; it ignores the importing of both capital goods and services. Since imports are a major, and growing factor in the economy, the Leontief-Duchin model does not reflect economic reality.

Leontief and Duchin developed a fourth scenario to assess the growth in demand that could actually be attained under their technological assumptions. Growth in demand was progressively reduced until the labor force needed fell within the range of the projected labor force available for the years 1990 and 2000, This scenario does not correct the defect of ignoring imports; all demand is again assumed to be supplied by domestic labor.

This required a reduction of their projected output demand of 4.4 percent for 1990 and 17.8 percent in 2000, Because overall economic activity is lower in Scenario 4, capital investment is also lower, and the number of jobs related to production of capital goods falls, especially craftsmen's jobs. The occupational composition of the work force otherwise remains much the same. The percentage reduction in demand for labor is, however, greater than the reduction in final demand.

Scenario 4 therefore represents an estimate of the extent to which real per capita consumption can increase *if* the entire projected labor force is employed, using computer-based technologies, and demand is met by domestic production. It is important to note that the Leontief-Duchin team did not generate its own projection of consumption (final demand, or delivery of goods and services), but used that generated by BLS for its moderate growth scenario, discussed above.

Leontief and Duchin, as noted, incorporated the potential effects of technology into their forecast by changing the input-output coefficients over time. These changes are exogenous to the model; the direction and magnitude of the changes were arrived at by the team of analysts on the basis of extensive review of research results and scholarly and trade literature, and their assumptions are set out within their project report. The factors explicitly taken into consideration were estimates of the rate and extent of capital investment, the amount of time in 1977 that a worker spends performing particular tasks, the amount of automatic equipment that will be applied to those tasks, the amount of time that can be saved per task by using automated equipment, the percent of workers in particular occupations and industry sectors that will use the

new technology in a given year, and the possible increase in demand for certain office occupations (i.e., the effects of increased demand for information-handling). Coefficients were modified accordingly; for example, in Scenario 3, the labor coefficient for "stenographers, typists, and secretaries" for 1990 was set at 0.65 of the 1977 coefficient, and for 2000 it was set at 0.45 of the 1977 coefficient, meaning that for a given unit of work done by these workers in 1977, only 65 percent as much labor will be needed in 1990 and only 45 percent as much by the year 2000. To look more closely at the narrower category "secretaries," the team assumed that by the year '2000 in comparison to 1977:

- 30 percent of secretaries will *not* be affected by word processing,
- 20 percent of a secretary's time is spent in tasks not affected by word processing,
- word processing saves 80 percent of the time required for conventional typing,
- 35 percent of secretaries are also affected by other office technologies,
- 45 percent of their time is affected by other office technologies, and
- 75 percent of secretaries' time is saved by new technology relative to old technology.

While other analysts may quarrel with one or all of these estimates or assumptions, and may question whether they have foreseen likely technological breakthroughs, their assumptions in general do not appear to be overly conservative. There is no obviously better way available as yet to arrive at such estimates than the one the project used–expert judgment. The far larger problem has to do with the assumptions about future economic growth.

This brings one back to a broader version of the question proposed at the beginning of this chapter: will the demand for information (which is to a large extent a function of the level of economic activity in this country) really grow to an extent that it will more than balance the labor-saving effects of information technology? Both the BLS and Leontief-Duchin forecasts of employment growth depend on an assumption that it will do so. The model formulated by Leontief and Duchin is dynamic in that investment is a function of changes in output in industry sectors. They project significant gains in employment in most sectors because the model projects nearly unlimited increases in the production of capital goods (output). But the model ignores the strong trend toward import of capital goods (and of services); in reality, the income generated by production of capital goods outside of this country does not directly translate into increased consumer demand within this country and can translate instead into a loss of employment.

Leontief and Duchin, recognizing this uncertainty, conclude that "it is not yet possible to pass a final verdict on the question of technological unemployment by the year 2000." Another reason is, as they acknowledge, that to do so they would have to incorporate into their forecast other kinds of technological change, which will change the nature and level of final demand for goods and services.

Leontief and Duchin also postulate on the basis of their model that "labor requirements to satisfy a continually but moderately increasing standard of living will number 124 million jobs in 1990 with the required occupational composition reflecting the technologies that will be in place . . . but because of very slow change in the orientation of education, training, guidance, and so on, these individuals' skills and occupational expectations will reflect the mix of jobs that corresponded to the technologies that were in place in 1978 . . . " Under those conditions, they point out, 744,000 managers and over 5 million clerical workers could be potentially unemployed while there would be about the same number of unfilled jobs in other occupational categories, for which they lacked the necessary skills. The problem for public policy, in other words, could be very serious even if demand for labor is equal to or greater than the supply.

A major difficulty with this forecast is doubt about the assumption of great and increasing demand for information-handling, which is ulti-

mately derived from the assumption of steadily increasing production of capital goods.

A *Georgia Institute of Technology Forecast* prepared for the U.S. Department of Labor[14] dealt with clerical employment in the banking and insurance industries only. It concluded that by the year 2000 there would be an absolute reduction in clerical employment of 22 percent (over 1980 levels) in the insurance industry and 10 percent in the banking industry, which together employed in 1980 more than 20 percent of all clerical workers (the clerical employees in these two industries alone constitute nearly 4 percent of the entire U.S. work force).

The Georgia Tech research began from the premise that there are "weaknesses in techniques used to incorporate technological change in employment forecasts, "*[5] including the unsystematic and qualitative consideration of emerging technological capabilities, the use of existing occupational descriptions based on fixed technologies, the inability to generate estimates of how particular technologies change the amount of time spent on basic tasks, and the use of an overly short time horizon (usually 10 years).

The study began with a technological forecast of office automation hardware and software, organized in terms of information processing functions (descriptions of the content of tasks related to information processing in the two industries). The forecast was designed to identify breakthrough technologies that would have major consequences for clerical employment. Industry officials participated in a Delphi (a forecasting technique that generates by consensus opinion quantified estimates of specific variables). This produced assumptions about different paths that penetration of office automation technology might take in each industry and the different employment/occupational mixes that might result. The analysts then used the technological assumptions to estimate the reduction in clerical time needed to perform specific functions in 1985, 1990, 1995, and 2000. Tying these estimates to 1980 clerical employment, an analytical model calculated the changes in the task/function work distribution over the period 1985-2000 for specific clusters of clerical jobs in each industry. For sensitivity analysis and validation, the results generated by the model were compared with those generated by the industry Delphi to determine the sensitivity of results to different estimates of the extent to which and rapidity with which specific technological changes will affect particular clerical functions.

The Georgia Tech team concluded that breakthrough technologies have the potential to displace or otherwise reshape clerical employment in at least two functional areas-data input and data processing. These include technologies such as optical scan, speech recognition, software languages and programs, and artificial intelligence, most of which the OTA Assessment also identifies as critical elements in the employment outlook.

There were several strengths in the Georgia Tech approach which lent credibility to the results. First, it went beyond conventional occupational categories to consider what it is that clerical workers actually do, in these two industries, in their daily and hourly work. Secondly, it attempted to estimate the relative amounts of time spent in these tasks, and to relate this to the time-saving potential of existing and emerging office technologies. Thirdly, it considered a number of potential organizational adjustments to the changing nature of the tasks in terms of organizational structural patterns. Finally, this approach permitted examination of future clerical work at several disaggregate levels, e.g., functions, tasks, and job clusters, rather than in terms of formal occupational categories.

There are also a number of weaknesses in the approach. The analytical model lacked feedback loops–for example, it did not account for the way in which the level of clerical employment affects the number of clerical supervisors needed, and did not account for rela-

[5]Georgia Institute of Technology, *Impact of office Automation on Office Workers*, final report, April 1984, prepared for the Employment and Training Administration, U.S. Department of Labor; J. David Roessner, Project Director.

Georgia Institute of Technology, op. cit., vol. 1 I, Technical Report, p. 2.

tionships between clerical and nonclerical work. It did not consider creation of entirely new jobs and had little to say about the conversion of professional work to clerical tasks. It did not consider the possibility of significant restructuring of the industries themselves, and their products and services. More importantly, the forecast does not explicitly deal with growth in workload, except through very broadly stated, arbitrary macroeconomic assumptions, i.e., growth within the two industries of about 3 percent annually." There was not explicit consideration of expansion of the role of information within the two industries, which are of course already highly information intensive.

Finally, the methodology used depends on judgmental data—estimates by industry experts and team analysts-even though it is treated quantitatively. In this of course, all employment forecasts are alike insofar as they go beyond mechanical extrapolation of time-series data. To do otherwise would defeat the purpose of anticipating change brought about by technological or economic trends.

All of the above forecasts thus are highly dependent on the assumptions made about the increasing volume of information handling (independently of the credibility of the models used) and the continuation of long established trends in the growth of occupations and their association with specific industries. The BLS projection anticipates increases in office employment in the neighborhood of 25 percent over the next decade but is probably much too conservative in its attention to technological change. The Leontief-Duchin forecast points to continued growth, although highly constrained by the effects of automation, but bases this forecast on flawed economic assumptions. The Georgia Tech forecast, which points to a decline at least in clerical employment, gives more attention to likely technological breakthroughs (in this field more credible than an expectation of smooth technological evolution) but is narrowly limited to two industries.

Agreement or disagreement with these forecasts does not turn primarily on the models and methodology used, but on the complex assumptions, estimates, and judgment that generated the numbers fed into those models. All such models address the question of "what will happen if. . ."; if for example, technology changes in certain ways, is adopted at certain expected rates, produces in practice the productivity benefits that in theory should result, and leads to the changes in organizational behavior that can be rationally anticipated.

In spite of the fact that vendors and advertisers are often accused of overstating the benefits to be gained by automation, forecasts such as these may underestimate them. Technology and employment forecasts often misfire in this way, for two reasons. First, forecasters have no reliable way of estimating how pervasive a technological change will be–the ultimate rate of penetration. Some technologies are likely to be widely adopted only in a few industry sectors or in certain parts of a given industry, or only by organizations in a certain size range. Other technologies affect a broad range of economic and social sectors or become so pervasive that they fundamentally change social and economic activities—for example, the internal combustion engine and electric communications (the telephone and telegraph). Office automation, in particular, computers, are in the latter and more fundamental category of technology; and likely to become as pervasive in office activities as the telephone and the typewriter have become in the last few decades.

Secondly, technology forecasts often go wrong either because they assume technological or scientific breakthroughs that fail to come about, or because they assume a smooth evolutionary development of technology rather than breakthroughs that suddenly occur. In computer technology, the latter mistake is more common. Recent employment forecasts appear to assume that computer-based technologies of the next 5 to 15 years will not be signifi-

[1] The most important of these were (op. cit., p. 18): 1) periods of growth and recession, but no major depression; 2) modest overall economic growth averaging 3 percent annually; and 3) growth in insurance and banking industries paralleling growth in the general economy.

cantly better than or different from today 's. On the contrary, there is no reason to believe that their rapid development has come to an end. For example, input technologies, specifically optical character recognition and speech recognition, are likely to have a significant impact within 15 to 20 years. The rapid development and spread of end-use computing was not anticipated in many technology forecasts of the 1960s and early 1970s. In the field of microelectronics, it appears safer to anticipate quantum leaps in capability than to ignore the probability of their occurring.

The chief value in these and other such forecasts is that they force attention to the many and complex *uncertainties* that will affect future levels of white-collar employment. OTA's analysis differs from those above primarily in suggesting that there are impending technological developments that will have a particularly significant effect on some large categories of office employment; that adoption of office automation will proceed at an increasing rate and be much more widespread than most other kinds of technological change have been; that productivity gains have been and will be for a few years masked by transition problems but will soon become apparent; that economic growth rates could be lower than they have been for most of our history; and that competitive pressures will lead organizations to take full advantage of the labor-saving characteristics of the technology. These conclusions, like those of the forecasts described above, are certainly arguable but merit prudent consideration.

