NEW TECHNOLOGY AND THE END OF JOBS
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A technology revolution is fast replacing human beings with machines in virtually every sector and industry in the global economy. Already, millions of workers have been permanently eliminated from the economic process, and whole work categories and job assignments have shrunk, been restructured, or disappeared. Global unemployment has now reached its highest level since the great depression of the 1930s. More than 800 million human beings are now unemployed or underemployed in the world. That figure is likely to rise sharply between now and the turn of the century as millions of new entrants into the workforce find themselves without jobs.

Corporate leaders and mainstream economists tell us that the rising unemployment figures represent short-term "adjustments" to powerful market-driven forces that are speeding the global economy in a new direction. They hold out the promise of an exciting new world of high-tech automated production, booming global commerce, and unprecedented material abundance. Millions of working people remain sceptical. In the United States, Fortune magazine found that corporations are eliminating more than 2 million jobs annually. While some new jobs are being created in the US economy, they are in the low-paying sectors and are usually temporary.

This pattern is occurring throughout the industrialised world. Even developing nations are facing increasing technological unemployment as transnational companies build state-of-the-art high-tech production facilities, letting go millions of cheap labourers who can no longer compete with the cost efficiency, quality control, and speed of delivery achieved by automated manufacturing.

With current surveys showing that less than five percent of companies around the world have even begin the transition to the new machine culture, massive unemployment of a kind never before experienced seems all but inevitable in the coming decades. Reflecting on the significance of the transition taking place, the distinguished Nobel laureate economist Wassily Leontief warned that with the introduction of increasingly sophisticated computers, "The role of humans as the most important factor of production is bound to diminish in the same way that the role of horses in agricultural production was first diminished and then eliminated by the introduction of tractors."

In all three key employment sectors - agriculture, manufacturing, and services, machines are quickly replacing human labour and promise an economy of near automated production by the mid-decades of the twenty-first century.
1. No More Farmers

The high-technology revolution is not normally associated with farming. Yet some of the most impressive advances in automation are occurring in agriculture. New breakthroughs in the information and life sciences threaten to end much of outdoor farming by the middle decades of the coming century. The technological changes in the production of food are leading to a world without farmers, with untold consequences for the 2.4 million people who still rely on the land for their survival.

The mechanical, biological, and chemical revolutions in American agriculture over the past 100 years put millions of farm labourers out of work, transforming the country from a largely agricultural society to an urban, industrial nation. In 1850, 60 percent of the working population was employed in agriculture. Today, less than 2.7 percent of the workforce is engaged directly in farming. There are more than 9 million persons living under the poverty line in depressed rural areas across the United States - all casualties of the great strides in farm technology that have made the United States the number-one food producer in the world and made American agriculture the envy of every nation.

Although the farm population is less than 3 million, it sustains a food industry employing more than 20 million. In our highly industrialised urban culture, most people would be surprised to learn that the food and fibre industry is the single largest industry in the United States. More than 20 percent of the GNP and 22 percent of the workforce is dependent on crops grown on America's agricultural lands and animals raised on feedlots and in factory farms.

The decline in the number of farms is likely to accelerate in the coming years with advances in agricultural software and robotics that will lead to higher yields and fewer workers.

A new generation of sophisticated computer-driven robots may soon replace many of the remaining tasks on the land, potentially transforming the modern farm into an automated outdoor factory. Israel's farmers are already well along the way to advanced robot farming. Concerned over the potential security risks involved in employing Palestinian migrant labour, the Israelis turned to the Institute for Agricultural Engineering for help in developing mechanical farm labourers. In a growing number of kibbutzes it is not unusual to see self-guided machines travelling on tracks laid out between rows of plants, spraying pesticides on crops.

The Israelis are also experimenting with a Robotic Melon Picker (ROMPER) that uses special sensors to determine whether a crop is ripe to pick. The introduction of ROMPER and other automated machinery will dramatically affect the economic prospects of the more than 30,000 Palestinians employed during
harvesting season. In the United States, Purdue University scientists say they expect to see ROMPER in use "in every Indiana county by the end of the decade." Similar robots are being developed with artificial intelligence to plough and seed fields, feed dairy cows, even shear live sheep. Researchers predict that the fully automated factory farm is less than 20 years away.

