

ARTIFICIAL INTELLIGENCE: ITS IMPACTS ON HUMAN OCCUPATIONS AND DISTRIBUTION OF INCOME

a panel moderated by

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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 panel we explore how AI is likely to affect human occupations and the distribution of income. The panelists have summarized their positions on matters related to these topics below.

First, Nils Nilsson argues that future technical developments in AI will make it economically attractive to replace humans by machines in many jobs, leading to a reduction in the total need for human labor. (Note: A written statement by Alan Kay for inclusion here was not available in time.) Next, Faye Duchin analyzes in more detail the effects that these developments might have on employment and income distribution. Fears about unemployment involve both a fear of losing income and a fear of losing meaningful activity. While Dr. Duchin addresses the first of these fears by discussing the possibility of decoupling income from employment, Margaret Boden shows how AI can dramatically enhance our opportunities for richer and more human lifestyles. Finally, Dennis Chamot discusses many of the problems involved in the transition from our current economic systems to those that more properly take account of the potential of AI and related technologies.

ARTIFICIAL INTELLIGENCE AND THE NEED FOR HUMAN LABOR

Nils J. Nilsson

There are two somewhat opposite ways to look at the potential of AI for reducing the need for human labor. First, we might assume that AI is not really very different from other technologies that have supported automation and increased productivity -- technologies such as electronics, control engineering, materials science, and operations research. As these technologies did, we might then conclude that AI also will ultimately lead to an expanding economy with a concomitant expansion of employment opportunities. At worst, we might conclude that there will be some, perhaps substantial, shifts in the types of jobs, but certainly no overall reduction in the total number of jobs. In my opinion, such a view is based on an overly conservative appraisal of the real potential of AI.

On the other hand, we might base our prediction on a rather strong hypothesis about AI -- a hypothesis that sets AI quite apart from previous labor-saving technologies. Quite simply, this hypothesis is that anything (*anything!*) that humans can do, AI can do also. Certainly, AI has not yet achieved anything like human-level performance in many important functions, but many of us believe that AI inevitably will equal and surpass human mental abilities, if not in twenty years, then surely in fifty or one hundred. There is not very much that I can do in this short space (or even in a much longer one) to persuade those who are presently unwilling to accept this hypothesis. Perhaps many people, especially at a conference like this one, already believe it. Others may believe more-or-less weakened versions of it (leading to only proportionally weakened conclusions).

The main conclusion of this assumption is that, even if AI creates more work, no matter, this work *can also, in principle*, be performed by AI devices and, thus, will not necessarily lead to more jobs for humans. Of course, just because some work *can* be performed automatically, doesn't mean that it *will* be so performed. Automation depends on many factors, economic and social. The major economic factor would seem to be the relative costs of having humans or machines perform a given job (at a given rate and level of quality). Again, AI differs from many previous labor-saving technologies in that it is (and will be increasingly so) a very low cost technology. (Remember, computation is free!).

AI can be expected to reduce particularly the need for human "white-collar" and service work. 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 and AI companies will be able to handle many of these tasks completely automatically. Because such AI devices are mainly "computational" (that is, they involve only trivial amounts of energy and materials), we can expect their cost to be small compared to the cost of equivalent human labor, and thus we can conclude that these devices will in all likelihood be used instead of human labor. Since it has been estimated that these "information-processing activities" occupy over half of American workers, we can expect the automation of this work to have a significant effect on the total need for labor.

Even though there are economic reasons to substitute machines for human labor, we, as a society, may not choose to do so. That is, we may decide to continue to employ humans in jobs "next to the window" (as the Japanese say) merely as a way to distribute income and to give people something to do. But I leave that matter for the other panelists to consider.

COMPUTERS, EMPLOYMENT, AND THE DISTRIBUTION OF INCOME

Faye Duchin

There are several related propositions underlying this panel that, fortunately, one begins to hear discussed with increasing frequency. The fundamental observation is that the technological revolution based on the electronic, digital computer, now in its early stages, promises to be at least as disruptive to the existing economic and social order as the agricultural revolution of the tenth millennium B.C. or the industrial revolution of the eighteenth century. One of the direct consequences of the computer in the next few decades will be a significant shift in the composition of necessary labor skills and a dramatic reduction in labor requirements per unit of output and probably also in the aggregate. An increasing proportion of the adult population may thus be excluded from the labor-force of the future and without any sources of income, unless we implement a massive onslaught on computer-illiteracy and begin to formulate realistic strategies for the large-scale distribution of income other than by the paycheck. I will confine my remarks to the options for the distribution and redistribution of income, particularly in the context of a developed economy.