PRODUCTIVITY AND THE NATURE OF WHITE-COLLAR WORK

Productivity is defined in economic terms as a ratio between quantity of output and quantity of input; increased productivity is achieved by producing the same amount of product or service with fewer resources (technological change), or producing more product or service with the same resources (resource reallocation). Sometimes organizations automate their office work in order to do the same amount of work with less labor cost (which could mean either fewer workers, or the same number of workers doing less skilled work for lower pay). Sometimes organizations foresee or seek an expanding workload and hope to accomplish it without increasing their work force (or their total expenditure for labor).

Applied to white-collar work, however, the concept of productivity becomes complicated and troublesome. It is least complicated in the context of routine processing of large amounts of standardized, easily quantified data—number of units sold, dollars paid or received, ticket stubs returned, keystrokes made. It is most complicated when applied to work where quality is more important than quantity-analysis, decisions, staff support, and policy formulation.

If the final output of the organization's activity is an information product or service (an advertisement, a document or research report, a legal brief, an advisory memorandum or set of guidelines), then the number of units processed per hour is often less important than the quality, the timeliness, the fit to a client needs, or the degree of customer satisfaction. Effectiveness is more important than efficiency. But effectiveness is much more difficult to measure, since it refers to the characteristics of the output rather than to a ratio between countable units of input and output.

If the organization's final product is a material good such as automobiles, the contribution of office work to overall productivity is difficult to determine because much of it is concerned with the coordination of intermediate steps in the conversion of resources into products. Both effectiveness and efficiency are important and impossible to separate.

There are other general problems in discussing the productivity of service industries. Service outputs are different from material products. They can usually not be stockpiled. Customer behavior intrinsically affects the delivery mechanism. For example, a study of increased productivity in British accounting firms found that most of the productivity gains came not so much from anything the accountants did but rather from the clients' computerization of their own accounts, which allowed the accountant to save vast numbers of person-hours in auditing.[17]

In fact, the concepts of "input" and "output" both become blurred in many kinds of whitecollar work. "Hours logged in" or "hours paid for" are often not the same as "hours worked. " This is true in both blue-collar and white-collar work, but perhaps most obvious for professional and managerial workers who may be 'processing information' or "formulating decisions' while they read the newspaper or fall asleep at night. The quality of work is often more important than the quantity of work for both blue- and white-collar workers, but for white-collar workers quality is more difficult to measure in terms of error rates. The skill that a receptionist uses in soothing irate clients, or that a secretary uses in locating an elusive file, shows up in the company's records only indirectly as an addition to a salesperson's accounts or a lawyer's clients. Contributions to corporate reputation or employee morale are difficult to measure.

In terms of outputs, a good decision or the elimination of erroneous information from a data bank may not be counted, or even be possible to identify as a discrete output. There is a tendency to use worker activity, an input, as surrogate for an output in measuring productivity, with the unwarranted assumption that more is better. Thus, computers and word processors sometimes lead to a proliferation of reports that may or may not be useful and may or may not represent increased productivity.

[17] 'Irving H. Siegal, *Productivity Measurement: An Evolving Art,* Work in America Institute Studies in Productivity, No. 16 (New York: 1980).

It is therefore difficult to measure, to define, and even to discuss the amount of increased productivity that could be gained by office automation even if it is widely adopted by organizations of all kinds and all sizes. Some organizations have been slow to adopt office automation for this reason.

However, an organization will usually not decide to automate a specific task or set of tasks if it expects that over the long run the task will therefore require more labor, or will take longer to perform per unit of workload than without automation. Automation usually implies some transference of work from humans to machines, and thus a substitution of capital for labor.

If office automation only allowed those organizations that automate (assumed for the present to be more efficient) to take over markets previously served by nonautomating organizations, the result would be a reduction in the total amount of labor used. On the other hand, if office automation only stimulated the creation and sale of products and services that could not previously be offered—that is, created new markets-the total amount of output and labor used would increase. But office automation will both create new information markets and reduce the amount of labor required for existing and new products and services. The difference-net labor demand-could be either positive or negative.

The factor of time is crucially important. For some period of transition, longer for some organizations than for others, there is little or no gain in productivity and often some loss. On the other hand, the new technologies are so powerful that some organizations settle for the short-run labor savings and limited cost reductions that are possible from limited use of automated devices, rather than run the risk of temporarily disruptive restructuring of the work to systematically capture all the potential benefits. Across the economy as a whole, with sectors and industries and organizations at all stages of this transition, it is difficult to anticipate how long this transition will take. Over time–measured in decades–more efficient organizations should tend to replace less

efficient ones, and newly created organizations should tend to be automated, and more efficient, from the beginning.

This is the dynamic shift which needs evaluation in terms of the net labor demand. How thoroughly will office work, throughout the economy, be automated in the next 15 years? Will the demand for information processing create more than enough new jobs to compensate for the labor reduction effects of office automation?

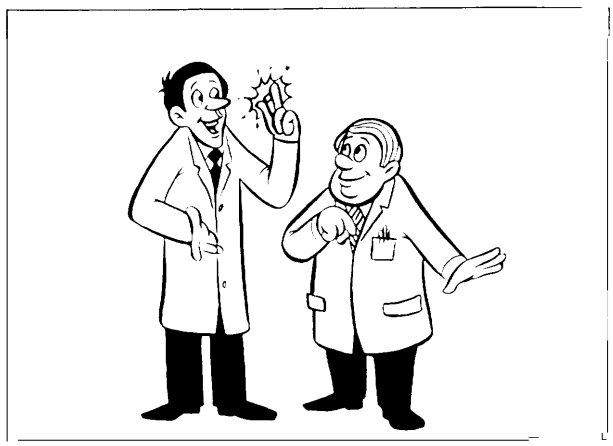
HOW OFFICE AUTOMATION AFFECTS EMPLOYMENT

Office automation can substitute for labor, supplement labor, or reorganize work and thereby make labor more efficient. It can allow highly technical, knowledge-intensive work to be done by relatively untrained and unskilled, lower paid workers. (Skill enhancing and job enhancing features of the technology are also important, but are discussed elsewhere.) It can change the characteristics and skills associated with occupations and alter their role and relative importance to an industry. It can allow office work to be done away from the office and outside of conventional office hours, even outside of the country.

The most dramatic potential substitution of technology for labor, in the future, could be the elimination of a large proportion of today's data-entry work (either numeric or text) by:

- interorganizational transfer of data, directly from computer to computer;
- direct input of data by optical scanning technologies, and possibly by speech recognition technology; and
- capture of data at the point of origin, in a variety of ways ranging from bar code readers to consumer use of terminals, e.g., bank automated teller machines (ATM s).

In short, second-time keyboarding of the same data may eventually disappear almost completely (i.e., once data exists in machine readable form it will be endlessly changeable and exchangeable). First-time keyboarding may also be sharply reduced. This may not happen within the next decade, and yet optical scanning technology and computer exchange of data is already reducing data entry in some areas, and all of these trends could develop very quickly.



Credit Communications Workers of America

"We 've decided to call it the neutron chip. It eliminates jobs but /eaves the work-p/ace intact".

Direct substitution for labor is only one possibility. Automation reduces the time required for many tasks. The measured time-saving for specific tasks, in numerous pilot projects and implementation case studies, varies from minutes to days. There is no way to validate, compare, and aggregate such figures across organizations. The estimate of "15 percent time saving" for complex procedures and task clusters recurs with great frequency in both private and public sector office automation plans, cost justifications, and cost-benefit studies surveyed by OTA, but again it is difficult to document or generalize this measure. The most that can be concluded is that time-saving is real but its magnitude and overall effect on productivity cannot yet be stated. 's

'App. B summarizes several case studies done for this OTA assessment; others from scholarly and trade literature are referenced throughout the report,.

Automation also can reduce the time that people have unavoidably spent between productive tasks, or in sequencing tasks. One example is the way voice mail and electronic mail can reduce the time spent in communicating by eliminating "telephone tag" or frequent callbacks, searching for telephone numbers, and getting wrong numbers or busy signals. Electronic filing can eliminate walking to a file cabinet and searching for a particular file; word processing eliminates cutting and pasting or retyping documents to eliminate errors.

In some applications a long series of tasks that required several workers is combined into one task. For example, in mail processing, a many-step function that involved several clerks (mail openers, sorters, typists) can be redesigned to require only a mail opening machine and a clerk entering information into a computer terminal.[19] Professional case workers in a New York City Municipal agency formerly sorted mail from clients and selected and typed one of four form letters in response. Now lower paid clerical workers call up the client file and push one computer key to send the appropriate form.[20]

These are examples of process change, or reorganization of work and workflow to take advantage of office automation. Some insurance companies have been phasing out jobs that involve responding by individual letters to mail inquiries about claims, policy changes, or policy applications. Policy holders or applicants have a toll free number to call. The employees who answer such calls use terminals to retrieve the information required to answer most queries. By telephone the employee can elicit all the necessary information, some of which is often absent from mail communication, thus requiring more than one exchange of letters. The cost per inquiry is reported to be one-third the cost per mail inquiry.[21]

As the conceptual model described in chapter 1 suggests, even if an organization adopts office automation to reduce unit labor costs in standard tasks, managers will subsequently recognize that it also has other capabilities, and will adapt the workflow or production process to take better advantage of those possibilities. This may take considerable time, since problems arising from the initial substitution and from the interface of new technology with old procedures usually get first attention. Initial transaction costs of adapting the production process to new technology are high. Training and system support costs in particular often outweigh hardware and software expenditures. The risks associated with trying new ways to get the work done appear very large and potentially disruptive to many firms. For this reason the full effects on employment are likely to appear only after considerable time and experience.

Office automation can also complement and augment labor, making new tasks possible. Computers made it feasible for insurance companies to move from annual billings to quarterly or monthly billings (thus encouraging lower wage earners to buy insurance), and the increased availability of information also led States to impose increased reporting require ments on the industry. In other financial service industries, automation allowed the creation of new consumer services that would not have been cost-effective otherwise. In large law firms, some evidence suggests that the introduction of word processing resulted in support staff employment growing several times faster than legal staff.[22] Some people suggest that once word processing is substituted for typing, a great deal of "hidden work" appears-work that there was no time to get done before. This is one aspect that leads to an increase in the demand for information processing, and often therefore to a net increase in demand for labor.

[18] Matthew P. Drennan, "Implications of Computer and Communications Technology for Less Skilled Service Employment Opportunities," Final Report to the U.S. Department of Labor, grant No. USDL 21-36-31, Jan. 21, 1983, p. 2.

[19] See ch. 10.

[20] Matthew P. Drennan, op. cit., p. 64.

[22] Mary C. Murphree, "Brave New Offices: The Changing World of the Legal Secretary," *Women's Toils and Triumphs at the Workplace*, Karen Sacks and Dorothy Remy (eds.) (New Brunswick, NJ: Rutgers University Press, 1984).

The net effect of other, equally important, effects of office automation on work and workflow is even more difficult to assess. Chapter 4 considers these changes in considerable detail. Automation clearly leads to reallocation of tasks, for example, professionals and managers drafting their own letters and documents on the word processor. Analytical work that formerly required specialists with long training can be incorporated in software that can be used by people without extensive professional training. Reason suggests that in the interest of cost-saving organizations will tend to professionalize clerical work–i.e., push tasks downward in the hierarchy-and reduce the number of middle-level professionals and managers rather than the number of clerical workers, since the former are paid more. This is the argument for the so-called "disappearing middle management or "flattened hierarchy' phenomenon that some experts anticipate.[23]

The "clericalization of professional work" appeals to many professionals, because it gives them more autonomy and more control over the quality and pacing of their work; they can alter and revise as they go, they need not queue up or compete with others for the typists' time. There is some evidence from case studies and general observation that the ratio of support staff to professional staff is tending to decrease in many offices—that is, the pattern of one secretary to one boss has already commonly changed to one secretary serving three to five professionals, or a cluster of support staff working for a large group of professionals and managers.

