

Full Length Research Paper

Social implications of robots – An overview

V. C. Chijindu^{1*} and H. C. Inyama²

¹Electronic Engineering Department, University of Nigeria, Nsukka, Nigeria.

²Electronic and Computer Engineering Department, Nnamdi Azikiwe University, Awka, Nigeria.

Accepted 26 January, 2012

Machines by their design are aimed at increasing and improving the efficiency of productive activities where they are applied. The result is that they are given preference against manually operated productive activity. This paper explored the gradual and yet progressive introduction of machines, namely, robots into the production processes of industries following the industrial revolution of the 20th century and the attendant 'threat' to the percentage of human capacity engaged in the production processes of industries in most of the industrialized nations. It is observed that the automation of industrial operations using robots will result in precision production and maximum throughput. However, the more robots are engaged by industrialized nations, the more human capacity is rendered redundant and consequently people are thrown out of job. It is therefore proposed that industrialized nations and other emerging economies embracing modern automation using robots should set in motion a long-term mechanism of re-engineering of the workforce through reforms in their educational curricula to prepare the displaced workforce for alternative employment and subsequently redirect the workforce of the future towards survival in an industrial revolution where robots will take over most of, if not all, the technical and operational functions of today's industries.

Key words: Robots, automation, workforce, replacing people, reducing labour costs.

INTRODUCTION

Since the introduction of automation in industry (the first major automation was achieved on weaving looms and its opponents were called luddites); there has been an understandable fear of technology-related unemployment. Automated looms were designed to do the same job as the weavers. Thousands of workers lost their jobs when these machines were introduced. More recently the introduction (from 1980) of automated tellers has displaced thousands of jobs in the banking industry. Humanity has built tools to increase its power by eliminating manual labour and needless drudgery. This factor has become one of the keys to successful economic progress, especially since the Industrial Revolution and emergence of a mechanized economy and even more so with the introduction of automatic machines in the 20th century (Brooks, 2002). Today, advances in computer and telecommunication technology allows us to equip machines with sufficient intelligence

that they can act independently. Thus, we can forecast that in the 21st century, humanity will coexist with the first alien intelligence we have ever come into contact with – robots (Landes, 2003). Robots are mechanical intelligent agents which can perform tasks on their own, or with guidance. In practice, a robot is usually an electro-mechanical machine which is guided by computer and electronic programming (Russell and Norvig, 2003). Labour-intensive heavy industries were quick to adopt robotic technologies in the interests of perceived efficiencies, safety and economy. Robot can work round the clock, are easier to repair, do not get sick and do not require staff amenities. Replacing people with robots was seen as a way of reducing labour costs, workers' compensation and union influence.

The replacement of people by automated systems contributes to unemployment in society, especially for the most disadvantaged group – unskilled workers – which can result in long-term unemployment. Certainly, robotics which is the art and commerce of robots, their design, manufacture, application, and practical use is changing our way of living, working and operating in the world.

*Corresponding author. E-mail: vin.chijindu@yahoo.com.

Table 1. Estimated annual shipments of multipurpose industrial robots in selected countries. Number of units.

Country	2008	2009	2010	2011*	2014*
North America	16,242	8,417	16,356	21,000	24,000
China	7,879	5,525	14,978	19,500	32,000
Japan	33,138	12,767	21,903	26,000	30,000
Republic of Korea	11,572	7,839	23,508	24,500	21,000
Germany	15,088	8,507	14,000	15,500	16,500
Italy	4,793	2,883	4,517	4,600	4,900

Source: Extract from IFR World Robotics 2011. *Forecast.

Robotics when applied to society in numbers and volumes larger than today is going to trigger widespread social and economic changes, opening new social and ethical problems for which the designers, the end user, the public and private policy must now be prepared (Capurro, 2000). The robot – which was expected to be an extended intelligent tool for the human – is becoming a partner and a companion and indeed a competitor.

Evidence of presence and preference of robot technology in the automation of industrial processes

The industrialization of the 19 and 20th centuries witnessed increasing development and deployment of robots in the production processes in many of the industrialized economies. It is evident, from social writers' records that robots are gaining preference as shown by the record of their development and deployment in many companies and countries. Consider the following news reports:

- i) A large Japanese company, Hitachi Ltd, in 1981, assembled a workforce of 500 technical people with the express purpose of developing by 1985 a universal assembly robot with visual and tactile sensing.
- ii) The largest manufacturer of robots in the United states, Unimation, Inc., a Division of Westinghouse has also about 90 robotics engineers (Business Week, 1981).
- iii) Fujitsu Fanuc Ltd. Has opened a plant that employs robots to produce about 100 robots per month. Human beings are still used for final assembly, but they represent only 20% of the normal workforce that would be required in a plant of the same size.
- iv) Renault, the French automobile giant developed "vertical robot" equipment with TV and sonar sensors that are used to locate, lift, turn and move a 26 lb crankshaft from a pallet to an assembly line (Business Week, 1980).
- v) Many United States firms are introducing robot systems into their production plants. For example, McDonnell-Douglas is employing a million-dollar robotic manipulator to control a laser beam that cuts out sheets of graphite used in aircraft brakes. This device also forms tail and wing section parts that are then welded together

by an arc-welding robot. Two workers and the robots now do work that previously took 30 people to do.

vi) Also, Texas instruments uses three robots to test its hand calculators. One brings a particular unit into the test area, another one presses the keys in a prescribed sequence, and the third looks for the correct numbers on the calculator's display (US News and World Report, 1981).

