

Artificial Intelligence, Employment and Income

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Abstract

Artificial intelligence (AI) will have many profound societal effects. It promises potential benefits (and may also pose risks) in education, defense, business, law, and science. In this article we explore how AI is likely to affect employment and the distribution of income. We argue that AI will indeed reduce drastically the need for human toil. We also note that some people fear the automation of work by machines and the resulting unemployment. Yet, since the majority of us probably would rather use our time for activities other than our present jobs, we ought thus to greet the work-eliminating consequences of AI enthusiastically. The paper discusses two reasons, one economic and one psychological, for this paradoxical apprehension. We conclude with a discussion of problems of moving toward the kind of economy that will be enabled by developments in AI.

ARTIFICIAL INTELLIGENCE [AI] and other developments in computer science are giving birth to a dramatically different class of machines—machines that can perform tasks requiring reasoning, judgment, and perception that previously could be done only by humans. Will these

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machines reduce the need for human toil and thus cause unemployment? There are two opposing views in response to this question. Some claim that AI is not really very different from other technologies that have supported automation and increased productivity—technologies such as mechanical engineering, electronics, control engineering, and operations research. Like them, AI may also lead ultimately to an expanding economy with a concomitant expansion of employment opportunities. At worst, according to this view, there will be some, perhaps even substantial shifts in the types of jobs, but certainly no overall reduction in the total number of jobs. In my opinion, however, such an outcome is based on an overly conservative appraisal of the real potential of artificial intelligence.

Others accept a rather strong hypothesis with regard to AI—one that sets AI far apart from previous labor-saving technologies. Quite simply, this hypothesis affirms that anything people can do, AI can do as well. Certainly AI has not yet achieved human-level performance in many important functions, but many AI scientists believe that artificial intelligence inevitably will equal and surpass human mental abilities—if not in twenty years, then surely in fifty. The main conclusion of this view of AI is that, even if AI does create more work, this work can also be performed by AI devices without necessarily implying more jobs for humans.

Of course, the mere fact that some work can be performed automatically does not make it inevitable that it will be. Automation depends on many factors—economic, political, and social. The major economic parameter would seem to be the relative cost of having either people or machines execute a given task (at a specified rate and level of quality). In

this respect too, AI differs from many previous labor-saving technologies in that it is relatively very inexpensive and will undoubtedly become even more so in the future. Yet, even granting an economic rationale for replacing human labor with machines, we as a society may choose not to do so. That is, we may decide to continue to employ humans in jobs "next to the window" (as the Japanese say), simply as a way to distribute income and to give people something tangible to do.

In this paper I examine the potential economic effects of artificial intelligence. I conclude that AI does indeed offer the potential for achieving massive reductions in the amount of human labor needed to produce the world's goods and services. While acknowledging that there are understandable reasons people might feel threatened by this outcome, it seems to me that we should view it as a blessing rather than a curse. As John Maynard Keynes said over fifty years ago:

"All this means in the long run [is] that mankind is solving its economic problem. . . The economic problem is not—if we look into the future—the permanent problem of the human race (Keynes, 1933)."

From this standpoint, I then review some suggestions for disassociating income from employment so that people will be able to benefit from the elimination of unnecessary toil.

The Diminishing Need For Human Labor

Commonsense Arguments. Before beginning a more technical discussion of the economic effects of AI, it is worth considering a few general statements that are being made about the consequences of automation.

First, let's look at some of the arguments supporting the view that automation (including AI) will not result in unemployment. In a recent interview, James Albus, a leading researcher in robotics, made several important points. He stated, for example:

"There is no historical evidence that rapid productivity growth leads to loss of jobs. In fact, quite the contrary. In general, industries that use the most efficient production techniques grow and prosper, and hire more workers. Markets for their products expand and they diversify into new product lines (Albus, 1983)."

A related argument is based on the observation that unemployment is worse in the developing countries than in the industrialized ones. Since automation is much less pervasive in the Third World and unemployment is still so acute there, automation obviously cannot be the principal cause of unemployment.

Even if automation makes it possible to perform every task with fewer workers, there are a great many needs to satisfy. Albus expands on this point by observing that

"... there is not a fixed amount of work. More work can always be created. Work is easy to create. . . There is always more work to be done than people to do it. . . The problem is not in finding plenty of work for both humans

and robots. The problem is in finding mechanisms by which the wealth created by robot technology can be distributed as income to the people who need it. If this were done, markets would explode, demand would increase, and there would be plenty of work for all able-bodied humans, plus as many robots as we could build (Albus, 1983)."

There are several industries that have pursued automation aggressively without reducing overall employment. In U.S. banking, for example, because the increased productivity resulting from automation has been accompanied by a relatively even higher demand for bank services, employment grew by 50 per cent between 1970 and 1980 (Ernest, 1982). (On the other hand, however, we note that most of the jobs in the banking industry involve "knowledge work" of one sort or another—*i.e.*, the very category that is succumbing most rapidly to automation by AI techniques. In fact, the Bank of America recently announced that it is now seeking to reduce its employment levels significantly (Gartner, 1984).)