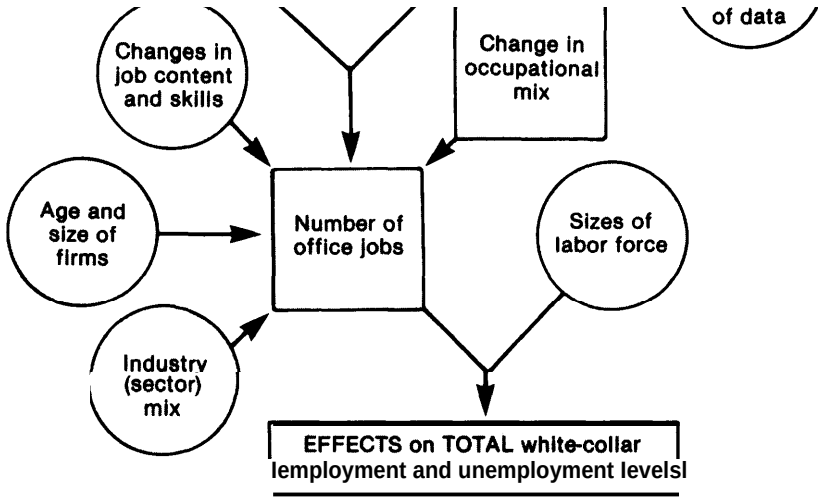
Office automation may result in a more varied occupational structure, because of the diverse choices among applications and because automation allows production process and staffing to vary widely with the type of product. For example, three staffing patterns have been observed among insurance carriers." In highly automated personal lines underwriting departments of large property/casualty carriers, rating and risk assessment may be computerized and the functions formerly divided among many clerks, raters, and underwriting assistants, may be consolidated and delegated to highly skilled clericals. Unskilled clerical work is then largely eliminated. Underwriters become "exceptions handlers, " doing more complex work, and their work may shift to planning and marketing. Skilled clericals become the bulk of the work force. In other insurance firms, where products are standardized and high volume, almost all of the semiskilled tasks are computerized and a bipolar work force is created, with a large number of routine-data entry clerks and a few highly skilled, professional exceptions handlers. In still other cases where product lines are low in volume, specialized or complex, there is likely to be less extensive, more discrete automation. Data entry will be done by operators using dumb terminals, and underwriters review all policy.

Thus, a view of office automation's effects on employment must take into account not only substitution of capital equipment for labor in specific tasks, and the expansion of workload, but many additional and intervening variables including (see figure 2-2) recombination of tasks, reassignment of tasks across jobs and occupations, changing skills

Many office automation experts and industry planners expect that various computer applications will allow managers to extend their scope of supervision and planning, and will thereby allow organizations to reduce the number of super\' isory managers required, and flatten the management hierarchy. This thesis has sometimes been addressed, in popular literature, in terms of a related issue, that of the "disappearing middle (income class)." Saskia Sassen-Koob and others have put forward an argument that there is, or will be, a growth in employment in both high- and low-income categories in the fastest g-rowing industries {ad\' anced services), with a decline in middle-income categories, and thus income polarization. See Saskia Sassen-Koob, "The New Labor Demand in Local Cities, " *Cities in Transformation,* Michael Smith (cd.) (Beverly Hills, CA: Sage Publications, 1984), pp. 137-171. The income statistics put forward by Sassen-Koob as evidence that the ' 'disappearing middle' is occurring are effectively challenged by Neal H. Rosenthal, ' 'The Shrinking Middle Class: Myth or Reality?'' *Monthly Labor Review,* March 1985, pp. 3-10, However, the possibility of a reduced management hierarchy need not stand or fall on the terms of this controversy at the macroeconomic level.

-'Barbara Baran, ''Technology Innovation and Deregulation: The Transformation of the Labor Process in the Insurance Industry, " Berkeley Roundtable on International Economy, contract No. 433-3610.0, prepared for Technology and Economic Transition Project, Office of Technology Assessment, January 1985.

Figure 2"2.—Framework for Analyzing Long"Range Effects of Office Automation on White"Collar Employment



SOURCE Office of Technology Assessment

requirements and corresponding job definitions, changes in the definition of occupations, and shifts in the number of jobs per occupation. The way in which these changes occur is further discussed in chapter 4.

Emerging Occupational Shifts

Other things being equal, the introduction of labor-saving technology is most likely to cause displacement where the task that is auto mated has constituted all, or nearly all, of the responsibilities of a given job. In other words, the more narrow and specialized the job, the more likely the job-holder is to be displaced by automation. This applies, at least potentially, to professional specialists as well as to clerical workers. Highly specialized knowledge is potentially most appropriate for incorporation into an expert system (a special software for decisionmaking) while broad, general knowledge is difficult to incorporate.[25]

When word processing is introduced, assuming that the workload does not increase, fewer dedicated typists (keyboarders) will be needed. A general secretary who spends only a part of her time typing, is not likely to be displaced by a word processor; more likely she will have more time for other responsibilities and may take on new ones. Secretarial positions have been increasing throughout the two decades of office automation, while "typist" jobs are decreasing.

-"*Science,* "Artificial Experts, " Mar. 23, 1984, p. 1281.

At the most general level, table 2-2 shows the relative shares of major occupational categories in the economy. Clerical workers are the largest employment category, followed closely by professional and technical.[26]

In the first stage of automation (large computers), the tendency was to make affected jobs more narrowly defined—in other words, to rationalize work. Batch data processors did not learn or do other work. Word processors were set apart in word processing centers. New specialties were created, ranging from computer operators to programmers, and the holders of those jobs typically did nothing else. If data-entry work is completely automated (e.g., by optical scanning technology) those who do only data entry are most likely to be displaced and secretaries are unlikely to be displaced by that development.

As discussed in chapter 4, second phase automation—end-user computing—appears less likely to rationalize tasks or to narrow jobs. Personal computers can be used to integrate tasks and broaden jobs. Moreover, organizations that rationalized work during their early office automation are in some cases using further automation to reverse that process. Many firms have decided that computer and communication technologies are often most effective in reducing costs when control, communication, and decisionmaking are decentralized and when hierarchic organization and functional specialization of tasks are reduced. They are experimenting with the elimination of both low-skill clerical jobs and routine technical/professional jobs, and with the creation of new multiactivity, skilled clerical positions.[27] In some insurance firms, the result of task reintegration has been a significant reduction in unit labor requirements and an increase in the average skill levels of the remaining clerical, sales, and professional work force.[28]

It is important to note that reduction of unit labor requirements has been achieved in both work rationalization and work integration, with office automation being used for both,

The networking of computers is likely to eliminate some jobs that have until now provided the link between automated tasks—for example, those concerned with reorganizing

‘ A major problem in assessing occupational change is a set of difficulties and deficiencies encountered in working with occupational data as it is now collected and aggregated. Occupational data are derived from surveys, and the more specific and narrow the occupational category used, the smaller the survey sample is, and therefore the less reliable the estimate of the total. A more important problem is the lack of consistent time-series data because of frequent changes in occupational classifications, especially between the 1970 and 1980 censuses. Much of the data used in this chapter is drawn from the occupational industry employment matrix prepared by the Bureau of Labor Statistics from occupational Employment Survey data, modified by BLS use of a statistical model. Both the survey and the model have some methodological problems; for example, there are variations over time in the way that survey data was collected, and matrix data for 1980 and 1982 are not fully comparable. For more information on employment statistics consult the *BLS Handbook of Methods*, vol. 1, Bulletin 2134-1, December 1982.

-“In the insurance industry, management first tended to follow the logic of scientific factory management, rationalizing and fragmenting tasks. Some insurance firms are now using integrated systems to reintegrate tasks, allowing one person to handle multiple service transactions so that the individual master record for each policy is a complete database.

-“Eileen Appelbaum, ‘‘Technology and the Redesign of Work in the Insurance Industry, ” Stanford University, Institute for Research on Educational Finance and Governance, Project Report No. 84-A22, November 1984, p, 10,

Table 2-2.— Percent of Total Work Force in Occupational Groups by Selected Industry Sectors, 1982

		Industry Sector					
Occupations	All industry	All manufacturing	FIRE[a]	Services	TCU[b]	Health services	Trade
Professional, technical, and related occupations	16.39%	10.27%	9.46%	33.65%	7,86%	34.47%	3,78
Managers. officials, and proprietors	8.37	6.69	17.06	6.82	8.99	4.38	9.34
Clerical	20,36	11,75	63,40	19,11	33.29	17,02	20.68
Total	45,12	28.71	89.92	59.58	50.14	55.87	33.80

[a]FIRE Financial Insurance real estate
[b]TCU Transportation communications utilities

SOURCE U S Department of Labor Bureau of Labor Statistics Employment *and Earnings,* VOI *30, No* 1 January 1983

or resorting data generated by computers in one department for entering into another system, or the rekeyboarding that has been necessary when one organization's data was passed on to another.

Office occupations must be considered in the context of industries and industrial sectors, all of which have some component of office work. In office-oriented industries such as finance, insurance, and real estate (FIRE industries), a very high proportion of the work force in clerical and professional occupations is likely to be directly affected by office automation. In other industries, such as machine tools production, a much smaller proportion of the work force is in office occupations, and these tend to be in less specialized jobs (i.e., general secretary).

Some occupations are more or less standard across industries. Typists and payroll clerks do much the same work with only minor variations in whatever industry they find themselves. The same is true of many professional categories—tax lawyers, auditors, or certain types of engineers work for many industries that require the same general skills. Other occupations are characteristically found in one industry or a cluster of highly related industries.

Both generic and industry-specific occupations may perform narrowly defined tasks and thus be potentially subject to displacement. If office automation is broadly adopted across industries for tasks performed by generic occupational groups, then the people who are displaced will find it difficult to find similar jobs in a different industry. On the other hand, if industry-specific occupations find their work being automated, they may move to smaller firms or less rapidly automated firms within the same industry—unless those applications are insensitive to the size of the firm.

Labor force adjustment to office automation may require major shifts in employment levels across occupations. Industry sectors differ in the proportion of workers in major occupational categories (see table 2-2).

Professional Occupations

Professionals here are defined as workers doing cognitive tasks that require specialized knowledge gained through lengthy education, often with a graduate degree, or special certification or licensing.[29] They make up more than 16 percent of the work force and are found in all industry sectors, but there are relatively few in some sectors such as agriculture and trade, whereas in some service industries (health services, business services) they make up more than a third of the work force. Some professional categories are generic; lawyers, accountants, and computer scientists for example are found in every industry. Others are industry-specific, such as insurance investigators, title examiners, and broker's floor representatives; or are heavily concentrated—more than 82 percent of financial analysts, for example, are in the FIRE industries.[30]

In an information-driven economy, in which services—with high concentrations of professionals-is the most rapidly growing sector, it is likely that the demand for professional workers will increase. This category has indeed been increasing much more rapidly than any other occupational category. Its growth is not, however, unaffected by office automation.

Many professionals are not primarily office workers; for example, teachers, medical doctors and laboratory scientists may have or use offices, but the core of their activity is not office work and is not directly susceptible to office automation. However, it usually requires supporting clerical and administrative work that will be affected. Professionals may themselves use office automation in peripheral tasks, and their professional tasks may be

[29] The term "professional" has undergone a subtle change in meaning in this century: historically, most professionals practiced their calling on an independent or free-lance basis and in common parlance professionals tended to be distinguished from salaried workers. Now most professionals are probably employees of organizations.

[30] To some extent, however, this distinction is an artifact of the way jobs are titled in various industries. People with different job designations in different industries may still do much the same work, or have much the same training and basic skills.

automated by other kinds of computer applications (e.g., diagnostic technology) beyond the scope of this assessment.

About half of all professionals are in office-oriented occupations; for example, lawyers, accountants, analysts, and consultants. As already noted, some highly specialized professional tasks are potentially subject to computerization through expert systems. More commonly, information systems and data banks allow part of the professional's responsibilities to be taken over by paraprofessionals with less extensive graduate education and less stringent credentialization and certification requirements. For example, paralegals, engineering technicians, and library assistants do some of the work formerly done by professionals, and are paid less than professionals. Thus, there is strong economic motivation to constrain the increase in professional jobs by combining automation and paraprofessional workers, and the number of paraprofessionals is growing rapidly.