New gene-splicing technologies, which change the way plants and animals are produced, are greatly increasing the output of animals and plants and threatening the livelihood of thousands of farmers. To eliminate the cost of insecticides and the labour required to monitor and spray crops, scientists are engineering pest-resistant genes directly into the biological codes of plants. Some of these transgenic plants can produce a continuous supply of the specific toxins to kill invading insects.

Genetic engineering is also being used to increase productivity and reduce labour requirements in animal husbandry. Bovine Growth Hormone (BGH) is a naturally occurring hormone that stimulates the production of milk in cows. Scientists have successfully isolated the key growth-stimulating gene and cloned industrial portions in the laboratory. The genetically engineered growth hormone is then injected back into the cow, forcing the animal to produce between 10 and 20 percent more milk. A study conducted several years ago predicted that within three years of the introduction of BGH into the marketplace, upwards of one-third of all remaining US dairy farmers may be forced out of business because of overproduction, falling prices, and dwindling consumer demand.

Scientists have succeeded in producing genetically engineered pigs that are 30 percent more efficient and brought to market seven weeks earlier than normal pigs. A faster production schedule will mean less labour is required to produce a pound of flesh. In 1993 researchers at the University of Wisconsin announced a successful attempt to increase the productivity of brooding hens by deleting the gene that codes for the protein prolactin. The new genetically engineered hens no longer sit on their eggs as much. They do, however, produce more eggs.

The coming together of the computer revolution and the biotechnology revolution into a single technological complex foreshadows a new era of food production - one divorced from land, climate and changing seasons, long the conditioning agents of agricultural output. In the coming half century, traditional agriculture is likely to wane, a victim of technological forces that are fast replacing outdoor farming with manipulation of molecules in the laboratory.

Chemical companies are already investing heavily in indoor tissue-culture production in the hope of removing farming from the soil by the early decades of the twenty-first century. Recently, two US-based biotechnology firms announced they had successfully produced vanilla from plant-cell cultures in the laboratory. Vanilla is the most popular flavour in America. One third of all the ice cream sold in the United States is vanilla. Vanilla, however, is expensive to produce because it has to be hand-pollinated and requires special attention in the harvesting and curing process. Now, the new gene-splicing
technologies allow researchers to produce commercial volumes of vanilla in laboratory vats, eliminating the bean, the plant, the soil, the cultivation, the harvest - and the farmer. While natural vanilla sells on the world market for $1,200 a pound, Escagenetics, a California biotechnology company, says it can sell its genetically engineered version for less than $25 per pound.

Over 98 percent of the world's vanilla crop is grown in the small island countries of Madagascar, Reunion, and Comoros. For these tiny islands in the Indian Ocean, the indoor farming of vanilla is likely to mean economic catastrophe. The export of vanilla beans accounts for more than 10 percent of the total export earnings of Madagascar. In Comoros, vanilla represents two thirds of the country's export earnings. According to the Rural Advancement Fund International, more than 100,000 farmers in the three vanilla-producing countries are expected to lose their livelihood over the next several decades.

Vanilla is only the beginning. The global market for food flavours is hovering near $3 billion as is expected to grow at a rate of 30 percent or more a year. According to a Dutch study, upwards of 10 million sugar farmers in the third world may face a loss of livelihood as laboratory-produced sweeteners begin invading the world markets in the next several years. In addition, scientists have successfully grown orange and lemon vesicles from tissue culture, and some industry analysts believe that the day is not far off when orange juice will be grown in vats, eliminating the need for planting orange groves.

Martin H. Rogoff and Stephen L. Rawlins, biologists and former research administrators with the Department of Agriculture, envision a food-production system in which fields would be planted only with biomass perennial crops. Using enzymes, the crops would be harvested and converted to sugar solution. The solution would then be piped to urban factories and used as a nutrient source to produce larger quantities of pulp from tissue cultures. The pulp would then be reconstituted and fabricated into different shapes and textures to mimic the traditional forms associated with soil "grown" crops. Rawlins says that the new factories would be highly automated and require few workers.