Even if automation proceeds rapidly, the task of converting to automatic factories and offices will itself require considerable labor. According to Albus, "...building the automatic factories . . . is a Herculean task that will provide employment to millions of workers for several generations (Albus, 1983)."

Critics of the hypothesis that artificial intelligence will be able to do anything argue that there is a large number of tasks that simply can never be completely automated. For instance, some people believe that it will prove impossible or undesirable to automate such services as marriage counseling, child care, and primary-school teaching. They might also claim that machines will never be able to generate truly excellent music, literature, and other art forms. Some, such as Professor Thorne McCarty of Rutgers, have suggested that the economy of the future might be based on these specialized kinds of "human-oriented" and creative services, just as much of our present-day economy is based on a more general array of services.

On the other hand, those who argue that the more advanced forms of automation (like robotics and AI) will cause increasing unemployment have several reasonable arguments on their side. For example, they point to the fact that over the past decade or so unemployment in the technically advanced societies does appear to have grown. With each successive business cycle, the "troughs" in the unemployment graph move upward. Although many people lose their jobs at times of recession, there are many others among the jobless who can blame their plight on robots and other automatic devices. Some economists think that we are already in the initial stages of a critical period in which large-scale unemployment due to automation is inevitable. For example, Dr. Gail Garfield Schwartz, an economic consultant in Washington, D.C., was recently quoted as saying "perhaps as much as 20 per cent or more of the work force will be out of work in a generation (Neikirk, 1982)."

Nobel-prize-winning economist Wassily Leontief, direc-

tor of the Institute for Economic Analysis, at New York University, adds weight to this prediction. He says that

“ . . . we are beginning a gradual process whereby over the next 30-40 years many people will be displaced, creating massive problems of unemployment and dislocation . . . In the last century, there was an analogous problem with horses. They became unnecessary with the advent of tractors, automobiles, and trucks. . . . So what happened to horses will happen to people, unless the government can redistribute the fruits of the new technology (Leontief, 1983) ”

We should also realize that employment data, as collected and published by the Bureau of Labor Statistics of the U.S. Department of Labor, include all the people who are ordinarily considered to be working. We must be honest enough with ourselves to admit that probably not all of these people are really presently required to produce the goods and services that we need. Some might not actually be needed—but are being paid anyway because of labor contracts that have set excessive standards as to the number of persons it takes to perform certain jobs. Most of us are being paid, quite legitimately perhaps, for vacations—which is one way of spreading the available work around. Some are being paid because various governmental bodies have been persuaded that certain goods and services are “needed,” despite the fact that they are quite controversial and might not even be desired by a majority of those of us who are *buying* them. Some are being paid for crops not produced. Some are being paid because of eliminable inefficiencies that we prefer to continue tolerating. Because statistical employment does not necessarily mean real employment, the magnitude of the unemployment problem may already be greater than we realize.

Another factor pointing toward future reductions (or at least shifts) in the labor force is the rapid progress in automating much “white collar” work. It has been estimated that more than half of all American workers are engaged in “information-processing activities.” Included in this category are many managerial functions, such as decision-making, reporting, communicating and coordinating, fact-gathering, and the supervision of similar activities by subordinates. Also included are many paper-handling clerical functions. The “expert systems” and automatic planning programs currently being developed in AI research laboratories will be able to perform many of these tasks, with a consequent drastic reduction in the need for human involvement or intervention.

Others have argued that the majority of new jobs created by automation will require only low-skilled labor. In a recent Stanford study Levin and Rumberger conclude the following:

“Most new jobs will not be in high-technology occupations, nor will the application of high technology in existing jobs require a vast upgrading of the skills of the American labor force. To the contrary, the expansion of the lowest-skilled jobs in the American economy will vastly outstrip the growth of high-technology ones. And the proliferation of high-technology industries and their

products is far more likely to reduce the skill requirements for jobs in the U.S. economy than to upgrade them. . . . About 150,000 new jobs for computer programmers are expected to emerge during [the next] 12-year period, a level of growth vastly outpaced by the 800,000 new jobs expected for fast-food workers and kitchen helpers. . . . Past applications of technology in the workplace as well as present evidence suggest that future technologies will further simplify and routinize work tasks and reduce opportunities for worker individuality and judgment. Moreover, the displacement in jobs and the downgrading of skill requirements for most of the new positions will undermine employment generally, and especially the employment of skilled workers (Levin & Rumberger, 1983).”

So we see that there are many more or less reasonable arguments on both sides of this issue. It is likely that we will continue, almost daily, to hear conflicting opinions about the prospective impact of AI on employment. For a more prescient analysis, however, we must turn to more technical economic arguments.

Technical Arguments. The economists from whom we seek consultation also have differing opinions on this matter. In fact, two Nobel laureates in economics, namely Herbert Simon and Wassily Leontief, seem to be on opposite sides. On the one hand, Herbert Simon (who, of course, is also a distinguished AI scientist) invokes the law of comparative advantage, which is, as he states, the standard rebuttal of economic theory to the concern that mechanization causes technological unemployment. Simon claims that this law

“ . . . shows, essentially, that both people and machines can be fully employed regardless of their relative productivity. By adjustment in the relative price of labor and capital, respectively, it will come about that labor will be employed in those processes in which it is relatively more productive, capital in the processes in which it is relatively more productive.”