Office automation also typically decreases the amount of time that a professional spends in accomplishing a given amount of work, for example, in telephone communications, locating and aggregating information from scattered libraries, or reformatting tables and drawing graphics. Some tasks incidental to, and preparatory to, generating or analyzing information can be eliminated or shortened.

From this perspective, it can be argued that the amount of information-handling might increase a great deal before requiring a significant increase in the number of professionals. Once organizations have gained experience in successfully automating basic clerical tasks, office automation for professionals and managers will look increasingly attractive, since their higher wages will increase the cost-saving possible from automation.

Office automation stimulates the growth of some professional categories. Between 1970 and 1978, the number of computer specialist jobs grew by 58 percent (compared to 20 percent growth in all jobs). BLS expects growth in computer specialists employment throughout this decade, and the National Science Foundation has forecast a shortage between 1982 and 1987.[31] This is however growth from a small base; there were just over half a million computer specialists in 1982, 0.56 percent of total employment. Moreover, computer technology itself may dampen the expected demand; as computers and their software become more usable by nonspecialists, the need for programmers is shifting from user organizations to producers of computer goods and services, and should grow at a slower rate. Software engineering systems will automate some of the work of both programmers and systems analysts. Thus, there is likely to be some leveling off of the need for computer specialists in spite of the growth in number of computers in use.

Demand for information scientists may continue to grow, especially with the spread of the relatively new industry of information service, which provides and manages databases, on-line search services, and customized searching and abstracting.[32] It is not clear from occupational statistics how many information scientists there are or how rapidly their number is increasing, since many different job titles are used in this new professional area.

There are other specialized professional occupations that are growing because of computers. For example, personal financial advisors and tax advisors were once used only by the very rich, but small computers made it possible for them to offer their services more cheaply to middle-income people who have money to invest but are confused by complicated choices among financial services and investment and tax-sheltering schemes.

The ultimate effect of office automation on professional employment is hotly debated. Some argue that there will be a peaking and eventual decline in information-handling jobs,

[31] National Science Foundation, *Projected Response of the Science, Engineering, and Technical Labor Market to Defense and Nondefense Needs: 1982-1987* (Special report NSF 84-304), January 1984.

[32] U.S. Department of Commerce, International Trade Administration, *Competitive Assessment of the U.S. Information Services Industry*, May 1984.

including professional jobs.[33] Others argue that the role of professionals within organizations will change, as the information component of products and services increases, and they will become "generalists who include many traditional managerial functions in their everyday work. [34] Possibly the meaning of the term "professional" will become progressively blurred as specialized knowledge becomes more widely accessible through information technology.

Clerical Occupations

The great growth in clerical occupations mirrors the broad shift from a manufacturing-based economy to a service-based economy. In manufacturing, clerical jobs are only a small proportion of employment, although that proportion has been increasing. In those service industries that collect and use large volumes of standardized data, such as legal firms, insurance, banking, and credit, more than half of all employees are clerical workers.

A large number of clerical occupations are generic, and the work is similar across industries. For example, bookkeepers, accounting clerks, file clerks, general clerks, office machine operators, payroll and timekeeping clerks, personnel clerks, receptionists, telephone operators, order clerks, and shipping and receiving clerks can be found in nearly all industries. There are more than 100,000 workers in each of those categories. Official occupational statistics treat other occupations as industry-specific; thus, according to BLS, all insurance clerks (medical) are employed in health services, all train ticket clerks and freight rate clerks are in transportation, communications, and utilities industries, and all credit authorizers are in wholesale and retail trade. However, the basic office skills used in those industry-specific occupations are in large part transferable to other clerical occupations."

To the extent that office automation reduced employment in one or a few industries, clerical workers should be able to move to similar jobs in other industries. Their mobility might be greater than that of professionals in industry-specific occupations. This rationale sometimes appeared in the 1970s, for example, in explaining why more attention was paid to the displacement of aerospace engineers than to displacement of clerical workers from the same firms. But office automation appears likely to be adopted across industry boundaries in a relatively short time. Thus, if computers sharply reduced the demand for bookkeepers, bookkeeping jobs would be increasingly difficult to find in most industries or locations.

Potentially the most dramatic and widespread impacts of office automation on clerical employment are related to data entry, as already discussed. The strong trend toward capture of data at the point of origin, and further development of optical character recognition (OCR) technology and speech recognition technology are likely to greatly reduce the need for primary keyboarding. OCR is already being used to this end. More and more information will be in machine-readable form from the beginning, and computers and telecommunication technologies will increasingly exchange information between organizations without the necessity of rekey boarding. This trend alone will have a strong impact on clerical employment.

Advanced communications strongly affect clerical jobs that provide the interface between people, organizations, and activities, for example, messengers, mail clerks, and telephone and switchboard operators. Such displacement has been going on for a long time. It also affects clerical workers not usually considered communications workers. A chain of hotels may have a centralized, computerized worldwide reservation system with local-area networks and microcomputers. When a reservation is made through a toll-free phone number, all appropriate information, including credit references, will be automatically loaded into the central mainframe database. Information about next-day guests will be transferred to the hotels' microcomputers in the middle of the night and a reservation clerk will have only

[33] For example, Charles Jonscher, "Information Resources and Economic Productivity, *Information Economics and Policy 1* (North Holland: Elsevier Science Publishers, 1983).

[34] Paul A. Strassman, *Information Payoff: The Transformation of Work in the Electronic Age* (New York: The Free Press, 1985).

There are of course exceptions to this general rule; general secretaries could probably not become legal secretaries without additional training. although legal secretaries might become general (or executive) secretaries in another industry,

to key in information on last minute walk-in guests. [36]

Not all clerical jobs are equally vulnerable. of the ten fastest growth clerical occupations between 1970 and 1978, all but one (computer operator) were occupations that require direct contact with people outside an office—e.g., cashiers and receptionists. These jobs are sometimes considered relatively impervious to office automation. However, when the personal transactions can be standardized the job can be automated; again the bank's automated teller machine is one example. Supermarket cashier stations are another.

Some clerical jobs include both information-processing and manual tasks. Shipping and weighing clerks, packing clerks, etc., may be only indirectly affected by office automation, but are also vulnerable to the effects of automated materials handling and storage systems. Many organizations are also beginning to electronically print forms as needed, eliminating the need to buy, handle, and warehouse preprinted forms. In this case, the cost-saving sought is primarily in the costs of space and materials, but labor-reduction is an added benefit.

Ten occupations with declining employment from 1970 to 1978 were tabulating, bookkeeping, calculating, keypunching, stenography, postal clerk, telephone operators, mail carriers, and meter readers. Most of these are occupations directly affected by the early phase of office automation and the effects are now showing up in statistics. They are also occupations that are relatively narrowly defined in terms of tasks, again illustrating that the most narrowly defined jobs are those likely to be first eliminated.

In a later section of this chapter, the use of part-time and temporary office workers is discussed, and other chapters examine in detail the phenomena of home-based work and off-shore work. Part-time and temporary work distribute employment among more workers, but they tend to depress the number of full-time-equivalent jobs. They allow employers to hire the minimum number of people necessary for their base workload, relying on part-timers and temporaries to handle short-duration increases or peak loads. Home-based work programs have the same benefit of load-leveling since most of the home-based workers are used on the basis of "when work is available. Off-shore data entry, on the other hand, simply eliminates jobs in the United States.

In short, while office automation will likely lead to a great deal of shifting between clerical occupations, it is also highly likely to result in an absolute reduction. across the board.

Managers and Supervisors

Table 2-2 showed that managers comprise a relatively small proportion of total employment; the proportion varies considerably across industries. BLS data identify a principal group of managers, officials, and proprietors, and also identify supervisory occupations within the clerical and other personnel categories. within most industries, firms vary considerably in the proportion of managers to other employees, with small firms tending to have proportionately fewer managers—i.e., a flatter structure.

Organizations are generally using more data, in more systematic ways, in coordinating their operations. As management becomes more information-intensive, it is possible that more managers may be needed. There is some relationship between the information intensiveness of an industry and the industry proportion of employees who are managers. Manufacturing firms have relatively low levels of managerial staffing, while insurance carriers, securities, computer and data processing services, and mailing and reproduction services have relatively high levels. Managerial employment is also above average in accounting and auditing services; engineering, architectural, and surveying services; wholesale and retail trade; transportation, communications, and utilities; and printing and publishing. It is relatively low in health services and legal services, but

Communications Week, "Holiday 1 nns to Use SN A Gateway to Link 1,600 P(’s With M ainframe, N 01’. 5, 1984, p, 49.

these industries have large numbers of professionals who also act as managers.

There are large numbers of managers whose work is only partly and secondarily office work; for example, bar and cafe managers or automobile repair shop managers. Office automation technology, if adopted, may help them to focus on supervisory responsibilities by reducing the time spent on "office" chores.

In offices, some managers are primarily concerned with the direction and supervision of clerical or production operations and personnel. If fewer clerical personnel are needed with office automation, proportionately fewer supervisory managers should also be needed. In addition, as discussed in chapter 4, office automation can be used to increase the scope of supervision; that is, one manager or supervisor can monitor the performance of more workers or an increased volume of production.

The tasks of many lower and middle-level managers largely center on: 1) information collection, processing, and reporting, tasks that office automation either facilitates and enhances, reduces the necessary expenditure of time, or takes over completely; and 2) communication and coordination, where office automation can be very time-saving. Higher level managers concentrate more on decisionmaking. Here computers can be used in many ways. Some decisionmaking can be, and is being, built into computer programs, reducing the need for lower level managers. Management information systems and other kinds of computer programs are designed to help managers make decisions, by integrating and displaying the information they need. In some situations this saves a great amount of time for the manager; in other situations, it takes more time to make a decision because more information is available to be considered.

In some organizations, information that was once collected, integrated, and laid out by lower level managers for review by higher level executives, is now aggregated and formatted by computers and accessed directly by the decisionmaker. This points toward a reduced number of lower level managers, and some corporations are reported to have adopted office automation with the explicit objective of flattening the management hierarchy. Heightened competition and pressure to cut labor costs can lead firms to try to keep a lean management staff, since their salaries are high compared to other workers. At present, the job market for managers is strong because of overcutting of managerial ranks during recent recession years.[37]

Thus, there are conflicting trends to be considered in the outlook for managerial jobs, but they are not immune to the effects of office automation.

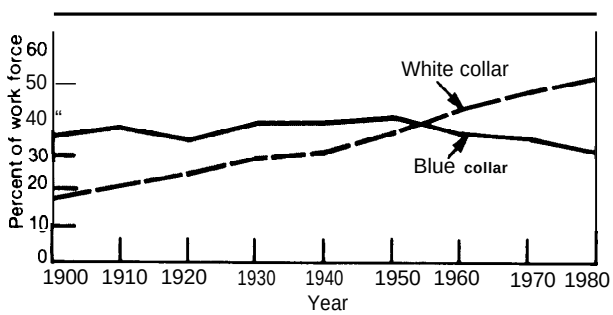
Technology and Recent Trends in White-Collar Employment

White-collar employment has grown rapidly in recent decades. (See figure 2-3.) The narrower category of clerical jobs, about 16 percent of all employment, has also grown rapidly even through the first phases of office automation. Table 2-3 appears to indicate, however, that this growth may already have slowed or stopped.[38]

[37] *Dun Business Month*, "Executive Job Market: Filling the Talent Gap, " November 1984.

[38] Does not include cashiers (of whom there were about 230,000 in 1950 and 2.2 million in 1984). Beginning in January 1983 BLS reclassified some occupations; cashiers and real estate appraisers were removed from the clerical occupations category. These reclassifications are one of the continuing pitfalls of working with occupational data time-series.