The era of whole-commodities food production is likely to decline in the decades ahead as chemical, pharmaceutical, and biotech companies are able to increasingly substitute tissue-culture production, significantly lowering the price of food products on world markets. The economic impact on farmers could be catastrophic. Many third-world nations rely on the same of one or two key export crops. Tissue-culture substitution could mean the near collapse of national economies, unprecedented employment, and default on international loans, which in turn could lead to the destabilisation of commercial banking and to bank failures in first-world nations.

Hundreds of millions of farmers across the globe face the prospect of permanent elimination from the economic process. Their marginalisation could lead to social upheaval on a global scale and the reorganisation of social and political life along radically new lines in the coming century.
2. No More Factory Workers

The spectre of the world's farmers being made redundant and irrelevant by the computer and biotechnology revolutions is deeply troubling. Even more unsettling, the manufacturing and service sectors, which have traditionally absorbed displaced rural workers, are undergoing their own technological revolution, shedding millions of jobs to make room for reengineered, highly automated work environments. Transnational corporations are entering a new era of fast communications, lean-production practices, and "just-in-time" marketing and distribution operations relying increasingly on a new generation of robotic workers. Much of the human workforce is being left behind and will likely never cross over into the new high-tech global economy.

From the very beginning of the Industrial Revolution, machines and inanimate forms of energy were used to boost production and reduce the amount of labour required to make a product. Today, the new information and communication technologies are making possible far more sophisticated continuous-process manufacturing. Some of the most dramatic breakthroughs in reengineering and technology displacement are occurring in the automotive industry. The world's largest manufacturing activity, auto manufacturers produce more than 50 million new vehicles each year. The automobile and its related industrial enterprises are responsible for generating one out of every 12 manufacturing jobs in the United States and are serviced by more than 50,000 satellite suppliers.

Industry experts predict that by the end of the current decade, Japanese-owned factories will be able to produce a finished automobile in less than eight hours. The shortening of production time means fewer workers are required on the line. Kenichi Ohmae, a leading Japanese management consultant, notes that Japan's nine automakers produce more than 12 million cars a year, with fewer than 600,000 workers. Detroit automakers employ more than 2.5 million workers to produce the same number of vehicles.

Following Japan's lead, US automakers are beginning to reengineer their own operations in the hope of increasing productivity, reducing labour rolls, and improving on their product share and profit margin. In 1993 General Motors president John F. Smith Jr. announced plans to implement changes in production practices that could eliminate as many as 90,000 auto jobs, or one third of its workforce, by the late 1990s. These new cuts come on top of the 250,000 jobs GM had already eliminated since 1978. Other global automakers are also reengineering their operations and eliminating thousands of workers. By 1995 industry analysts predict that German automakers could eliminate as many as one in seven jobs. This in a country where 10 percent of the workforce is either in the automotive industry or services it.
As the new generation of "smart" robots, armed with greater intelligence and flexibility, make their way to the market, automakers are far more likely to substitute them for workers because they are most cost effective. It is estimated each robot replaces four jobs in the economy, and if in constant use twenty-four hours a day, will pay for itself in just over one year. In 1991 according to the International Federation of Robotics, the world's robot population stood at 630,000. That number is expected to rise dramatically in the coming decades as thinking machines become far more intelligent, versatile, and flexible.

The steel industry's fortunes are so closely related to those of the automobile industry that it is not surprising to see the same sweeping changes in organisation and production taking place in the steel business. By the 1890s the United States was the leader in steel production. Today, that competitive edge has been seriously eroded, in large part because of the failure of US companies to keep up with Japanese steel manufacturers, which have transformed steelmaking to a highly automated continuous operation. Nippon Steel's new $400 million cold rolling mill near Gary, Indiana - a joint venture with Inland Steel - is run by a small team of technicians and has reduced the production time from 12 days to one hour.