The total national income earned by labor plus property-type income accruing both to individuals and to businesses must (by definition) cover national expenditures for personal consumption and new business investment. A given bill of consumption and investment goods can be produced either in the existing way, or, alternatively, using new types of capital and significantly less labor. (Studies of technological change lead us to

expect declining labor to output ratios and increasing capital to labor ratios. While the measurement of capital is problematic, capital to output ratios can be expected to fall once a certain level of industrialization is reached.) The unit-cost savings obtainable by adopting the new technology will be distributed between labor and capital in the form of increasing (real) wage and/or profit rates. If the economy could grow indefinitely, then increased automation would make it possible to increase real wage and profit rates and keep everyone employed, as in the past. There are good reasons, however, why it may not be realistic to count on this outcome.

Declining employment opportunities could be accompanied by a sufficient rise in real wage rates to assure that labor's share of income was maintained or even increased. Then a significant distributional role could be played by mechanisms such as decreasing work hours or the work lifetime to spread around existing jobs and thus increase leisure while maintaining income. Another option is moving toward larger households, within which income would be shared with nonworking "family" members. These alternatives naturally have different social implications.

If a significant part of the benefits of technological change accrue to capital, some of this property-type income could be more widely distributed than presently is the case if all or most workers owned, or received part of the return on, the capital they employ. This is achieved, for example, in the case of the farm family, which both owns its capital and provides its labor. In the future this could take the form of extensive industrial and service sector employee profit-participation or ownership schemes. Such an approach has the potential advantage of being decentralized in its implementation, but reaches only those who have jobs.

Some redistribution is, of course, already effected by central governments through the taxation and transfer systems, and the scale of such operations could, and no doubt will have to, be expanded as the number of unemployed and impoverished grows. These programs will assume both familiar and new forms, like larger welfare programs on the one hand and negative income tax schemes on the other. In these cases, the provision of income is dissociated from work.

Governments can also effect transfers by organizing large-scale work programs like the maintenance of infrastructure or care and companionship for various categories of individuals (e.g., childcare), not to mention upgrading and updating the public educational curricula to teach computer literacy along with reading and writing. Such programs would have to be conceived as *permanent* measures, more like the public education system than the New Deal. In this way jobs could be created and income redistributed through the provision of useful, even essential, services, financed by the taxation of those income shares that have benefited the most from automation.

In the future we will no doubt see increased reliance upon all of these mechanisms. The relative equality of the distribution of income that results and the smoothness

with which redistribution is carried out will depend in large part on the quality of the policy dialogues now emerging. My colleagues and I are pursuing, in our research on the changing structure of the U.S. economy, the detailed, concrete analysis of the types and numbers of jobs that will be displaced and the new ones that will be required over the next few decades, under alternative scenarios about the nature and the pace of technological change in each sector of the economy. Such studies are a necessary input to the formulation of realistic employment and income policies.

ARTIFICIAL INTELLIGENCE AS A HUMANIZING FORCE

Margaret A. Boden

The quantitative unit of beauty, it has been said, should be the "milli-Helen" -- the amount of beauty required to launch exactly one ship. The unit of happiness might be the "Polynesian": the amount of happiness enjoyed by a South Sea Islander in one hour, at Pacific temperature and pressure. But why? Why did European explorers compare Tahiti to the lost paradise of Eden, and why do many Westerners today envy the people of the South Seas? Climate and physical beauty are only part of the answer: at least as important is the Polynesian way of life, which seems more congenial -- even more *human* -- than our own.

On the one hand, Tahitians do not have to spend their days working in field or factory, since their island is so fertile that ripe mangoes (still) lie uneaten under the wayside trees. On the other hand, they have developed a culture in which personal relations are supreme, in which families are extended, sexual life is adventurous, and social occasions are marked by the subtle rituals of the dance. These facts are connected, for Tahiti's mango trees provide another precious resource besides food. Dancing, offering the cup of "kava," playing with children, sharing a friend's joys and anxieties, or exploring one's own -- all these social skills take *time*.

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 fulltime, 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.

Strange as it may seem, AI could foster a renewal of the ritual element in Western life. Rituals (like the Pacific "kava" ceremony) are often scorned by us as "timewasting," because of their apparent lack of function and rationality. But the common commitment to a specific social nexus is itself an important function, providing a human meaning to life distinct from bread-

and-butter issues. Many rituals in our society have died because their context-defining functions have been taken over by mass-employment: one's workplace is, among other things, an arena for ritual enactment. Jobs provide a social focus and context, a recognized network of social relations (some formally labeled, others not) within which individuals can seek their niche. With decreasing emphasis on a person's *job*, these functions will need to be fulfilled in other ways. This is not to say that old rituals will be revived, for many of them symbolized and reinforced particular social structures that have lost favour. Nor should one expect that postindustrial rituals will attain the baroque degree of complication that some preindustrial ceremonies did: there will, after all, be more alternatives available for filling our time. But, for all our impatience with anachronistic absurdities, we should not deny the human satisfactions of etiquette and ritual.