Simon does admit, however, that the law of comparative advantage

“ . . . does not settle all the essential issues. In particular, although it shows that at some wage all labor would be employed in equilibrium, no matter how efficient machines become, it does not predict what that wage would be. It does not guarantee that real wages will not drop as the economy’s productivity improves through mechanization. It does not even guarantee that real wages will remain above the subsistence level (Simon, 1977).”

To pursue this matter further, Simon analyzes in more detail the effects of technological progress in a model economy (Simon, 1977). Equilibrium conditions in his model are given by the following equation:

$$\begin{aligned}
& (\text{labor wage rate}) \times (\text{average labor time required to} \\
& \quad \text{produce one unit of output}) \\
+ & (1 + \text{interest rate}) \times (\text{average capital required to} \\
& \quad \text{produce one unit of output}) \\
= & 1
\end{aligned}$$

A labor-saving technological change in Simon's model economy would lower the average labor time required to produce one unit of output. He concludes that "...so long as the rate of interest remains constant, an advance in technology can only produce a rising level of real wages." He then gives several reasons, some historical, why he believes it likely that (real) interest rates will remain constant.

Simon summarizes his position by saying that

"...nothing about the current advances in automation indicates that these advances will have any different economic effects than earlier industrialization and mechanization. The main long-run effect of increasing productivity is to increase real wages—a conclusion that is historically true and analytically demonstrable."

In Simon's model, the entire cost of capital (interest on borrowed capital plus return on invested capital) is combined as "*interest*." One wonders whether the predictions of his model would survive an analysis in which technology makes possible a shift from salaries paid to humans toward "*salaries*" paid to machines (in the form of higher profits to the robot owners). Would he include these "*salaries*" as "*wages*" or as "*interest*?"

It is true, as Simon notes, that the cost of capital (the real interest rate) has remained fairly level over recent decades. Consequently, as our economy has become more productive, both the labor wage rate and total labor wages have risen. But, as Kelso and Adler (Kelso, 1958) argue, it is machines, not labor, that have become more productive; therefore, it is capital, rather than labor, that might more appropriately have received the extra reward. Our society has simply "chosen" (through various social and political means) to distribute income to consumers through higher wage rates, rather than through higher return on investment. However, there is no compelling reason to believe that, as capital becomes even more productive (through the use of AI devices), equilibrium won't ultimately be attained by rewarding capital more handsomely than labor. (For example, could not the recent upward pressure on real interest rates be partially explained by the fact that it is becoming ever more difficult for society to deal with the increased productivity of capital by repeatedly granting further rises in wage rates?)

Taking a somewhat different approach, Leontief and his colleagues have used arguments based on input/output analysis to show that automation will lead to a reduced need for human labor. Input/output analysis is a computer-based technique for quantitatively analyzing how the various sectors of an economy supply and depend on one another for goods and services (Leontief, 1966). A series of input/output simulations of the Austrian economy, for example, forecast that intensive automation would increase Austria's cus-

tomarily low (2 per cent) unemployment rate to 10 per cent by 1990 unless the reduced need for work were offset by a shorter work week (Leontief, 1982).

Together with Faye Duchin and colleagues, Leontief has recently developed a dynamic input/output model of the American economy that has been used to make predictions about employment levels on the basis of three different assumptions about technological change. They conclude that a rather

"intensive use of automation over the next twenty years will make it possible to conserve about 10 per cent of the labor that would have been required to produce the same bill of goods in the absence of automation. The impacts are specific to different types of work and will involve a significant increase in professionals as a proportion of the labor force and a steep decline in the relative number of clerical workers (Leontief & Duchin, 1983)."

After discussing these results with Faye Duchin, I think it is likely that AI technology will allow even more automation than that assumed in their "intensive" scenario (Duchin, 1983).

One could cite other economists who take opposing positions on the effects of automation. In my opinion, however, those who expect AI and automation to expand the number of jobs available fail to take into account some important distinctions between AI and previous technologies. I believe that a relatively straightforward chain of economic reasoning, based on the special nature of artificial intelligence, leads us directly to the conclusion that the total amount of human labor used to produce our goods and services will decline markedly.

Our terminology will be simplified if we use the word "*consumables*" in place of the phrase "*goods and services*." By "consumable," I mean to include specific physical objects, such as automobiles, cameras, shoes, apple juice, missiles, and all the other tangible items that might be needed (purchased) from time to time by or for persons, animals, processes, corporations, governments, or other consumers. I also include all kinds of services, such as rides on jet planes, hairdressing, the production and issuance of environmental impact reports, deciding about factory locations, financial management, poetry composition and readings, and such other services as might be performed in a society. Although there may be intermediate non-human consumers, such as corporations, processes, or robots, the most important class of consumers consists of people—*i.e.*, of living, breathing individuals. If consumption by a nonhuman does not, in some manner, relate ultimately to the consumption of something by a human, we might well ask (anthropocentrically): "What's the point?"