The increasing automation of steel production has left thousands of blue collar workers jobless. In 1980 United States Steel, the largest integrated steel company in the United States, employed 120,000 workers. By 1990 it was producing roughly the same output, using only 20,000. These numbers are projected to fall even more dramatically in the next 10 to 20 years as new, even more advanced, computerised operations are introduced into the manufacturing process.

The new, highly automated manufacturing methods are being combined with radical restructuring of the management hierarchy to bring steelmaking into the area of lean production. Japanese companies, with joint ventures in the United States, have reengineered traditional plant operations, restructured management hierarchies and slashed job classifications to improve efficiency. According to the International Labour Organisation, finished steel output from 1974 to 1989 dropped by only 6 percent in the Organisation for Economic Cooperation and Development (OECD) countries while employment fell by more than 50 percent. More than one million jobs were lost in the steel industry in OECD nations during this fifteen year period. "In up to 90 percent of the cases," said the ILO, "the basic explanation for the reduction in employment is therefore not changes in the level of output but improvement in productivity." [van Lienmt, Gijsbert. Industry on the Move; "Labor-Management Bargaining in 1992," Monthly Labor Review.]

Other industries that use steel to make products are also undergoing a fundamental overhaul, reflecting the new emphasis on lean-production practices. Between 1979 and 1990, employment in the metalworking-machinery industry declined by an average annual rate of 1.7 percent. The Bureau of
Labour Studies predicts an overall loss of an additional 14,000 workers by the year 2005. For operators, fabricators, and labourers the decline in employment is expected to be even higher, reaching 14 percent between now and the first decade of the coming century.

In industry after industry, companies are replacing human labour with machinery, and in the process changing the nature of industrial production. One of the industries most affected by reengineering and the new information-based technologies is rubber. Since the 1980s, tire companies around the world have been restructuring their operations by introducing work teams, flattening the organisational hierarchy, reducing job classifications, instituting job retraining programs and investing in new equipment to automate the production processes.

Less than five years after the Japanese owned Bridgestone acquired a Firestone facility in La Vergne, Tennessee, the production increased from 16,400 to 82,175 tires per month with blemishes declined by 86 percent. Goodyear claims a similar success story. Goodyear earned a record $352 million in 1992 with sales of $11.8 billion. The company is producing 30 percent more tires than in 1988 with 24,000 fewer employees. The Bridgestone and Goodyear experience is being duplicated in other tire plants around the world.

The mining industries, like agriculture, have been undergoing a steady process of technology displacement since 1925, when 588,000 men, nearly 1.3 percent of the nation's entire workforce, mined 520 million tons of coal. In 1982 fewer than 208,000 men and women produced more than 774 million tons of coal. With the use of advanced computer technology, faster excavation and transportation equipment, improved blasting technologies, and new processing methods, mining companies have been able to increase output at an average annual rate of 3 percent since 1970. The Bureau of Labour Statistics forecasts a yearly decline in employment of 1.8 percent through the year 2005. By the first decade of the coming century, fewer than 113,200 people - a labour force 24 percent smaller than present - will produce all of the coal to meet both domestic and overseas demand.

Not surprisingly, some of the most significant strides in reengineering and automation have occurred in the electronics industry. General Electric, a world leader in electronic manufacturing, has reduced worldwide employment from 400,000 in 1981 to less than 230,000 in 1993, while tripling its sales. In the household appliance industry, new labour and time-saving technologies are eliminating jobs at every stage of the production process. By the year 2005, a mere 93,500 workers - fewer than half the number employed in 1973 - will be producing the nation's total output of home appliances.

In recent years, even the labour-intensive textile industry has begun to catch up with other manufacturing industries by introducing lean-production practices and advanced computer automation systems. The goal is to introduce flexible manufacturing and just-in-time delivery so that orders can be "tailor-made" to individual consumer demand. The new technologies are beginning to make garment
manufacturing in the industrial nations cost competitive with firms operating in low-wage countries. As more and more of the manufacturing process bends toward reengineering and automation, even third-world exporters, like China and India, will be forced to shift from current labour-intensive manufacturing processes to cheaper and faster methods of mechanised production.