Figure 2-3.—Changing Percentage of Work Force From 1900-80 White-Collar Compared to Blue-Collar



SOURCE U S Department of Commerce, *Statistical Abstracts of the United States*— 1981, No 673

Table 2-3.—The Growth in the Number of Clerical Jobs, 1950.84

Year	Number of clerlcal jobs[a] (mllllonj	Growth In the Total number of jobs	employ-merit (percent)
1950	66		11 3V
1960	88	33'1	134
1970	129	46	164
1980	169	31	169
1982	168	–O 6	168
1984	167	–O 6	159

[a]The difference between the 1982 figure for clericaljobs on tables 22 and 23 Ill ustrates the difficulty of analyzing detailed employment trends because of am biguities in data sets

SOURCES U S Department of Commerce Bureau of the Census Census of *Population 1950 1960* 1970 *1980* and U S Department of Labor Bureau of Labor Statistics *Current Population Survey Annual Averages 1982 and 1984*

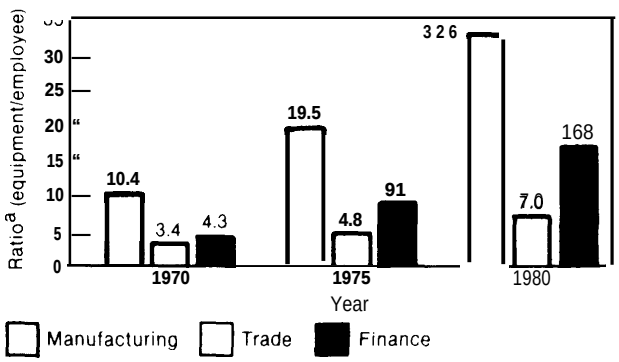
If the automation of office work is labor-saving, why did clerical employment increase so rapidly during the 1960s and 1970s? The capital-output ratio, which has traditionally been very low in white-collar work," increased steadily (see figure 2-4), but from these figures would seem to have had little effect on labor demand. A closer look at the financial service industries, which have been at the forefront of office automation, tends to counter this impression. They were expanding rapidly during this period in part because of the new products and services made possible by their office automation. Life insurance carriers, for example saw sales increase over 49 percent from 1970 to 1980. Yet their labor force increased only 9.8 percent. During the 1970s the average annual real value added per full-time employee equivalent (a measure of productivity) for all industries was 1.1 percent; in the insurance industry it was 2.7 percent. From 1975 to 1979 it was 1.3 percent for all industries but 6.7 percent for insurance carriers.'"

Social, economic, and political conditions favored the expansion of the FIRE industries during this period. High levels of employment growth during the 1960s and 1970s and the rapid increase in the number of two-income small families drove the proliferation of checking accounts. The rising level of disposable personal income during much of that period, and the fact that more women were earning income and insuring themselves for the first time, increased insurance expenditures. Fringe benefits also expanded, and workers compensation coverage was extended. A flood insurance program was established. New insurance and financial service products responded to, as well as contributed to, the growth in the market. 'l

Because these industries were growing rapidly, office automation in the 1970s constrained growth of their work force but did not reverse it. The labor-saving effects are nevertheless apparent; between 1970 and 1978, insurance industry professional and technical workers increased by 24 percent and managers by over 21 percent, but clerical workers increased by only 8 percent. During this first phase of automation, technology most directly affected clerical work. In the occupations where automation directly substituted for labor the effect was greater. Key operators declined by 22 percent, bookkeepers by 7 percent, file clerks by 20 percent, mail clerks by 11 percent, and typists by 12 percent (but secretaries increased

'Leontief and Duchin, citing many sources, accept that white-collar workers at the beginning of the 1980s worked with an average of $2,000 in equipment compared to the factory workers $25,000 in equipment; op. cit., p. ,5.7.

Figure 2-4.—Capital Investment Per Production Worker, 1970-80



[a]The ratio is net equipment stock (in bill ions of dollars) to number of production employees in constant dollars

SOURCE David Roessner Market Penetration of Off Ice Automat Ion Equipment Trends and Forecasts (working paper) School of Social Sciences Georgia Institute of Technology 1985

"Baran, op. cit., pp. 100 ff.

"Inflation and higher interest rates had a mixed effect; insurance carriers, for example, derive more income from investments than from policies but were sometimes locked into older low-interest investments and needed new investments to balance these. Inflation left life insurers more vulnerable to disintermediation and made forecasting of future cash flows for investment difficult. Liability settlements were also growing.

by 8 percent and computer operators by 119 percent)."

In some parts of the insurance industry, there were also dramatic labor reductions in some areas of professional work; for example, among underwriters in the life and health insurance fields, there was a dramatic decrease in numbers during the 1970s.

As a result of the interaction between market growth and office automation, labor displacement in FIRE industries as a whole clearly occurred but resulted in depressed growth, rather than decline, in employment.[43] In financial services, employment increased by about 2o percent, but growth was lowest in sales and clerical jobs, and highest for managers and professionals."

The labor-saving effects of office automation are likely to become more apparent in the near future. The first phase of automation was a more direct substitution of machine for labor than is later office automation, but in the first decade of use, organizational goals placed higher priority on better data collection and reporting and news services. The mass data handling industries were automating pre-existing functions, such as payroll, inventory control, and other basic procedures. But they were dealing with anew technology, with no experience and precedents to guide them; reorganization of the organizations' workflow and labor force took time. In the FIRE industries there are strong indicators that the emphasis has more recently shifted to cost-reduction, and much reorganization and labor force reduction is now occurring. Unit labor costs have in fact been dropping since 1969 and the drop began accelerating about 1975.[44]

Market conditions can either offset or reinforce employment effects. In the case of the insurance industry, one group of analysts concludes that:

> ... some of the present job losses occurring in the industry are directly attributable to computer technology, though more often than not these are the delayed effects of an earlier stage of innovation rather than the latest developments: some of the losses are best regarded as the indirect consequences of technology, which for example might allow reorganization and rationalizations to be made; and some losses are attributable to separate factors such as declining market conditions or out-moded management structures. On the whole one might sum up by saying that computer technology has provided the vehicle which makes it possible to respond efficiently to market conditions, whether this be by expansion of business or by contraction of operating costs. [46]

This analysis agrees with other evidence that white-collar employment is becoming more sensitive to cyclical economic conditions.

In both future and past shifts in employment, it is difficult to separate the role of technology from the effects of market change and other broad economic factors. But analysts at Bell Canada have studied the effects of technological change on their work force from 1952 to 1972, and concluded that "technological change resulted in substitution of capital for low-skill labor, overwhelming any price complementarily with capital.'"

In 1952, Bell Canada was using an average of 48 to 52 million person hours yearly, 23,000 to 25,000 jobs. Over the next two decades output steadily increased by 7 to nearly 10 percent per year, or over 500 percent, but labor demand at the end of the 20 years was less than 15 percent higher than in 1952.

The econometric model used in the Bell Canada study was designed to separate technological effects (i.e., automation) from price and

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[42] Baran, op. cit.

[43] Valerie Personick, "The Job Outlook Through 1995: Industry Output and Employ merit," *Monthly Labor Review*, November 1983, p. 34; U.S. Department of Labor, Bureau of Labor Statistics, *Technology and Labor in Five Industries*, Bulletin 2033, 1979.

[44] Baran, op. cit., p. 105.

[45] Baran, op. cit.; also Eileen Appelbaum, op. cit.

[46] Richard Barras and Julia Swarm, *The Adoption and Impact of Information Technology in the UK Insurance Industry* (London: The Technical Change Centre, November 1983), p. 21.

[47] Michael Denny and Melvyn Fuss, "The Effects of Factor Prices and Technological Change on the Occupational Demand for Labor: Evidence From Canadian Telecommunications," *The Journal of Human Resources*, XVII, 2, spring 1983, pp. 161-176.

market effects. The study concluded that technological change out weighed wage/capital and wage/material ratios in affecting overall employment levels, and in the case of demand for telephone operators, whose jobs were the primary focus of technological change, far outweighed the effect of output growth.

Small computers and word processors allow the standard office functions to be automated in small organizations, and incrementally, with relatively low capital investment at one time. Office automation need not involve construction of new facilities or extensive alteration of facilities. Where it replaces existing equipment—typewriters, calculators, bookkeeping machines, and old telephone systems—that stock does not represent large amounts of embedded capital. Most such equipment is more than 5 years old and has already been amortized. Office computers and equipment also enjoy a rapid tax write off. For all of these reasons, office automation may proceed more evenly, more widely, and more rapidly than other kinds of automation did in the past.

The speed with which a technological change occurs, and its breadth, are both important in assessing the impact. A slower pace allows both individuals and the labor market to make whatever adjustments are possible. In this regard the potential office automation of small businesses is particularly important. Small firms, in many parts of the country, account for the preponderance of office jobs. A reduction in the number of office jobs available relative to the total work force would therefore be felt in all areas of the country as well as in all industrial sectors, although not with the same force in all sections and sectors.

Part-Time and Temporary Employment

The proportion of part-time and temporary workers has been increasing since the early 1950s. The number of voluntary part-time workers has remained between 13 and 14 percent since 1970 but the proportion of involuntary part-time workers has continued to increase (see table 2-4 and figure 2-5), indicating that the strongest factor in the growth

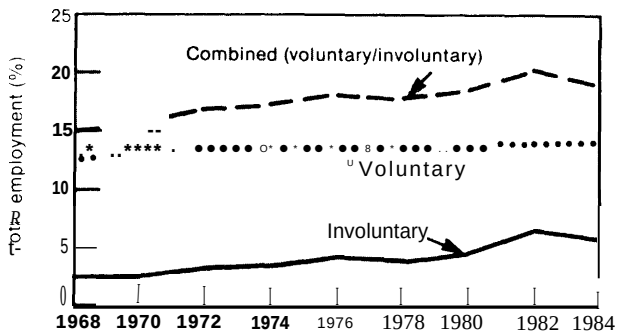
Table 2-4.—Changes in the Percent of Total Employment[a] for Involuntary and Voluntary Part-Time Workers as Percent of Total Employment, 1968-84

Year	Part-time work force		
	Total	Involuntary workers	Voluntary workers
1968	14 9“	2.5	12.400
1969	155	26	129
1970	164	31	133
1971	16.8	34	134
1972	16.8	33	135
1973	166	31	135
1974	171	35	13,6
1975	184	4.6	13,8
1976	180	42	13,8
1977	180	40	140
1978	177	38	139
1979	17.6	38	138
1980	184	4.5	13,9
1981	186	49	13.7
1982	202	64	13.8
1983	200	6.5	13,5
1984	189	57	13.9

[a]These calculations are for nonagricultural workers aged 16 and over

SOURCES 1968.81 — Labor force statistics derived from the *Current Population Survey A Data Book Volume 1* (Washington DC U S Department of Labor Bureau of Labor Statistics September 1982 Bulletin 2096) p 682 1982 – *Employment and Earnings* vol 30 No 1 (Washington DC U S Department of Labor Bureau of Labor Statistics January 1983) p 169 1983—Employment and Earnings vol 31 No 1 (Washington, DC U S Department of Labor, Bureau of Labor Statistics January 1984) p 194 1984— *Employment and Earnings* vol 32 No 1 (Washington DC U S Department of Labor Bureau of Labor Statistics January 19851 p 192

Figure 2.5–Changes in the Percent of Total Employment[a] for Involuntary and Voluntary Part-Time Workers, 1968-84



[a]These calculations are for nonagricultural workers aged 16 and over

SOURCES 1968.81 — Labor force statistics derived from the Current *Population Survey A Data Book Volume 7* (Washington DC U S Department of Labor Bureau of Labor Statistics September 1982 Bulletin 2096) p 682 1982—*Employment and Earnings* vol 30 No 1 (Washington DC U S Department of Labor Bureau of Labor Statistics January 19831 p 169 1983—Employment and Earnings vol 31 No 1 (Washington DC U S Department of Labor Bureau of Labor Statistics January 19841 p 194 1984—*Employment and Earnings* vol 32 No 1 (Washington DC U S Department of Labor Bureau of Labor Statistics January 1985) p 192

is not workers' choice of a more flexible lifestyle, but employers' response to economic pressures. In some industries and some organizations, slack workloads lead employers to convert workers to part-time in preference to a layoff. Other employers, however, are adopting a policy of keeping a minimum-size work force, which can be temporarily augmented when necessary .48

There are reports that in other industrialized countries automation has greatly increased part-time work; for example in Japan, "introduction of part-time workers and subcontraction has grown massively.'" Office automation and creation of a part-time work force are in some situations alternative or competing strategies for cost-cutting but they may also be complementary. Part-time workers (considered by BLS as an employee working less than 35 hours a week) are cheaper than a proportionately smaller number of full-time employees because they often are paid lower wages and do not qualify for benefits packages, regular yearly wage increases, or job security agreements based on seniority. There have been many anecdotal and press reports of companies reducing work hours to one or two hours fewer per week than would qualify workers as full-time employees, but few companies are willing to admit formally to this practice. The biggest advantage of part-time workers for employers however is that of load-leveling; that is, they can be used during parts of the day or week when the workload is heaviest.[50] To the extent that office automation allows the work force to be reduced and workflow made more efficient, it may obviate some interest in moving toward a part-time work force.