People are both *consumers* and *producers* of consumables. Economic systems and economic theory seek to establish relationships between these two activities. Let us focus first on consumption.

It is particularly difficult to analyze our "needs" for consumables. Consumables can often be replaced by substitutes

without objection or detriment. Cheap plastic parts can be used instead of more expensive metal parts, resulting in a different consumable. If the substitution is successful, our “need” for the original consumable disappears. Sometimes people can be convinced that they really do not need consumables formerly considered essential. (What has happened to “house calls” by medical doctors?) Previously contented, satisfied people can also come to believe that they can no longer be satisfied without acquiring additional or different consumables. Suddenly we “must have” a new kind of toothpaste, a backyard swimming pool, a particular weight-reducing program, and so on. Times, styles, and values change—and, as they do, our needs expand and contract correspondingly.

Another important point is that, regardless of changing needs in the industrialized countries, most of the people in the world presently consume relatively little; consequently, the global demand for consumables can (and ought to) increase dramatically. James Albus has noted the effect that this accelerating demand will have on employment:

“The world is filled with need. It is premature to worry about robots eliminating work as long as there exist such overwhelming problems as providing food, clothing, shelter, education, and medical care for millions of people living in desperate poverty (Albus, 1983)”

Nevertheless, one should not assume that the potential for humans beings to absorb consumables is infinite. It may in fact be very large, but it is finite. There is a “law of diminishing returns” for consumption as well. After a certain level of consumption has been reached, people just don’t have the extra time, attention or desire to absorb even more goods and services, regardless of their cost. Those consumables that are purchased, but which are then literally forgotten and abandoned before they are used at all, might just as well not have been produced—except, possibly, for the role their creation might have played in providing jobs. But such jobs, we would all agree, would certainly be of the “makework” category. It should also be clear that the finite nature of material and energy resources might effectively limit the production of some consumables even before people became satiated with them.

The reason for pressing this point is that some might argue that there will always be a requirement for large amounts of human labor if demand is potentially infinite. Automation will simply never catch up with continually increasing demand. Now, we might agree that the ultimate ceiling on demand could be very high indeed—far above current levels. But AI applications will lead to increases in the exponent of a productivity that is already rising exponentially, and such “superexponential” increases overtake finite (even if large) limits very quickly. (A similar argument supporting continuing requirements for human labor might be based on a constantly shifting but finite set of needs. Here again automation might have difficulty keeping pace with constantly shifting needs—but so might human workers.)

We should also question whether we, as a society, really

want to persuade ourselves to increase consumption mainly for the purpose of providing employment. If drastically increased consumption does not result in more fulfilling and rewarding lives, the extra production seems rather pointless. I am reminded of the naturalist John Muir’s statement, “Why, I am richer than [railroad magnate Edward] Harriman. I have all the money I want, and he doesn’t.”

Now let us consider production. Consumables are produced by processes that change from time to time. Each process involves an amalgamation of human labor (of various types), capital (machinery and plant), and materials (including energy). In a free-market, competitive economy, suppliers of consumables seek to reduce the individual costs of these components. We might call this tendency the “law of reduction.” Reduction is often achieved through “technology.” (Of course, suppliers might also seek to substitute a different, lower-cost consumable by attempting to convince purchasers that they need the substitute instead.) Most attention is paid to that component of a consumable’s production which offers the best expectation of achieving maximum overall cost reduction.

Given the law of reduction (and a strong belief in the power and economy of artificial intelligence), we can conclude that the cost of the human-labor component of any consumable will fall until it is no longer a significant percentage of the cost of the consumable. The law of reduction, in this case, works as follows. So long as the cost of the human-labor component of a consumable remains a significant factor in the latter’s total cost, producers will want to substitute lower-cost machines for human labor. This desire will motivate attempts to increase the power and decrease the cost of computer hardware and AI software. It is technologically inevitable that such attempts will succeed and will continue to do so until the cost of the human-labor component of consumables becomes insignificant. Essentially what we shall be witnessing will be the replacement of expensive human labor by ever-cheaper AI “labor” until a consumable’s ultimate cost approaches the sum of the costs of the non-AI capital, materials, and taxes. (Since AI is so inexpensive, we are assuming that the cost of the AI capital is also insignificant.) Thus, the total cost of human labor needed to produce all consumables will become small in comparison with the sum of the other costs.

An economic tautology that links input and output tells us that the total income earned by people through labor is the same as the total human-labor cost in producing all consumables, and that the total income earned by people through means other than labor (such as transfer payments and return on investment) is the same as the total nonlabor costs of producing all consumables. Therefore, the total income people earn through their labor can be expected to fall until it is a small percentage of the total income earned by people through other means.