In virtually every major manufacturing activity, human labour is being steadily replaced by machines. Today, millions of working men and women around the world find themselves trapped between economic eras and increasingly marginalised by the introduction of new laboursaving technology. By the mid-decades of the coming century, the blue collar worker will have passed from history, a casualty of the relentless march toward ever greater technological efficiency.

3. The Last Service Worker

While the industrial worker is being phased out of the economic process, many economists and elected officials continue to hold out hope that the service sector and white collar work will be able to absorb the millions of unemployed labourers in search of work. Their hopes are likely to be dashed. Automation and reengineering are already replacing human labour across a wide swath of service related fields. The new "thinking machines" are capable of performing many of the mental tasks now performed by human beings, and at greater speeds.

In February 1994, The Wall Street Journal ran a front page story warning that a historic shift was occurring in the service sector, with growing numbers of workers being permanently replaced by the new information technologies. According to the Journal, "Much of the huge US service sector seems to be on the verge of an upheaval similar to that which hit farming and manufacturing, where employment plunged for years while production increased steadily... Technological advances are now so rapid that companies can shed far more workers than they need to hire to implement the technology or support expanding sales." ["Retooling Lives: Technological Gains are Cutting Costs and Jobs in Services." Wall Street Journal, February 24, 1994.]

Anderson Consulting Company, one of the world's largest corporate restructuring firms, estimates that in just one service industry, commercial banking and thrift institutions, reengineering will mean a loss of 30 to 40 percent of the jobs over the next seven years. That translates into nearly 700,000 jobs eliminated. Many banks are using voice-mail systems for customer service calls, greatly reducing the amount of time representatives have to spend answering enquiries. Automatic teller machines, once a rarity, have become ubiquitous in US cities and suburbs, significantly reducing the number of human tellers. Between 1983 and 1993, banks eliminated 179,000 human tellers, or 37 percent of their
workforce. By the year 2000, upwards of 90 percent of banking customers will use automated teller machines.

In The Future Impact of Automation on Workers, author Wassily Leontief and Faye Duchin describe the improved efficiency of automated tellers: "A human teller can handle up to 200 transactions a day, works 30 hours a week, gets a salary anywhere from $8,000 to $20,000 a year plus fringe benefits, gets coffee breaks, a vacation and sick time... In contrast, an automated teller can handle 2,000 transactions a day, works 168 hours a week, costs about $22,000 a year to run, and doesn't take coffee breaks or vacations."

Debit and point-of-sale banking are also gaining wider use, allowing customers at supermarkets and elsewhere to pay electronically, thereby eliminating cheque writing, credit clearance, handling, posting, record entry, and the many other steps involved in processing paper cheques.

The insurance industry is also making a quick transition into the high-tech era. Mutual Benefit Life (MBL) was among the first of the nation's giant insurance companies to reengineer its operations. MBL did away with the slow, cumbersome, multilayered system of processing applications and installed a single case-manager. Armed with a new computer-based workstation and programmed with an "expert system" to help answer questions, the caseworker can now process an application in less than four hours. The average turnaround for an application has been reduce from upwards of 22 days to only two to five days, allowing MBL to eliminate 100 field office staff while processing twice the volume of applications as before.

The transformation of the traditional office from a paper-handling to an electronic-processing operation will greatly increase the productivity of businesses and eliminate millions of clerical workers by the end of the decade. The nation's secretaries are among the first casualties of the electronic office revolution. The number of secretaries has steadily declined as personal computers, electronic mail, and fax machines replace manual typewriters, paper files and routine correspondence. Economists Wassily Leontief and Faye Duchin estimate that the conversion from paper-handling to an electronic processing office will save 45 percent of all secretarial time and between 25 percent and 75 percent of all office-related activity. Receptionists are also being reduced in number as new automated computer systems can answer calls, record messages, and even hunt down the party being phoned.