But in other situations, office automation encourages the creation of a part-time work force. Where it is used to standardize and deskill work many employers have found it profitable to use part-time, low-paid workers. Some have reportedly moved to suburban locations to take advantage of the availability of housewives willing and eager to work part-time at low wages because there is another primary wage-earner, with a full benefits package, in the family. As discussed in chapter 7, office automation also makes it feasible to use home-based workers, on a part-time and piece-rate basis. In the long run, office automation may stimulate a stronger trend toward use of part-time or temporary workers by allowing employees to maintain a minimum work force that will need supplementing during hours or seasons of work overload; and by standardizing the basic skills needed by clerical workers and some kinds of professional and technical workers.

In 1955, only 8 percent of American workers were part-time;[51] this rose fairly steadily to about 15 percent in the late 1960s and continued to rise to 20 percent by the 1980s. (See table 2-4.) Thus, about one-fifth of American workers are working part-time. Women are much more likely to work part time, often in order to combine paid employment with child care. About 29 percent of working women work part time, compared to 12 percent of working men. About 21 percent of teenagers aged 16-19 and employed, are working part time.

In 1983, in the FIRE industries—leaders in office automation—only 11 percent of employees were part-time. This sector ranked fourth among major industry sectors, after the wholesale and retail trade (32 percent), service industries (27 percent), and construction (14 percent). In the service industries, a large proportion of the part-timers were probably also office workers.

In the office-oriented sectors of banking and insurance of other industrialized countries, however, part-time work is expected to increase,

[48] See, for example, a recent article in *Business Week*, "Part-Time Workers: Rising Numbers, Rising Discord, " Apr. 1, 1985, p. 62, reporting explicit statements by several company spokespersons about reluctance to staff to full capacity.

[49] Katsus Nishiyama, "Introduction and Spread of VDT Work and Their Occupational Health Problem in Japan, " to be presented at the 5th UOEH International Symposium in Japan, Sept. 19, 1985.

[50] *Business Week*, op. cit. Another strong factor has been the growth in demand for part-time employees by fast-food restaurants, shopping centers and shopping malls, and neighborhood banking locations, many of which are open long hours, at night, or on Sundays.

[51] *New Work Schedules for a Changing Society* (Elmsford NY: Pergamon Press, 1981), p. 45.

According to the International Labor Organization, part-time employment in the banking and insurance industries is rising in its member countries, and in Sweden over 26 percent of banking and insurance employees are part-time.[52]

ATMs have probably reduced the need for part-time tellers and clerks in the United States. But other forces are now at work. Four of the biggest eight accounting firms, and many financial service firms including Citibank, Traveler's Insurance Company, and other major employers of clerical workers such as Control Data Corporation (CDC) are now emphasizing part-time employment.[53] Travelers Insurance Company has developed a job bank of retired professionals for temporary market research and product development, and plans to train them for use as programmers, part-time. CDC has a formal program of using part-timers, which has been in effect for 2 years. The goal is to have 15 percent of their work force (chiefly clerical and production workers) on part-time or temporary status and another 15 percent as independent contractors. This goal has been partly realized; by 1984 CDC was reported to have 4,500 part-time workers, or 10 percent of their work force.

Closely related to part-time work is temporary work, which for employers is another strategy for workload leveling. Many clerical workers are temporaries, but there is a growing trend toward using temporary programmers, systems analysts, computer engineers, and data communications specialists.[54] Temporary workers can be called in on short notice when work is briefly or seasonally heavy, and can be dismissed almost instantly and without penalty. From the employer's viewpoint temporaries are part-time workers for whom the organization has no responsibility for long-range job security. The worker who is individually hired on a temporary basis generally suffers the disadvantages of apart-time worker—i.e., not qualifying for benefits and relatively little chance of promotion, and by definition has no job security. Many temporary office workers, however, are employed by firms within the new temporary employment service industry; that firm provides them with assignments to client firms. The worker may be available to the employment service firm full-time or nearly full-time, or may wish to work only occasionally or sporadically. Some employment service firms are now providing their regular workers with prorated benefits similar to those that they might receive as permanent employees of a large firm. More generally, however, temporary workers do not have such benefits.

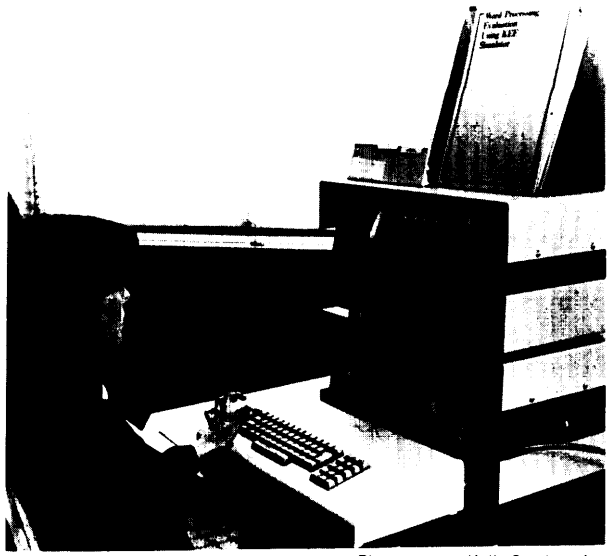


Photo credit " Kelly Services, Inc

This simulator exactly duplicates several major word processing systems and is used for testing in an employment services firm.

The temporary service industry is growing rapidly, nearly twice as fast as GNP over the last 14 years; and faster than the computer equipment industry, to a payroll of $5.5 billion in 1984.[55] At first, it appeared that auto-

"International Labor Organization, Advisory Committee on Salaried Employees and Professional Workers, *The Effects of Technological and Structured Changes on the Employment and Working Conditions of Non-Manual Workers,* Eighth Session, Geneva, 1981, pp. 50-51.

"Joann Lublin, "Shorter Hours: More Managers Are Working Part Time; Some Like It But Others Have No Choice, " *Wall Street Journal,* June 2, 1982, p. 50.

"John J. Davis, President of Worldwide Computer Services, Inc., "Is There a High-Tech Pro in Your Future?" *Management Information Systems Week,* May *22, 1985,* p. *64.*

"The National Association of Temporary Services reported a payroll of $431 million in 1971 and $5.50 billion in 1984, an average of nearly 20 percent growth per year. (Figures sup-

(continued)

mation would be a barrier, since temporary workers would be unfamiliar with equipment, which varies widely between offices, but the larger temporary agencies provide training in a broad spectrum of office automation equipment and applications, particularly word processing. Also, automation has standardized and de-skilled some tasks for which temporary workers can be used. Clerical occupations accounted for over 60 percent of temporary assignments made by the industry in 1980, although it accounted for only 49 percent of the revenue since clerical wages are generally lower than those in technical, medical, and industrial assignments made by the temporaries industry.

Temporary computer and data communication specialists, and other professionals, are in growing demand. They can offer up-to-date knowledge of current systems, languages, and protocols, because of recent schooling and varied experience, and may choose to work as temporaries for fear of becoming trapped in a narrow specialty or job where their knowledge will gradually become obsolete.[56] A computer services official attributes the trend toward use of temporary professionals in computer-related work to "the triangle brought about by mounting costs in corporate and government-mandated fringe benefits, the inability of many companies to meet peak workloads with their permanent staff, and finally the growing number of professionals who desire to change their work patterns.""

Closely related to temporary employment are employee leasing and use of independent contractors. Employee leasing may be used by employers as a still longer term strategy for workload leveling (by month, year, or project-duration), but it is more generally used by very small firms or professional offices (doctors, lawyers, dentists) to shift the administrative costs and benefits costs associated with employees to a contracting firm, which can benefit by economies of scale.[58] The leased worker usually enjoys a full benefits package, although he or she is not guaranteed permanent employment (in practice, the job security may be about the same as in conventional forms of employment).

Office automation appears to have given a large boost to the growth of independent contractors offering business services such as word processing, data entry, and computer programming. Independent contractors are self-employed, with all the risks and benefits this entails; he or she assumes the costs associated with slack work periods and loss of worker's benefits in return for autonomy. The work may be done in the employer's facility, with the contractor/worker effectively indistinguishable to observers or coworkers from employees. The work may however be done in the contractor/worker's home, using the communication capabilities of office automation.

Some clerical and professional independent contractors are entrepreneurs, or small business men and women, seeking multiple clients either at one time or in sequence. They may or may not plan to expand their activities and take on employees of their own. Many contractors on the other hand work for only one firm and are in effect employees without the benefits otherwise associated with employment. The unresolved tax and legal issues associated with independent contractor status are discussed at greater length in chapter 7 in connection with home-based clerical workers, many of whom are former employees converted to the status of independent contractor.

Part-time and temporary employment and independent contracting are likely to increase as automated offices move toward a lean work force with need for occasional supplementary business services, and as more workers are familiar with the equipment. There are strong

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(continued from p. 61)

plied by the National Association of Temporary Services and also based on the Census Bureau's *Count~~ Business Patterns,* "Vital Statistics of the Temporary Help Industry, " Contemporary *Times,* vol. 2, issue 6, fall 1983.)

'Davis, op. cit., says "In practical terms, they do not want to spend the next 5 years of their careers learning how to apply Unix or C into an insurance company microcomputer system."

Davis, op. cit.

"Some service contracting companies make their profits from the interest on advance deposit of the monthly fees paid by the client to cover wages plus associated costs.

benefits in it for workers as well as for employers. Many people prefer and actively seek part-time work. Students, mothers, and retired people often want to work less than a standard workweek; others want more time for families, education, or recreation. They choose to trade income for leisure time, and are willing to pay the additional costs in terms of loss of benefits such as health insurance, lack of job security, and diminished likelihood of promotion and advancement. The standard 40 hour workweek has not changed since the 1930s, and part-time work is the way some people create their own shorter workweek,

Many 'temporaries" choose this form of employment because they want or need the flexibility it gives them.. Some use it as a form of job-hunting, or trying out potential employers. However, some temporaries are unable to get assignments as regularly as they wish, and find the unpredictability y of their income a severe disadvantage, but have been unable to find permanent employment.

At a minimum, part-time work is preferable to unemployment, Employers sometimes convert full-time employees to part-time status during a recession, in preference to laying them off and losing a valuable worker. [59]

If part-time work is beneficial to many employers and is sought by many employees, under what conditions is it a public policy concern? First, if enough full-time jobs are eliminated–-i.e., converted to part-time jobs, opportunities will be diminished for those who must have full-time work to make enough money to support themselves and their dependents. Second, in the United States, many social services and income protection mechanisms are provided not directly by tax payers but through employee benefits packages–e.g., health insurance, life insurance, income during illness or childbirth, pension plans, and to some extent training and higher education. These protections are much more costly, if they are available at all, on an individual basis. If conversion to part-time work means that a sizable proportion of the population no longer has these protections through employment, then the taxpayer is in the long run likely to bear more of the burden of the illness, old age, and death for these people, and the average level of health and well-being of the population is likely to decline.

Society may be willing to bear this risk, if that is the price of allowing people to choose part-time work. If part-time work is not a choice, but the only alternative available to them, and especially if this limitation on choice is the result of employers' decisions, then the public policy issue becomes one of whether this shifting of responsibility for basic protections from employer to employee is acceptable to the society at large. Historically, the choice of full-time or part-time work has been regarded as the individual's prerogative. We must then ask: is this still a free choice, and will it be so in the future? To what extent is *involuntary* part-time work increasing?