These trends have already been evident in our economy for many individual industries, such as agriculture—even if they have not yet been prominent in the aggregate. The

primary income source of a typical family farmer, for example, has shifted from his own labor to a return on his investment in laborsaving farm machinery. In general, however, labor has been able to move to areas in which its technological replacement by lower-cost machines has not yet occurred, such as service industries and white-collar work. This shift has been possible because demand has expanded to include consumables produced by such labor. But the law of reduction is still operative, chipping away at the labor component of these consumables as well; and, through AI, their labor costs too will ultimately be drastically reduced. With inexpensive AI in relentless pursuit, it seems likely that there will be few sanctuaries left where income is derived from toil. The only way in which the labor fraction of overall income will not be lowered is if many new "automation-proof" consumables are added to those we need. For example, some people think that several human-service occupations (nursing, teaching, psychiatry, marriage counseling, etc.) will remain forever beyond the reach of automation, and that our future economy might be based entirely on that sort of work. It seems to me, though, that there are too few intrinsically nonautomatable services on which to base an entire economy.

If the small percentage represented by overall labor income is concentrated among a small percentage of the total population, then the rest of the population will be unemployed. Alternatively, if that small amount of overall labor income is evenly spread among the population, everyone will obtain only a small percentage of his income through work, there will be a disincentive to work long hours, and everyone will be largely unemployed. In either case we have unemployment.

By "unemployed" I do not mean *unoccupied*. Nor do I mean to imply that people will regard their unemployment as in any way undesirable. I merely mean that people's time will not be spent predominantly working for an income. Income will come from other sources. I shall discuss this issue further in the next section.

What's So Bad About Unemployment?

Two Fears. Instead of welcoming the arrival of mechanical slaves to perform much of the world's toil, most people view the prospect of increasing unemployment with great alarm. Leontief puts this paradox in sharp relief:

"Adam and Eve enjoyed, before they were expelled from Paradise, a high standard of living without working. After their expulsion, they and their successors were condemned to eke out a miserable existence, working from dawn to dusk. The history of technological progress over the past 200 years is essentially the story of the human species working its way slowly and steadily back into Paradise. What would happen, however, if we suddenly found ourselves in it? With all goods and services provided without work, no one would be gainfully employed. Being unemployed means receiving no wages

As a result, until appropriate new income policies were formulated to fit the changed technological conditions, everyone would starve in Paradise (Leontief, 1982)"

Leontief's story highlights one of the fears that people have about unemployment namely, that they will lose their incomes. Presumably this economic fear would evaporate if people could obtain an income in some other manner so that they could purchase goods and services produced by the machines. Many economists, as well as others, have proposed various schemes that separate income from employment; I shall examine some of them in this section.

Another cause for apprehension has to do with social and psychological needs of human beings rather than with their economic requirements. What will people do with their "free time?" What activities will be as fulfilling and rewarding as jobs? Some people are pessimistic about the ability of their fellows (but not of themselves) to adjust to "becoming rich." Others, like John McCarthy, an AI pioneer, opine facetiously that this adjustment "... could take all of ten minutes (McCarthy, 1983)" I shall also have some comments about this problem.

Allaying the Economic Fear. There are several ways of dealing with the economically motivated fear of unemployment. They range from rather crude approaches, like attempting to slow down or halt technological change so as to delay or prevent unemployment, to more sophisticated and possibly impractical reorientations of our economic system.

Placing obstacles in the path of either using or abetting technology might be called a "Luddite approach" to the economic problem of unemployment. This approach is unfair to humanity because it condemns us to continue toiling when toil is technologically unnecessary. To use Leontief's metaphor, it is equivalent to disrupting our attempts to re-enter Paradise. In any case, the approach would inevitably fail because, fortunately, no government or other group has sufficient repressive power to prevent technical progress. Even if technology were temporarily slowed in one country, so much the worse for that country; its foreign competitors would soon outrace it and it would have unemployment anyway—unemployment and poverty.

Another way to solve the economic problem posed by technological unemployment is to invent jobs that are either unnecessary (that is, they do not contribute to absorbable consumables) or could be performed by machines. This approach may be one way of distributing income, but it is unfair because it condemns some people to unnecessary toil. There is reason to fear that the conventional goal of full employment (espoused by both political parties in the United States) can be achieved only through such "makework" schemes.

Separating income from employment would seem a better way to solve the economic problem of unemployment. This solution actually suggests itself as a corollary of our earlier economic analysis; if income is not derived principally from labor, it must instead come from either capital investments, sale of materials, or transfer payments.

As regards transfer payments, the industrialized nations already have a great deal of experience with government techniques for distributing income independently of work. Social security, “welfare” payments of various kinds, farm subsidies, and the “negative income tax” have all been used in the United States. Expansion of these programs is one possible way of decoupling income from work. I shall not attempt here to give arguments for or against transfer payments, except to note that many people fear the pernicious effect of some types of transfer payments—*i.e.*, that they might subvert the American ideal of a free and independent citizenry.

There have been many intriguing proposals for more of us to obtain more of our income from a return on capital investment. Louis Kelso and Mortimer Adler have written a book that proposes an imaginative, capitalistic “. . .society in which machines do all or most of the mechanical work that must be done to provide the wealth necessary both for subsistence and for civilization.” They recommend a diffuse, private ownership of the means of production so that

“ . . .every man, or every family, has a sufficient share in the private ownership of machines to derive sufficient subsistence from their productivity In this automated industrial society, each man, as an owner of machines, would be in the same position as an owner of slaves in a slave society. As a capitalist, he would be an economically free man, free from exploitation by other men, free from destitution or want, free from the drudgery of mechanical work—and so free to live well if he has the virtue to do so (Kelso & Adler, 1958).”