The intelligent machine is steadily moving up the office hierarchy, subsuming not only routine clerical tasks but even work traditionally performed by management. High-tech computerised hiring systems have been installed in hundreds of companies to screen job applications. Field tests have shown the systems to be at least as skilled as human personnel directors in making evaluations and much quicker in processing applications.
Dramatic gains in productivity have led to the elimination of jobs in virtually every area of the telephone industry. Recent technological innovations, including fiber-optic cable, digital switching systems, satellite communications, and office automation have kept the telephone industry's output per employee increasing at nearly 5.9 percent per year. Between 1981 and 1988 alone, employment declined by 179,800. AT&T announced that it is replacing more than 6,000 long-distance operators with computerised voice-recognition technology. Over the next several years, AT&T expects to replace more than half of its long-distance operators with the voice-recognition technology, which is able to distinguish key words and respond to caller's requests. The new silicon operators are the latest in a string of technological advances that have allowed AT&T to handle 50 percent more calls with 40 percent fewer workers in recent years. The number of workers employed in central office repair is expected to decline by more than 20 percent by the year 2000.

Equally dramatic developments are taking place in the United States postal service. In 1991 Postmaster General Anthony Frank announced the replacement of more than 47,000 workers by 1995 with automated machines capable of sight recognition. The new silicon-sorters can read street addresses on letters and cards and automatically sort them faster than postal workers, who often spend up to four hours a day hand-sorting mail for their routes.

While the office is being revolutionised by intelligent machines, so too is every other area of the service economy. The changes have been dramatic in the wholesale and retail sectors. Wholesalers, like middle management, are becoming increasingly redundant in the age of instant electronic communication. Retailers like Wal-Mart are now bypassing wholesalers altogether, preferring to deal directly with manufacturers. With computerised monitoring and scanning equipment at the point of sale, retailers can transmit shipping orders directly to manufacturer's warehouses by way of electronic data interchange (EDI). At the other end, automated warehouses staffed by computer-driven robots and remote-controlled delivery vehicles fill orders in a matter of minutes without the assistance of human physical labour. Since 1989 the wholesale sector has dropped a quarter of a million jobs. By early in the next century most wholesaling, as we have come to know it, will have been eliminated.

Retail establishments are also quickly reengineering their operations, wherever possible, introducing intelligent machines to improve productivity and reduce labour costs. In most retail outlets, the use of electronic bar codes and scanners at the point of sale has greatly increased the efficiency of cashiers. According to a survey prepared by the Bureau of Labour Statistics, the new electronic scanning equipment "permits a 30 percent increase in ringing speed and possible overall 10 to 15 percent reduction in unit labour requirements for cashiers and baggers." Some retailers hope to eliminate cashiers altogether by using new electronic technology that allows the customer to insert his or her credit card in a slot on the shelf holding the desired product. Cashiers are currently the third-largest clerical group after secretaries and bookkeepers, with nearly 1.5 million employed in the United States alone.
The retail sector has long acted as an unemployment sponge, absorbing countless numbers of displaced blue collar workers let go by the automation of manufacturing industries. Now, with retail industries undergoing their own automation revolution, the question becomes one of where will all the workers go. Many economists look to the food industry to rescue the workers cast adrift by the technological innovations in other sectors. Even here, though, employment is sluggish, suggesting hard times ahead for the unskilled and semi-skilled service workers. In many restaurants, computer systems allow the waiter to transmit orders electronically, avoiding unnecessary trips back to the kitchen. The same electronic transmission can be used by the computer to prepare a check for the customer and alert the store manager or suppliers to replenish the stocks being depleted. A new state-of-the-art cooking method, which allows food to be cooked in large centralised commissaries, reduces labour costs by 20 percent in most restaurants. Some fast-food drive-through restaurants are beginning to replace human order takers with touch-sensitive screens that list the items on the menu. Drive-through restaurants have become so highly automated and efficient that six to eight employees can serve as many customers at peak hours of operation as 20 employees working in a sit-down restaurant.