Sex-roles might be profoundly affected by AI-grounded changes in the distribution and division of labour. The increase in out-of-job time (to call it "leisure" time has some misleading connotations) will benefit more men than women, given that women today tend to have more of this time available. The new jobs in the service sector (which has traditionally been seen as a largely female preserve) will attract men, who will thus have increased occupational opportunities for "caring" as well as "problem-solving." Combined with the increase in time for domestic pursuits, this could foster a re-evaluation of the emotional dimension in the masculine role. Western men are discouraged from expressing emotion in all but a very limited family circle (and even there do not have the emotional freedom that women do). With changed job-patterns and increased "social time," they may achieve an emotional liberation; this, in turn, could lead to shifts in family life and other social groupings and patterns of communication.

A re-evaluation of emotional and personal relations could also be encouraged by the likely contrast between computers and human beings, assuming that AI-programs in general will be unemotional systems. People will probably want (as they clearly do today) to draw a line between human beings and computers, and will argue (again, as they do today) that they themselves are emotional whereas artificial systems are not. I do not believe -- as do most of the general public -- that computer-systems, in principle, could not even simulate emotion. But I do doubt that seemingly "emotional" features will be built into the AI-programs used by public institutions and individual citizens. This view is not shared by the social psychologist, Neil Frude, whose book *The Intimate Machine* (1983) reminds us of the universal human tendency to anthropomorphism, and predicts widespread sales of "friends-off-the-shelf." These include cuddly, weeping, friendly robots akin to the inflatable dolls sold by sex-shops, and sympathetic conversationalists, religious advisers, and marriage-counselors. I see this prospect as highly threatening: such quasi-emotional AI-products would be deeply dehumanizing, for they would lessen our reliance on, and concern for, our fellow humans. I find comfort, therefore, in judging Frude's predictions to be technologically and commercially implausible.

Even those who deny that AI can acknowledge emotions are forced to admit that it has helped to bring the *mind* back into psychology, to make *ideas* theoretically respectable again. Behaviourism is a dead horse, and I shall not flog it here; but it is relevant to note that AI was a main cause of its demise. In this sense, AI has already had a humanizing influence.

Social critics who complain of the alienation endemic to industrial society are commonly derided as unrealistic sentimentalists, or -- at best -- plucky idealists doomed to scratch a living by a self-defeating self-sufficiency. This derision has two sources. One is the impossibility of producing modern goods and services (such as medicine) on a preindustrial economic base. The other is the Protestant work ethic, which suggests that solving problems and *doing* things is the essence of a fulfilling life, personal concerns being mere irresponsible self-indulgence. This astringent view may have been essential to the rise of capitalism, but it is becoming increasingly inappropriate now. Information technology, while helping to provide the goods and services on which we have come to rely, will undermine the Protestant ethic and make way for a different view of life and society. AI can be a humanizing force, for it offers us the chance of developing a more Polynesian culture.

PROBLEMS OF TRANSITION

Dennis Chamot

The nature of work in many industries is being transformed through the development and introduction of new technologies based upon computers and related equipment. Unlike previous periods of workplace automation, the changes being made today affect much more than production industries and production workers. Office work and service industries are also becoming heavily dependent upon electronic systems. While many of the benefits of these changes have already begun to be felt -- greater productivity; new and better services -- the problems are only beginning to surface.

In the past, productivity improvements brought about by new technologies were often confined to particular industries, or more often, certain specific functions within production facilities. In the long run, businesses expanded and jobs were created (although there may have been severe short-term dislocations). Usually other growing areas were available to absorb excess labor during the transition. This *de facto* piecemeal approach, coupled with shifts into growing economic sectors, permitted both overall economic growth and employment growth.

Today, *all* sectors are embracing computer technologies -- manufacturing, private services, government operations, agriculture. When the world recovers from the current severe recession, we may well be faced with economic growth fueled by higher capacity equipment, but without the high rate of job growth experienced in the past.

All this having been said, most people need to work. The primary questions for the next several decades relate

to the potential for long-term imbalance between demand for jobs and the supply of meaningful, satisfying, and economically rewarding jobs. For well into the foreseeable future, most people will still derive a major part of their income from their jobs. Even in the most economically advanced societies, and in the most technologically advanced industries, people will be required for planning, economic analysis, oversight, research and development, design, sales, technical support, customer service, and so on. For these people, computerized systems represent powerful tools for assisting them in the performance of their work. The problems derive from the increasing ability of these systems to take over much of the work now performed by manufacturing, clerical, and service workers.

Solutions will not be simple. Elements leading towards acceptable solutions must include human considerations in the direction and pace of change; shortening individual work time to spread available jobs around more widely; and creation of new products and services both to create additional jobs and to meet social needs.