Kelso and Adler envision that people would receive most of their income from dividends on common stock. To achieve this situation, they make proposals that would:

- 1 Broaden the ownership of existing enterprises.
- 2 Encourage the formation of new capital and the organization of new enterprises by new capitalists
- 3 Discourage concentration of the ownership of capital by households in which such concentration has passed beyond the point determined to be the maximum consistent with the just organization of a completely capitalistic economy (Kelso & Adler, 1958)

They also list specific recommendations, including the use of tax and credit devices, whereby families may begin to accumulate stock ownership in corporations.

James Albus has suggested the formation of a National Mutual Fund [NMF], which would use credit from the Federal Reserve System to finance private investment in automated industries. Ultimately this fund would invest about \$300 billion a year, which would double the then current (1980) rate of investment in plant and equipment. This extra investment in private companies would earn profits that would be distributed by the NMF to the general public as dividends to stockholders “Everyone would receive a substantial income from invested capital. Everyone would be a capitalist, not just the wealthy (Albus, 1981).”

To offset the short-term inflationary effect caused by the investment of this newly created money, Albus suggests that short-term demand be restrained through a mandatory savings bond program. These bonds would bear interest and be redeemable after five years.

“The key idea in this plan, which might be called an Industrial Development Bond program, is to index the mandatory savings rate to the leading indicators for inflation on a monthly basis. If inflation is predicted, mandatory savings go up for the next month and reduce consumer demand. As soon as prices stabilize or decline, mandatory savings are reduced. This policy would effectively divert short-term demand from consumption into savings and compensate for increased investment. At the same time, it would assure that the purchasing power to distribute the fruits of investment in highly productive technology would be available once the new plants and modernized machinery began to produce increased output.”

As Albus notes, separating income from employment explicitly acknowledges

“ . . . that the primary goal of an economic system is not to create work, but to create and distribute wealth, *i.e.*, goods and services that people want and need.”

He goes on to say,

“I believe we have it within our power to create an everyperson’s aristocracy based on robot labor (Albus, 1983)”

The process of converting to an economic system that separates income from employment will face major, perhaps unsurmountable political, psychological, and social obstacles. “Earning a living” is a very deeply ingrained notion in our culture. Different levels of skill, luck, and hard work in earning a living allow a spread of incomes, from low to high, that many people regard as equitable and desirable. Even if most consumables were being produced automatically, material and energy limits might not allow everyone to consume at the rate he would like. Since some of us (perhaps many) will still need to work, the lure of higher incomes might provide the necessary incentive—even as it so often does now.

Allaying the Sociopsychological Fear. There are many people who are fortunate enough to gain many psychologically valuable benefits from their jobs in addition to those of a strictly economic nature. Job satisfaction, the joy of achievement, an enhanced personal identity, opportunities for growth and learning, and social interaction are among the things that many of us derive from our work. Clearly, humans need such beneficial activities, but must they be tied to the production of income? There is already a large number of people who gain fulfillment and psychological rewards from activities they pursue in retirement (at which time their income is derived from pensions, social security, investments, etc.), or from volunteer or public-service activities (with income perhaps provided by a spouse’s job or from inherited

wealth). Many people also forego a chance at higher incomes so that they can fulfill themselves in artistic and creative pursuits in which the potential for income might be very low or even nonexistent.

Although many of us fear the prospect of losing a job, do we really fear more the loss of psychological rewards than economic ones? One simple test is to ask, "Suppose you inherited one million dollars. Would you go back to your old job, or would you do something else with your time?" Probably not many people are fortunate enough to have a job they would want to continue if they were suddenly to become wealthy.

Margaret Boden argues quite convincingly that the new age of automation could be "rehumanizing" rather than "dehumanizing." She foresees a "Polynesian-type" culture based on artificial intelligence. In Polynesia (at least in precolonial times) no one worried very much about the fact that freely available mangos caused unemployment. Professor Boden states:

"AI could be the Westerner's mango tree. Its contribution to our food, shelter, and manufactured goods, and to the running of our administrative bureaucracies can free us not only from drudgery but for humanity. It will lead to an increased number of "service" jobs—in the caring professions, education, craft, sport, and entertainment. Such jobs are human rather than inhuman, giving satisfaction not only to those for whom the service is provided, but also to those who provide it. And because even these jobs will very likely not be full-time, people both in and out of work will have time to devote to each other which today they do not enjoy. Friendship could become a living art again (Boden, 1983)."

It should also be noted that, besides providing people with time for human-oriented activities, automatic devices can be utilized in support of these activities to make them richer and more enjoyable.

Thus, it seems that there is no real reason to believe that a paying job is essential for a rewarding life. There is abundant evidence that people can receive important life-filling benefits from a wide variety of activities that do not generate income. Some, like Willis Harman, envision a new conception of work made possible by our growing ability to produce goods and services automatically (Harman, 1981).

