

Automation and Employment

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Abstract

In the first Industrial Revolution, the effect of replacement of human or animal labor by the power of machines is compensated through the increase of industrial activities. In the recent automation, human workers in factories or offices are being replaced by robots or automated equipment decreasing the employment. But, at this time, because of the limitation of the available resources, industrial activities can not at increase infinitely. Several measures to deal with this situation are proposed in this paper. Also, discussed is the outcome of competitive economic growth and a different approach for the future is suggested.

1. Introduction

Many arguments have been made since the introduction of mechanical means to take the place of manual or animal powers in the Industrial Revolution started in the eighteenth century. But until recent time, the apprehensions concerning the loss of work or unemployment did not materialize because of the multifications of industrial activities since then. In these centuries of expansion, the resources available on the globe were only limited by the method of exploitation and the success has always fallen upon those with more powerful means.

In the above expansion, the relevant quantity was the energy, i.e., horse power or kilowatt.

During and after the last world war, the theories of automatic control (cybernetics) and information have advanced remarkably and, as the result of these studies, multitudes of machines and devices to control the flow of energy and information have appeared. In these theories and actual machines, the object of interest is the quantity of information, both analog and digital, instead of horse power or kilowatt. When these machines operate combined with suitable input and output devices, they can replace almost any human role in industrial plants, factories or offices for the routine work. This replacements are generally known as "automation".

By contrast with the situation in the first Industrial Revolution, it has become apparent that there is a boundary on the expansion of human industrial activities. Because of this restriction, the full employment of people in the industry, whose scope would increase many fold by automation, may be considered to be reckless if sustaining existence of mankind is desired. In the following, subjects related to this are discussed in several directions.

2. Biological Examples

In the process of evolution, every biological species attempts to increase its number of members, but is limited by environment and competition. In the following, two rather simplified examples are described to be referred to in the latter part of this paper.

(a) Goats on the Bonin Islands.

On an island in the group of the Bonin Islands located in the subtropical region of the Pacific, someone released a number of goats to be fed on the rich vegetation covering the island from shore to top. Some years later, after exponential increase in their number, 1000 goats had devoured the plants reaching to the top. Then their number decreased catastrophically to a small number 30, when all the existing trees were consumed and they had to feed themselves on the meager grass on the ground.

It is conceivable that if there had been a concerned goat among them to propose to limit the rate of consumption to a proper value matched with the growth of trees and other goats had listened to him, it might have been possible for the island to sustain 200 goats forever. But if there were two groups of goats competing each other, it is not possible that the worries of the concerned goat would have been listened to, because one group might have taken advantage of this restraint of the other to dominate the vegetation. Because of the suspicion among themselves, the catastrophe would not be avoided. Also, if one group had strived to limit its number to under 100 and the other group did not, the ratio of number of the former against the latter after the catastrophe would be one to nine because the chance of collapse would have been uniform in both groups. It is possible that the smaller group might have been exterminated later by keener competition.

(b) Cancer Virus and Colon Bacilli.

These are two kinds of small life living in the human body, but their philosophies are quite different. The cancer virus can lodge in almost any part of the human body, multiplying power is large and in a few months it destroys the host, resulting in the termination of its own existence.

In contrast with the above, the life space of colon bacilli is limited; it has no resistance to the different environment from that of the large intestine in the body. Because of this nature, it can keep symbiosis with the host until the host dies of an other cause.

3. Technological Aspects of Automation

The wide usage of the word "automation" is relatively recent and, before the World War, the words automatic control and servomechanism were employed in engineering. By the latter, control devices with feedback loops or closed loops were meant. Also, some forms of sequence control were installed in large industrial plants. But at that time, the devices in control systems were considered as accessories to the main installation and these might have been treated as the premium for the sale of the main part. The idea of a calculating machine was introduced by Charles Babbage in 1835, but it did not materialize, and most of calculations were executed with pencils, mathematical tables, slide rules and

simple mechanical calculators. In those days, the most advanced calculator must have been the gun-sight which, however, was placed under top military secret. To estimate the course of on coming enemy planes, the use of pencil and table was not fast enough, even for the propeller machines. Here, analog type computation was used and, with the introduction of radar, it was once said that the destiny of a nation depended on ability to detect enemy planes and to forecast their course. Nowadays, airplanes are replaced by ICBMs and intense efforts are being made to improve the speed of digital computation to compute their courses as fast as possible.