The official part-time employment figures based on annual aver-ages do not tell the whole story. The number of people who work part time at some time during a year is often double the annual average. For example, in 1978, a recession year. the annual average was 21.4 million part-time workers, but a retrospective survey indicated that 40.9 million people, at some time during 1978, had only part-time work. '() While the annual average showed 3.4 million of the part-timers as working part-time involuntarily (that is, because they could not find full-time work)" the retrospectiv'e survey counted 10.1 million. The number of involun - tary part-timers has been increasing, as shown in table 2-4, to more than a quarter of all part-timers (and about 5 percent of all employed)

[59] Robert Bednarzik, "Short Workweeks During Economic Downturns," *Monthly Labor Review*, June 1982, pp. 3-11.

[60] Sylvia Terry, "Involuntary Part-Time Work: New Information From the CPS," *Monthly Labor Review*, Febrary 1981, pp. 7-74. See also U.S. Department of Labor, Bureau of Labor Statistics, *Employment and Earnings*, January 1984, table 31, footnote 17.

[61] The Bureau of Labor Statistics counts as involuntary part-time workers those who are working less than 35 hours per week because of slack workloads, material shortages, or repairs to plant and equipment (in other words, the employer has insufficient work for them to do), those whose job ended or whose new job began in the middle of a workweek, and those who cannot find full-time work.

at present. Recent increases in involuntary part-time employment and multiple-job holding for women suggest that there may not be enough full-time jobs for those that seek them.[62] Thus the number of people who "want" to work part-time may be smaller than assumed, and the change in attitudes and lifestyles cited above as a factor in the trend may not play as strong a role as is often assumed.

Public interest in part-time and temporary work is therefore twofold:

1. that the number of involuntary part-time workers not increase to undesirable levels, causing a deterioration in income levels, because full-time jobs have been converted to part-time jobs; and
2. that the costs of worker protection not be shifted from employer to worker to a degree that ultimately causes them to be borne by the taxpayer.

These unanswered questions again point to the need for more careful and systematic monitoring of trends in employment, since a significant increase in the number of long term involuntary part-time workers would challenge the adequacy of existing mechanisms for income security and other employee protection mechanisms.

Analogies From Past Waves of Automation

Throughout modern history, mechanization and automation of work have brought dire warnings of unemployment.[63] But employment has continued to expand. Mechanization and automation have contributed to, or driven, this expansion by reducing the costs of food and material goods, stimulating the market for them, providing paychecks for workers to buy those goods, and creating capital to be invested in production of more and still cheaper goods, further stimulating the market.

In general, workers displaced by mechanization have taken other jobs in the same industry as it expanded, or moved into new or expanding economic sectors.

The argument from history is powerful; in general, technology creates rather than destroys jobs. That is why developing nations, with exploding populations, struggle to industrialize. There are however several important considerations to be noted. The great waves of mechanization and automation in the past were still part of the continuing industrial revolution. The United States was, in the 19th century, a developing nation—an agricultural nation becoming an industrial nation, with an expanding national market based on plentiful resources, in which the consumers who bought goods were also the workers that produced them. From World War II through the 1950s, at least, U.S. technology enjoyed worldwide preeminence across the board. But this is now a mature economy, strong but with increasing competition for both domestic and world markets. Imports are a major factor in the economy. It is therefore not clear that the American economy will grow, in the future, at the vigorous rate of the past. In an economy that is growing more slowly, new jobs are created at a slower rate, and workers do not enjoy the mobility they have in a rapidly growing economy.

Secondly, past waves of automation have been concentrated in one or a few industries, for example, at one time agriculture, at another period commodity manufacturing or industries that could use assembly line techniques. Automation proceeded unevenly across economic sectors, crafts and occupations, industries, organizations according to size, and geographical regions. Jobs were increasing in some industries and occupations, when jobs at approximately the same skill level were decreasing in other industries. Large companies automated well before small companies. Many

[62] According to Professor Eileen Appelbaum in a talk prepared for presentation to the Panel on Technology and Women's Employment of the National Academy of Sciences, Washington, DC, Feb. 17, 1985.

[63] Mechanization is the use of machinery as a substitute for human or animal labor. Automation is a narrower term, meaning the use of machinery that "makes decisions" about the work without human intervention; that is, machinery with control systems that incorporate the principle of feedback to fine-tune or correct the machinery's operations. Computerization carries this internal decisionmaking a great deal further, with the use of information stored in memory and by the sensing of external conditions.

kinds of manufacturing automation, for example, have never been adapted to batch manufacturing or for small machine shops. This contrasts with office automation, which can be used in basic office functions across all industries, and especially with small computers and stand-alone word processors, which allow even small offices to automate.

Although total employment has grown through and after historical waves of automation, each has left behind some structural unemployment. In many cases, older workers failed to make the adjustment and new jobs went to new workers with more recent training, new skills, or more flexibility. In other cases, new jobs and new industries more than compensated for lost jobs in number, but were located in other regions, leaving displaced workers behind. (The coal miners of Appalachia are a pertinent example.)

Agricultural employment declined steadily from 27 percent of all employment in 1920 to 2.7 percent in 1980 (an absolute loss of 8.7 million jobs) as agriculture was mechanized. See table 2-5. However, employment was created in food processing (1.6 million jobs in 1982), in agricultural research, and in transport and sales of food. As population and the economy grew, blue-collar employment stabilized. There were only 3 percent more blue-collar jobs in 1980 than there were in 1950, while the work force grew by 69 percent in those decades. The 30.5 million blue-collar jobs in 1950 were over half of total U.S. employment, while the 31.5 million blue-collar jobs in 1980 were less than 32 percent of total employment. Now the number is decreasing. BLS reports that 2 million manufacturing jobs have been lost since 1979.[64] Had white-collar employment not been expanding rapidly, new workers could not have been absorbed into the economy.

At the beginning of the 20th century, there were only 5.1 million white-collar jobs, accounting for under 18 percent of all employment. By 1950 these jobs had quadrupled to nearly 22 million, but still accounted for less than 37 percent of employment. In 30 years-less than the working lifetime of an office worker—the number of white-collar jobs has more than doubled to nearly 52 million jobs, accounting for at least 55 percent of all American workers.

Structural change in the economy has created jobs in some sectors while it displaced jobs in others. The result is a net increase in employment, and there is also a more equitable distribution of employment opportunities (e.g., better status jobs for more people, and more jobs open to women). Creation of jobs has by and large kept up with both population growth and growing participation in the labor force. In 1950,57 percent of the population was in the labor force, but by 1980 this had grown to nearly 64 percent.

[64]BLS originally reported to the Joint Economic Committee that 8 million jobs had been lost, but issued a correction after this was reported in the press. See "BLS Corrects Figures on Factory Job Losses," *Washington Post*, June 18, 1985.

Table 2-5.—Shifts In Employment by Industry Sectors, 1900-80

	1900	1910	1920	1930	1940	1950	1960	1970	1980
Total labor force (000).	.29,030	37,291	42,206	48,686	51,742	58,992	67,990	79,802	104,058
White collar:									
Growth		560/o	320/o	36%	12%0	34%	260/o	39%	420/o
Labor force	18°/0	21%	250/o	290/o	31%	37"/0	40%	47"/0	51"/0
Blue collar[a]:									
Growth		37%	140/0	19%	11%	14"/0	9"/0	190/0	21%
Labor force	45°/0	480/o	480/o	49%	520/o	520/o	49%	490/0	450/0
Farm:									
Growth		60/0	−1%	−90/0	−130/0	−230/o	−41 0/0	−400/0	−60/0
Labor force	380/.	31%	270/.	21%0	17"/0	12"/0	60/0	30/0	3%

[a]This *includes manual and service workers*

SOURCES" U S Department of Labor, Bureau of Labor Statistics, *Historical* Abstracts, *Colonial Times to 1970*, Series D, Nos 182.232, p 139, and U S Department of Commerce, *Statistical Abstracts of the United* States— *7985,* p *400*

But it is not clear that the creation of new jobs has completely compensated for the long range labor-saving effects of mechanization and automation. High unemployment rates (7.5 to 7.1 percent) have persisted in spite of the highest employment ever achieved in this country. In 1984, after recovery from a recession, 3.5 million new jobs were created (the second highest growth rate in our history) but unemployment did not significantly decrease and stood at 7.2 percent at year end. [65] If those workers are counted who have dropped out of the labor market because of discouragement, or have accepted part-time work because they can not find full-time work, the unemployment rate would be several points higher than it officially is; for example, in early 1985, about 10.8 percent rather than 7.3 percent. The number of jobs in manufacturing declined by 1.6 million from 1979 to 1984, and in the goods-producing sector very few industries employ more workers now than before the recession began.[66] During a recession, some markets maybe lost to international competitors, and some organizations do not recover. Also, organizations tend to adjust slowly to labor-saving technology, preferring normal attrition to layoffs; but when layoffs are forced for other reasons, they are likely to take advantage of this to eliminate redundant jobs permanently.

The "normal" level of unemployment has in fact been rising for at least half a century. Several kinds of unemployment are usually distinguished. One kind is "frictional" unemployment–that which is normally attributed to the demise of individual firms and the mobility of workers moving between schools, jobs, and occupations. Another kind results from relatively discontinuous or sudden expansions of labor supply, for example, disbanding of a military force, a wave of immigration, or—less precipitous but still unprecedented–the increased participation of women in the labor force in recent years. Third, there is cyclic unemployment resulting from fluctuations in aggregate demand, which can be an acute and serious problem during recessions but declines when the economy recovers. The fourth kind of unemployment and the most serious in long-term considerations is structural unemployment, often defined as a mismatch between the supply of jobs and the supply of workers with the skills needed for those jobs, but in theory also possible when there are not enough jobs, at any skill level, to engage all would be workers.

Until about 1970 it was generally assumed in this country that an "acceptable' level of total unemployment was about 3 to 4 percent.[67] But the rate has not been that low, even in periods of expansion, since 1969. As shown in table 2-6, unemployment rates have been rising for about two decades, not falling back even in "boom" years to previous lows.

This long-term rise in unemployment has been attributed to many causes. One is demographic-the flow of young people and women into the labor market during the 1970s. Others are shifting industry patterns (e.g., involuntary job loss in the automobile industry as a result of foreign competition), changing life styles (willingness of people to take temporary or part-time jobs for the sake of leisure time, or greater mobility), and slackening of aggregate demand. But as shown in table 2-6, the increase can be seen through both the troughs

[65] U.S. Department of Labor, Bureau of Labor Statistics, *The Employment* Situation (monthly) and *Employment and Earnings*. January 1984; Linda LeGrande "Employment Status of the Nation: Data and Trends, Congressional Research Service. Issue Brief IB82097, updated May 6, 1985.

[66] LeGrande, op. cit., p. 3.

[67] "In fact, unemployment rates frequently exceeded this figure in recession years throughout the century and from 1931 to 1940 was higher than 14 percent, with more than 20 percent of the labor force unemployed in 1932. 1 933, 1934, and 1 935. During the war years unemployment was under 2 percent t, :1 nd has been on an upward slope since then.

Table 2-6. —National Unemployment Rates During Recession Troughs and Recovery Peaks, 1961-84

Recession troughs		Recovery peaks	
1969 -70... ..5	8%	1961-69, ., . .	3,6°/0
1973 -75., . . ., . . .	.8.3	1973, ...	.4,8
1980, ...	.75	1979. , ., ...	.6.0
1981 -82.., ...10.6		1981 ., ...	.7,4
		1984.	7.1

SOURCE Bureau of Labor Statistics data compiled by Michael Podgursky Sources of Secular Increases in the Unemployment Rate 1969-1982 *Monthly Labor Review* July 1984 p 20

and high points of business cycles. Economist Michael Podgursky notes that there has been a long-term rise in involuntary job loss and argues that:

> . . . rising structural unemployment in traditional segments of the labor force may also have played a significant role . . . the secular rise in the unemployment rate since 1969 seems to have been generated by more than just labor market adjustment problems associated with a rapidly growing labor force.[68]

It is worth noting at this point that Podgursky's analysis suggests that structural unemployment so far may have affected primarily blue-collar jobs. This would argue that both automation and rising imports of capital goods have played a role. Both will also increasingly affect white-collar work in the future (see chapter 8 for a discussion of off-shore sourcing of data entry work).