Before leaving this topic, however, we might mention another possible function of employment. In addition to the positive benefits that accrue to a job holder, some observers, citing the correlation between crime and unemployment rates, see compulsory employment as a way to keep people out of trouble. Such a view not only seems inordinately pessimistic with respect to human nature and the human potential, but is probably wrong about the underlying causes of criminal activity. In any case, there are probably more humane ways to maintain civil tranquility than chaining people to work they dislike. Also, as Herb Simon has pointed out:

"... most people who are alarmed at [the prospect of

too much leisure time] do not find that they themselves are endowed with too much leisure. But there are 'many people,' it is argued, who would not know what to do with leisure time, and who, presumably, would lend their hands to the Devil (Simon, 1977)."

The Transition

For those who are willing to grant that artificial intelligence and related technologies will eventually reduce the total need for human labor and that there are stable and desirable socioeconomic systems that separate employment from income, there still remains one very difficult question: how do we get there from here? Now some might say that we have plenty of time to worry about that problem and that now is too early to think about a transition. In the first place, it might be a long time before we develop the ultimate systems that will be able to perform the new jobs created by currently emerging AI systems. Secondly, a huge amount of human labor will be required to convert present-day industrial societies to fully automated ones (not to mention the labor needed to lift the living standards of the Third World).

Nevertheless, I think there are good reasons people should now start concerning themselves with this problem

- *First*, the pace of technical change is accelerating. While it is true that the technical problems involved in creating artificially intelligent systems are still immense, we may solve most of them within the next generation.
- *Second*, if we begin to welcome rather than fear the "unemployment" consequences of AI, we can avoid the technological lethargy that unwarranted anxiety might otherwise induce.
- *Third*, socioeconomic changes are extremely slow (compared with technical progress). We must allow time for the several stages needed for the transition to new systems of distributing income. There will be at least five to ten years of discussion and argument among intellectuals and other social thinkers. Next, the voting public must have sufficient confidence in some of these ideas to approve any necessary legislation. At the same time, we must anticipate an inevitable reaction against these changes, stimulated by a general yearning to return to the "good old days" in which everyone did an honest day's work for an honest day's pay. People may blame these economic experiments for one or more of the expected future slumps in the business cycle. Taking all of these processes into account, it may well require one or two generations before the necessary changes can be made in our economic system, even if concerned people begin thinking earnestly about the problem right now.
- *Fourth*, starting to think about the problem and instituting some transitional measures now will minimize the discomfort of workers who are already being affected by automation. There are grounds for believing that the current high unemployment rates of the

industrialized countries are not completely explainable by business cycles and will be cured by neither *supply-side* nor *demand-side* economic policies. This unemployment is rather a symptom of the "new automation," and it will continue to worsen even as business conditions improve. If the root causes of high unemployment are in actuality related to automation, policies that recognize this fact will have a better chance of alleviating the misery and poverty of the unemployed.

There are several things that we can begin to do now to prepare for these effects of AI. First, we must convince our leaders that they should give up the notion of "full employment" as a goal for the postindustrial economic system. It is unachievable, unnecessary, and undesirable—and it keeps us from focusing on the real problem.

Retraining is critically important, but we must not assume that everyone who now holds a blue-collar or middle-management job can become a computer scientist or programmer when his present job disappears. We must begin training for such automation-resistant "human service" jobs as teaching, family counseling, daycare, and health care. We must also educate people in arts, crafts, literature, writing, and sports so that they will benefit more from their increasing leisure time. People cannot become "Polynesians" without training. Many community colleges already give adult education courses with this orientation; these programs should be expanded.

We should also begin to work much more earnestly on the many transition projects required to move us into the computerized, postindustrial age. Probably our most important task is to improve the living standards of people in Third World countries. I agree with James Albus that

"Without rapid economic growth, a world of growing shortages will become an increasingly dangerous place. Nations competing over a shrinking stock of wealth and resources will inevitably come to military confrontation. The world's best hope is a great surge of industrial productivity that can outstrip the present population explosion and give us one more period of affluence in which we will have another chance at bringing the human population into stable equilibrium with the finite living space aboard the planet Earth (Albus, 1981)"

Another transition task is to design and build new automated equipment and factories. This work should be preceded by national projects, like those sponsored by the Japanese, that plan and develop the necessary technology. Additional projects could be initiated to improve education and health care in all parts of the world. Communities throughout the United States have been concerned about the problem of aging highways, bridges, and other transportation and communication facilities. Upgrading this "infrastructure" would absorb surplus labor during the transition stage. The postindustrial information age will need another infrastructure—one consisting of computer systems, data bases, and networks. Putting all of this in place and

maintaining it will require human labor for several more years.

Much of the work I have just mentioned can be funded only by governments. Because such work accomplishes goals that need to be satisfied, it should not be thought of as "made-work." But it does have the desirable side effect of giving people employment during the transition from an economy in which most income is derived from employment to one in which most income is derived from other sources. In order to undertake these large public projects, we need to think differently about the matter of spending public funds. Instead of asking the rather outmoded question, "*Can we afford such expenditures?*" we need to learn to ask instead, "*Should otherwise idle human labor be employed to accomplish socially desirable tasks?*" The use of terms like "spending public money" and "affordability" focuses on arbitrary accounting conventions rather than on reality. What really counts is not an abstraction like money but whether or not people who could be working on these projects would otherwise be idle and whether or not the rest of society can produce enough goods and services to satisfy the demand of people working on public projects.