As the result of the extensive research during and after the World War, mostly in the United States, the theories and technologies of automatic control and servomechanism have progressed remarkably. The outcome can be observed through the works of Wiener, Lee, Shannon, Hartree, Neumann and many other notable persons. The mathematical theories of Fourier, Boolean algebra and the theories on statistics were very much used in the analysis. On the side of hardware technology, the transistor invented by Shockley played an important part for the realization of automation with various other semiconductor devices. From the initial single transistor, technologies for the fabrication of LSI (large scale integrated circuit) and VLSI (very LSI) were developed. In the latter, tens of thousands of transistors are installed on a chip of a few millimeter square by means of processes similar to photographic printing. The speed of the operation is coming down to the order of nano-seconds (10^{-9} sec) or pico-seconds (10^{-12} sec) from that of micro-seconds, and the power consumption and the prices are also decreasing rapidly. Also, on the analog type integrated circuits, the present situation looks as if the dream, in the days of the vacuum tube, has come true.

The functions of these LSIs are memorization, computations, and exchanges of data to or from outside devices. The construction of a program to suit a particular type of work belongs to software engineering. There are still very large scale computers installed in air conditioned rooms, executing the central function of an organization. In these, the operating speed is faster and the memory size is larger than that of the processing unit made of LSI, but the latter is rapidly proliferating into every branch of application because of its size, price and ruggedness. In LSI, the size of element is already comparable to that of the cerebral cell and, ultimately, it may become possible to make interconnections between LSI and the human brain like present artificial organs.

Combined with input devices such as photo-sensor, position-sensor, etc., and output devices such as electromechanical manipulator, voice simulator, printer, etc., it is possible to program these LSI devices to do almost any type of work in factories as robots and in offices as electronic-clerks substituting for human workers.

4. Social Influence of Automation

It has been known for some time that the industrial plant type installation in an area did not provide large employment opportunities for the local people, even if its output was very large: however manufacturing factories were welcomed because they increased local

employment. With the introduction of automation, as mentioned in the previous section, it is inevitable that the demand for labor in factories and offices will decrease. If a factory, employing one hundred workers, can be operated with five attendants by means of an automatic machine, it is equivalent to the productivity increase of ten times even if the man-hours consumed in the manufacture of the automatic machine, which is assumed to be 5%, are included. Then what should the factory do with the other 90 people?

At this point, let us look back for a while. Through out the history of mankind, especially after the Industrial Revolution, human living style has changed very much when compared with the simple life of basic food, clothing, shelter and with fears of diseases and epidemics, against which no means were known. The most remarkable difference is the per capita consumption of raw materials and energies. These consumption figures vary very much among the nations or the regions on the earth as seen from the statistics. The people who were aggressive and quick were the winners of the game. This increase of consumption was hailed as economic growth.

Returning to the previous subject, and a 10 fold increase of economic growth is necessary for the full employment of the remaining 90 people. But in many publications, such as the Report to the Club of Rome or the Global 2000 Report to the President (United States) or others, the remaining estimate of raw materials on earth is shown. At this point, the attitudes for the future direction are much diversified among the persons concerned. Some opinions, in both free and communist economic systems, still advocate economic growth, even if their proposed rate of growth is somewhat decreased. Their aim may be the easy solution of today's problem and they expect that something good will appear when the raw materials are exhausted or they just don't worry about the time beyond their direct concern. The opposite opinion is the insistence that primitive life is superior to rich industrial life. Actually, the South American Indian people on the shore of Lake Titicaca will be able to sustain their way of living another 200 million years in the future as some species have already lived this much of period in the past on earth. (e.g. tortoise, coelacanth, nautilus). It is hoped that human wisdom will prevent the disaster of goats mentioned in the second section and the mankind will keep symbiosis with the earth.

5. Livelihood of the Surplus Population

As discussed up to this point, it is not thoughtful to adopt the policy of economic growth indefinitely because such growth will further increase the burden on earth. Under the feudal or planned economic system, a suppressive measure can be imposed on the growth without difficulty, whereas, it is a subject to be studied in the free economic system. Here the restraint is mostly achieved through the market mechanism and the free intentions of people. The effect of the large price increase of oil is in such a direction. In the following, a number of proposals, some of which might not be realistic, will be mentioned.