In summary, the number of jobs has continued to increase through waves of mechanization and automation in the past; the U.S. economy was growing strongly, and an assumed major driver in this growth was technological advancement. But there are disturbing signals that structural unemployment has also grown.

The Future White-Collar Labor Supply

The number of office jobs is likely to grow more slowly at best, and at worst to decline, with a possible precipitous decline in lower level clerical jobs such as data entry if certain technological developments proceed as anticipated. The effect on employment levels must be considered in terms of the supply of labor– or the demand for jobs.

During the coming decade, from 1985 to 1995, the population will grow by about 10 percent. But the work force will grow about 16 percent, from 113.5 million to well over 131 million; nearly 18 million more jobs will be needed.[69] There will be fewer young workers entering the work force each year; the number of people in the work force who are under 24 will in fact decline as will the number of workers 55 and over, while the number of 'prime age" workers, age 25-54 is growing. These changes of course reflect wide variations in the birth rate in past decades; the average age of workers will increase.

About 65 percent of the workers added to the work force will be women (by 1995, they will make up at least 47 percent of the work force). The number of working women between the ages of 35 and 44 is expected to more than double, and the number between 45 and 55 should increase by nearly 60 percent. Women in these age groups who are already working are heavily concentrated in clerical occupations. This is a demographic group that will be strongly affected by the outlook for office jobs over the next 15 years. The proportion of nonwhite workers will also be growing; now 12.5 percent, they will be 14.5 percent of the work force by 1995. The number of black women in the work force, for example, will increase by over 50 percent. Since minority women are disproportionately represented in lower level clerical jobs, this is another group that will be differentially affected by office automation. A further discussion of the effects on these groups is in chapter 12.

[68] Michael Podgursky "Sources of Secular Increases in the Unemployment Rate, 1969-1982," *Monthly Labor Review*, July 1983, p. 24.

[69] This is the middle growth scenario used by H 1.S; see *Employment Projections for 1995*, Bulletin 2197, March 1984.

CONCLUSIONS

The most likely outlook appears to be slowing growth in office employment over the next decade; some decline in office employment could begin by 2000. Slowing employment growth, or even decline, is most likely to occur in clerical occupations but may also affect lower and middle management positions.

This outcome is not certain or inevitable. Strong growth in the U.S. economy and continuing growth in demand for information, and information-based products and services may outweigh the labor-saving achieved through office automation. Nor would slow growth in office employment necessarily result in lower overall employment levels. Growth in other occupations could more than compensate for a decrease in office jobs, especially if higher office productivity contributes significantly to the productivity of U.S. industry and its competitiveness in world markets.

The possibility of slow growth or decline in office employment, which now occupies about 45 percent of all employed Americans, is nevertheless something which Congress should watch closely, in order to take preventative or corrective actions in a timely fashion. The further possibility of a significant increase in part-time and temporary work, at the expense of full-time employment, should also be watched carefully, lest it leave a growing proportion of American workers without essential benefits, income security, and other social protections.

As has been noted throughout this chapter, however, the ability of Federal policy makers to monitor technological change and its effects on employment and the structure of the economy is weak. It is limited both by inadequate data and by lack of capability in technological and economic forecasting. The latter limitation in turn, reflects in part the state of development of these disciplines themselves; however, in the civilian agencies little resources are being allocated to improving these capabilities and recent budget cuts, may have further eroded government capability for foresight and planning, at least in the important area of information and communication technology development.

POLICY CONSIDERATIONS: LABOR MARKET ADJUSTMENT OPTIONS

The Need for Monitoring of Structural Economic Change Related to Information Technologies

While the possible long-range effects of office automation can be foreseen, they are subject to many and complex uncertainties related to broader changes in the national economy and the global economy, as well as to natural social adjustments and accommodations and to specific policy interventions. Nevertheless, the potentiality is troublesome enough to merit both careful monitoring and systematic contingency planning by responsible agencies of the Government.

That kind of serious monitoring and planning is not being adequately done. Executive agencies have few incentives to warn of possible long-range problems when such warnings, or the preparatory actions they imply, may call into question immediate administration policies or the assumptions around which they are framed.

Congress may, therefore, wish to consider now how such monitoring and long-range planning may be set in motion.

There are serious institutional barriers to such analysis within the executive branch of Government. The first necessity for analysis

of emerging and potential employment problems related to structural change in the economy is the availability of time-series data organized in appropriate categories. There are at present troublesome deficiencies in the way in which labor data is collected and organized for use by government analysts. A second necessity is the continuing development of capability for monitoring and forecasting technological change. To analyze the employment implications of technological change, there must be a close link between technical, economic, and social science knowledge and analytical expertise. There is no institutional locus in the executive branch of the Government developing excellence in the technical monitoring and forecasting of information and communication technology and studying the economic, social, and political implications, despite the central role that information and communication technology now plays in the economy and in the Government itself. On the contrary, some of the relevant but partial and fragmented functions and capabilities that have been developed along those lines have recently been curtailed or weakened by budget cuts (e.g., the planning and forecasting elements within the Institute for Computer Science and Technology in the National Bureau of Standards).

Congress should therefore consider means of mandating and implementing a mechanism or governmental unit within the executive branch with the capability for systematic monitoring, analysis, and reporting of changes in the structure of the economy related to fundamental changes in the technologies of communications, computers, and information management.

Longer Range Policy Options

If, as it appears possible, office automation will over the long run lead to inadequate growth in demand for office work or outright decline in the number of office jobs, or in the narrower but still large category of clerical jobs, what could be done about it? The policy options discussed below are long-range options, interventions to be considered if and when it appears that white-collar unemployment is becoming a serious problem.

Discouraging the spread of office automation in the United States is clearly undesirable, because of the benefits it promises in terms of productivity and in terms of the quality of work life; and discouraging it is also virtually impossible under the U.S. economic and constitutional framework.

Some of the marginal effects of office automation on employment could be controlled directly. For example, Congress may wish to consider options to discourage the off-shore sourcing of office work, or of the narrower category of data entry, should this increase to the point of significantly affecting clerical jobs in the United States.

Conventional kinds of policy intervention would aim at improving labor market adjustment—that is, helping displaced workers get new jobs. These mechanisms might include a broadening of the applicability of labor market adjustment support to white-collar workers, and an increase in the level of that support.

In the matrix of 1982 dollars, the money spent by the Federal Government on general employment and training programs and for the Federal Employment Service per labor force participant has fallen from $46.35 in 1970 to $30.30 in 1982, a 35 percent decrease. This is about one-quarter of the expenditures in some other industrial nations, for example, Sweden. As pointed out by an expert in labor adjustment policy:[70]

> Current policy takes a passive orientation toward the labor market and services only the most disadvantaged workers. What is required is a more activist policy in which *structural change is anticipated* and a broad segment of the labor force is assisted in adjustment. With-

[70] Michael Podgursky, University of Massachusetts, "Labor Market Policy and Structural Adjustment," a paper prepared for the Conference on U.S. Industrial Policy and International Development, held by the Overseas Development Council, Washington, DC, March, 4, 1983. Podgursky made this argument in the context of displacement of manufacturing workers and overall structural changes in the economy and was not specifically referring to white-collar displacement.

> out such a change existing employment and training programs will continue to play only a marginal role in assisting workers in the mainstream of the industrial labor force who face economic hardship as a result of ongoing structural changes in the economy. (Emphasis added.)

An alternative or complementary strategy is to focus Federal programs on those office workers apt to be most directly and strongly affected, and also relatively disadvantaged in terms of current employment status. This group includes: 1) those in specific clerical occupations generally at lower levels of the wage scale, most of whom are women; 2) minority workers; and/or 3) all women office workers, since even in managerial and professional occupations women as a group have less seniority than men and are concentrated at the lower levels of the occupational hierarchy most likely to be affected by automation.

Existing job training programs and labor exchange or employment service systems that provide labor market information are primarily' framed around blue-collar employment.;[71] programs available to displaced workers in the automobile and steel industries, for example, have given relatively little attention to office workers in those industries. There may be ways to improve the quality and availability of labor market information and counseling services for office workers, with an emphasis on forecasting changes in occupational demand.

Development of serious white-collar unemployment could result in demands for actions in the broad category of "share the work" mechanisms; for example, a shortening of the standard workweek. Industry has generally resisted all such suggestions for three decades, and will surely continue to do so on the grounds that it would subvert the productivity increase sought in adopting office automation. From the standpoint of labor, such a strategy would be undesirable unless wages were raised proportionately. If wages did not rise, then many workers would seek to compensate for shorter working hours by taking second (part-time) jobs, which would tend to make the strategy ineffective.

In effect, the standard workweek may be shortened without policy intervention if the use of part-time workers increases. This has disadvantages from a public interest viewpoint, because as discussed above it would result in a deterioration of income security, and very likely a long-range increase in the costs of necessary social services and/or an increase in the share of that burden borne directly by taxpayers.

To some extent that problem might be alleviated by laws requiring the prorating of all workers benefits packages, stronger controls over conversion of employees to independent contractor status (or more stringent definition and clarification of that status), and nationwide eligibility of involuntary part-time workers for prorated unemployment benefits. This would lead to a more rational allocation of labor resources by eliminating the advantages that accrue to employers who substitute part-time workers for full-time workers not to level the workload but to save the cost of fringe benefits. Rigorous cost-benefit studies would be necessary, however, to assesss the desirability" of such policy action~: they should include cost-effectiveness studies to determine the relative advantages to employer sponsored fringe benefits publicly provided social services.

One possible strategy is shared work compensation, also known as voluntary reduced work time (VRWT). This concept calls for State legislation to allow payment of partial unemployment compensation to workers when companies, facing the necessity of laying off workers, choose instead to reduce the work time of employees (e.g., putting at least 10 percent of the workers on a 4-day week).[72] A VRWT

[71] See the forthcoming OTA report, *Technology and Structural Unemployment: Reemploying Displaced Adults*, early 1986.

[72] This strategy has been widely used in Europe; in Germany, payment of partial unemployment benefits to more than 770,000 involuntary part-time workers during the recession year 1975 was credited with keeping the unemployment rate about 1 percent lower than it would otherwise have been. In 1929 the Hoover Administration urged employers to reduce work weeks in order to spread work, but without unemployment pay-

program spreads available work (or more exactly, shares the burden of unemployment) thereby maintaining purchasing power and curtailing need for public welfare expenditures. It also has the advantage of preserving the employment gains of women and minorities, who constitute a disproportionate share of "last hired-first fired" workers. The full costs of such a program are uncertain, but in theory the benefits paid out should not be much greater than they would be under regular unemployment compensation programs since they would merely be partial payments to more workers rather than full payments to fewer workers. California passed Work Sharing Unemployment Insurance legislation in 1978 and at least six other States follow[ed]

States determine eligibility and terms for unemployment compensation, which is basically financed by taxes levied against employers by the Federal and State Governments. The Federal Government could provide incentives to provide such programs and in fact has already provided some incentives in this direction. The Federal [illegible] policy and several Congressmen [illegible] Secretary of Labor [illegible]

What Action Is Needed Now?

Office automation will restructure employment patterns for a large portion of the American work force. This will challenge much existing Federal labor policy. That policy may have to be altered:

- to maintain Federal policy objectives in this new environment;
- to prevent unintended barriers to social and labor market adjustments that are appropriate and desirable; or
- to mitigate undesirable side effects of such adjustments or to prevent undesirable adjustments.

The labor force adjustment mechanisms mentioned above are conventional proposals for dealing with cyclical unemployment problems. OTA does not suggest that white-collar unemployment resulting from office automation will call for such actions or more extensive actions in reaction to future. Such responses are however most effective at the early stages of job displacement problems. Without the capability to detect structural changes before they [illegible]