In seeking to analyze the financial aspect of these public works, one could begin by observing that laborers are idle because the type of work they would have been doing in producing consumables in the private sector is now being done by machines. During the transition—that is, before these idled laborers receive fully compensating income from sources other than employment—part of the automation-derived benefits realized by businesses and consumers should be used to help pay the salaries of the workers on public projects. Simply put, the public projects can be financed by taxes levied on automation and consumption. Salaries paid to workers on public projects will increase demand (beyond what it would have been if those workers had remained unemployed and unpaid), but this demand can be met by the increased productivity of the automated industries. Of course, the taxes levied on automation must not be so high as to destroy the incentive to automate. Furthermore, they should decline as the cost of labor for the public projects goes down because of automation.

As automation takes over more and more of the work heretofore performable only by humans, we need to take steps to ensure that people become unemployed in a gradual and nondisruptive fashion. New approaches to work, such as job-sharing, should be encouraged. Shrinking of the workweek and a compensating increase in income derived from nonemployment sources, such as stock ownership and transfer payments, should proceed in step.

Conclusions

To recapitulate, I have argued that artificial intelligence is quite different from previous automation technologies in that it will lead to machines capable of performing quite inexpensively most of the tasks that now require or are best

done by human labor. Business people in a free economy will then use these machines in preference to humans because this substitution will lower the cost of production—and simultaneously raise the quality—of goods and services. The overall consequence of using machines instead of people to produce goods and services will, of course, be unemployment.

Even though we have historically thought of unemployment as a serious problem to be corrected, the new unemployment might better be thought of as a liberating development. It will permit people to spend time on activities that will be more gratifying and humane than most “jobs.” Nor need this unemployment be accompanied by reduced levels of production and consumption. Various changes in our economic system can be suggested that will allow an ever-expanding flow of goods and services to be distributed equitably—not only in the industrialized nations, but in the “underdeveloped” ones as well.

I acknowledge that these developments will take time. The technology of artificial intelligence is still young; perhaps a generation or two must pass before its full impact on employment will be felt. Progress can of course be accelerated somewhat, if we so desire. Similarly, it will take at least a generation or two to make appropriate changes in our economic system—provided we start thinking seriously about these problems now. In the meantime, since AI and related technologies are undoubtedly already beginning to have some effect on employment, our concern is hardly premature.

It would be both foolish and tragic for us to slow our progress toward automation because of concern about unemployment. The world needs all the productive capacity it can create if its inhabitants are ever to live as human beings should. In fact, we may now be entering a very narrow and perhaps last-chance time window in which to make the transition from poverty, despair, and constant revolution and warfare to a more stable, just, and prosperous world society. Besides the will to accomplish this transition, we shall need all the help automation can give us.

References

- Albus, J. (1981) *Brains, Behavior and Robotics* Peterborough: BYTE Books, Subsidiary of McGraw-Hill.
- Albus, J. (1983) The Robot Revolution: An Interview with James Albus. *Communications of the ACM*, March.
- Boden, M. A. (1983) Artificial Intelligence as a Humanizing Force. *IJCAI*, Los Altos: William Kaufmann, Inc. August.
- Duchin, F. (1983) Private Communication.
- Ernest, M. L. (1982) The Mechanization of Commerce. *Scientific American*, September.
- Gartner, T. B-of-A Is Offering to Pay Workers Who Resign Early *San Francisco Chronicle*, January 17, 1984 Page 1.
- Harman, W. W. (1981) “Work.” In A. Villoldo and K. Dychtwald (Eds.) *Millennium*. Published by Jeremy Tarchure.
- Kelso, L. O., & Adler, M. J. (1958) *The Capitalist Manifesto* New York: Random House.
- Keynes, J. M. (1933) Economic Possibilities for Our Grandchildren (1930). *Essays in Persuasion*. London: Macmillan and Co.
- Leontief, W., & Duchin, F. (1983) The Impacts of Automation on Employment, 1963-2000. Draft Final Report. New York University: Institute for Economic Analysis September.
- Leontief, W. W. (1966) *Input-Output Economics*. Oxford University Press.
- Leontief, W. W. (1982) The Distribution of Work and Income. *Scientific American*, September.
- Leontief, W. (1983) The New New Age That’s Coming is Already Here. *Bottom Line/Personal*, Vol. 4 :8 p. 1 April.
- Levin, H. M., & Rumberger, R. W. (1983) The Educational Implications of High Technology Institute for Research on Educational Finance and Government Stanford University: School of Education, February
- McCarthy, J. (1983) Interview with John McCarthy *Omni*, April.
- Neikirk, W. Recovery Could Be A Jobless One *Chicago Tribune*, August 15, 1982.
- Simon, H. A. (1977) *The New Science of Management Decision*. Englewood Cliffs: Prentice-Hall.