(a). Free Distribution of Basic Commodities of Living.

The distribution should cover all people, not only in one country but over the whole world, through the large scale unemployment benefit system. Ninety percent of the

people are rewarded for doing nothing under the condition of steady population. This may be called the modern version of the Garden of Eden or the Paradise in the South Sea. This system can be executed by imposing a heavy tax burden on the producer as the social cost of production. At the present, the producer consumes the irreplaceable raw materials at the price cheaper than the real value and volumes of air freely. The oxygen in the air is formed by the photo synthetic process through ages and its consumption and production must be balanced. The compensations for the consumption beyond the amount of individual human breathing and for the pollution due to the industrial waste should be levied on the producer.

(b). 100% Employment for 10% work.

This case can be achieved through positive application of Parkinson's Law and is readily realized in socialistic structures and in the government organizations. Many positions and overhead organizations are installed and these may be called as pseudo-employment.

(c). The Decrease in the work day.

If only one day in a week or in ten days is designated as a work day, the effect is similar to that of the last option. But in this work day, one works efficiently. Also, when productivity is small, the number of work days can be increased.

Considering the above three options, the combination of (a) and (c) may be the most advisable. In (b), the focus of the problem may become blurred. In the following, less dismal options are proposed loosening the restriction on the new product introduction.

(d) Elaborate Products of Advanced Technology.

When the consumption of raw materials and energies are considered, the productions of fine or elaborate construction requiring advanced technology and software engineering have a large benefit when compared with crude products. Also, these types require much labor even if some parts are automated. The nations having an abundant, skilled, and educated labor force will naturally take this course without much orientation. In the commercial activities with these products, such as explanatory advertisement, persuasion of adoption and the maintenance in the field, a large number of working hours is consumed.

(e). Cultural Activities.

Besides the industrial and commercial activities, the cultural activity or output is the valuable subject in human livelihood. A country can be industrially superior and culturally inferior and vice versa. The cultural output includes all branches of liberal and scientific endeavor. At the present, this output is not evaluated quantitatively in statics like G.N.P., although this is the means to enhance and enrich the human mind. The cultural output is commonly generated by an individual or a small group of individuals. The general public is the audience of the performance. When the public level of culture is not high, the entertainment or amusement industry takes the place of cultural activity. Also, the intentional influence of government on cultural activity may distort real development. The publication business is much related to this activity, but its number of total money transactions is relatively small compared with its significance.

(f) Educational Activities.

The consumption of man-hours in education is large in both teaching and learning sides. Also, the required amount of physical material is small compared with the industrial facilities employing the corresponding number of people. Increased enrollment in the higher educational institutions by students after their basic education relieves the social burden of unemployment considerably.

(g). Objects of Taste and others.

In the textile and garment industries, if the style of garments is nationally standardized and they are mass-produced by automation, only a small amount of labor would be required even for a large population. But the public is not satisfied with such garments and multitudes of kinds of apparel are produced to match with individual taste. This diversification is providing large employment opportunities without a large increase of raw material consumption. There are many objects of taste having similar effect on employment. The increase in recreational activities and more participation in sports, chess or go playing, festivals, religious or social activities, advertizing and public relationg activities, maintenance services, to mention only a few, are the items to consume man-hours.

6. Conclusions

Reflecting back on various subjects discussed up to this point which are related to the productivity increase due to the automation, it seems that the solution of the problem can not be obtained by the industrial expansion. An obstinate adoption of such policy in one nation will impose adverse effects on other countries in many respects. But there are many directions in which the surplus population can be placed without increasing much the consumption of natural resources. There will be no such romantic age as that of the Great Navigation when vast expansion became available to the Western countries. Still there may be breakthrough type inventions, such as the conversion of solar energy with 30% efficiency by means of inexpensive artificial materials or discoveries of large oil deposits, but the general situation will not be much different. The present economic system based on currencies has originated in the prehistoric barter system. A completely different approach to civilization might well be sought for the coming ages where some quantity other than the conventional monetary amount has key value.

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