Electronic shipping of products will likely mean the loss of tens of thousands of jobs in the warehousing, shipping and transportation industries in the coming years. In May 1993 IBM and Blockbuster Video announced a new joint venture which will provide made-to-order audio compact disks, video games, and videocassettes through Blockbuster's 3,500 retail outlets. The store will bypass the warehouses, shippers, truckers, and loading docks, and transport products electronically to the customer by way of the information highway. Each store will have a kiosk where customers can order selections by touching a computer screen. The information will be transmitted to a central computer that will make an electronic copy of the item required and transmit it back to the store within minutes. Machines in the store will copy the electronic information into recordings, CDs and cassettes. Colour laser printers in the kiosk will reproduce the jacket pictures with the same clarity and resonance as exists on pre-existing stock. Other retailers are expected to follow Blockbuster's lead.

Electronic shipping is only a small part of the revolutionary changes taking place in retailing. Electronic shopping is also quickly penetrating the retail market, threatening the jobs of tens of thousands of sales clerks, managers, stock personnel, maintenance crews, security guards, and others who make up the retail employment complex. Many industry analysts are convinced that electronic home shopping will take over more and more of the nation's one-trillion-dollar-a-year retail market. Forbes calls the new revolution in retailing "a serious threat to the country's traditional retail industry and to the nineteen million people it employs." ["The Fall of the Mall," Forbes, May 24, 1993.]

Intelligent machines are already invading a range of professional disciplines and even encroaching on education and the arts, long considered immune to the pressures of mechanisation. Doctors, lawyers, accountants, business consultants, scientists, architects, and others regularly use specifically designed information technologies to assist them in their professional endeavours. The nation's 152,000 librarians
are growing increasingly concerned over electronic data systems that are able to search, retrieve, and electronically transmit books and articles over the information highways in a fraction of the time spent performing the same task with human labour. Data networks can provide abstracts from thousands of journals and books within a matter of minutes. Even the art of book writing itself is falling victim to intelligent machines. Using software equipped with artificial intelligence, Scott Finch was able to program his Macintosh computer to pump out three quarters of the prose in a torrid potboiler entitled Just This Once.

Although novelists may have little to fear in the short run, musicians have every reason to be alarmed by the new generation of high-tech synthesising machines that are fast redefining the way music is made. Piano sales have dropped by one third to one half in recent years, while digital keyboards, or synthesisers, have increased in sales by 30 percent or more in the same period. A synthesiser reduces musical sound to digitised form. Once digitised, the sounds can be stored and, when needed, be combined with other digitised sounds to create an entire symphony orchestra. In a process called "sampling", the computer might record a single note or a combination of notes by great musicians that can be rearranged into wholly different performances that were never performed by the artist. Vince Di Bari, former vice president of the Los Angeles local of the American Federation of Musicians, estimates that recording jobs for human musicians have dropped off by 35 percent or more because of synthesisers. Many musicians compare their circumstances with those of auto workers replaced by automation in Detroit.

Even more troubling than synthesised music is the new technology of "morphing", which allows movie and television producers to isolate, digitise, and store every visual expression, movement, and sound of an actor and then reprogram them in virtually any new combination, effectively creating new roles and performances for the artist. Nick de Martino, who heads the American Film Institute's computer lab, says that with the new computer technologies it is possible to eliminate sound stages, sets, even actors, and replace them with "synthespians", which are "created from libraries of gestures and expressions housed in a computer bank." Already, Humphrey Bogart, Louis Armstrong, Cary Grant and Gene Kelley have been digitised and put back to work in new television commercials. Live actors and entertainers are going to be increasingly competing for parts against their digitised and stored past images as well as those of actors long deceased. ["Hollywood Goes Digital," Forbes ASAP, December 7, 1992.]

The rapid elimination of work opportunities resulting from technical innovation and corporate globalisation is causing men and women everywhere to be worried about their future. The young are beginning to vent their frustration and rage in increasingly antisocial behaviour. Older workers, caught between a prosperous past and a bleak future, seem resigned, feeling increasingly trapped by social forces over which they have little or no control. In Europe, fear over rising unemployment is leading to widespread social unrest and the emergence of neofascist political movements. In Japan, rising concern over unemployment is forcing the major political parties to address the jobs issue for the first time in decades. Throughout the world there is a sense of momentous change taking place - change so vast in scale that we are barely able to fathom its ultimate impact.
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