Extract of statistical report on development and deployment of robot technology in the automation of industrial processes

Some statistical report on the development and deployment of robots in the production processes of industries in some selected countries for the period of 2008 to 2014 showed an increasing trend in robotic technology penetration of the industrial operations and consequently gradual replacement of human capacity (IFR, 2011). Table 1 shows the estimated annual shipment of multipurpose industrial robots to various countries while Table 2 shows the estimated number of units of operational stock of multipurpose industrial robots in these countries at year-end. The tables show considerable increase for most countries especially the most automated countries like Japan, Republic of Korea and Germany. However, in 2009 most countries suffered a decline following the worldwide economic and financial meltdown. In 2009, the worldwide economic and financial crisis caused a significant slump in the sales of industrial robots. Compared to 2008, considered one of the most successful years, 2009 had a decline of 47% (60,000 units). This is the lowest level reported since 1994. Robot installations had never decreased so heavily. Various regions experienced different rates of recovery in robot sales in 2010. The most dynamic markets were China, the Republic of Korea and the ASEAN countries. Sales to these markets almost tripled. In 2010, the Republic of Korea topped the list with some 23,500 robots sold, up from 7,800 units in 2009. Robot sales to Japan recovered by 72% to about 21,900 units. For the first time, Japan was the second largest robot market in the world.

The strong increase in 2010 could not compensate for

Table 2. Estimated operational stock of multipurpose industrial robots at year-end in selected countries. Number of units.

Country	2008	2009	2010	2011*	2014*
North America	168,489	166,183	173,174	181,300	216,600
China	31,787	37,312	52,290	71,200	155,600
Japan	355,562	332,720	285,800	276,200	262,200
Republic of Korea	76,923	79,003	101,080	123,150	169,300
Germany	144,643	144,133	148,195	153,100	158,300
Italy	63,051	62,242	62,378	61,800	58,400

Source: Extract from IFR World Robotics 2011. *Forecast.

the slump of sales in 2009 (IFR, 2011). Robot densities which is the number of multipurpose industrial robot per 10,000 persons employed in manufacturing industry has also recorded a progressive increase over the years at various rates from one country to the other. According to International Federation of Robots report, the most automated countries in the world including Japan, the Republic of Korea and Germany in 2010 had robot densities of 306, 287 and 253 respectively. While the densities in Germany and the Republic of Korea increased continuously up to 2010, it was more or less stagnating in Japan between 2006 and 2009. Japan has by far the highest robot density in the automotive industry. 1,436 industrial robots are installed per 10,000 persons employed in the automotive industry. In Germany, 1,130 robots per 10,000 employees were installed in the automotive industry. Italy and United States had robot densities of 1,229 and 1,112 in the automotive industry respectively in 2010. In China, the huge robot investments in the recent years resulted in a substantial increase in the robot density of the automotive industry. Between 2006 and 2010, it was up from 37 to 105 robots per 10,000 employees. Also, all other sectors increased their robot density considerably from 30 to 86 during the same period. However, the potential for new installations in this market is still tremendous.

The overall conclusions indicate that in almost all the surveyed countries, not only the potential for robot installation in the non-automotive is still tremendous, but it is almost considerably high in the automotive industry among the emerging markets and in some traditional markets as well. This is mostly due to the necessary modernization and retooling that is needed in these markets (IFR, 2011). As the robot densities are increasing in these countries and industries, the direct implication on labor densities is the reverse. Labor population obviously is decreasing. The tremendous increase of automation in the automotive industry in the past years led to redundancy of the workforce displaced by the installation of robots. Recent statistical reports showing the proportion of robot application for regions of the world reveal some interesting trend in social impact across global lines. Roughly, half of all the robots in the world are in Asia, 32% in Europe, and 16% in North

America, 1% in Australasia and 1% in Africa, 30% of all the robots in the world are in Japan, making Japan still the country with the highest number of robots (IFR, 2007).

Consequently, it is estimated that Japan will lead the rest of the world in experiencing strong social and ethical imbalance due to introduction of robots in industrial automation. They will proportionately be followed by Europe and North America. Australia and Africa will be least affected in the short run, but in the long run will suffer the same imbalance, may be at a minimized degree.

EVALUATION OF THE EFFECT OF ROBOTICS ON THE WORKFORCE

What effect does the introduction of robots into the production processes of industries in the industrialized nations have on the workers and entire national workforce? It is obvious that robots are becoming a viable option for automation with economic advantage over human option. Writing in the New Republic, Mark Miller of the University of Pennsylvania suggested that "the fear of the robots is an apprehension of gradual displacement... a foreboding of our own annihilation" (Miller, 1981).

Projections on the replacement of human capacity with robots in American industries

The following projections from various organizations and individual researchers are few among numerous others:

- i) General electric projects that eventually it will replace almost half its 37,000 assembly workers with robots. The company feels that in some instances, robots will increase productivity in their plants by 50%.
- ii) It was predicted that, by 1980 in the auto industry alone, as many as 100,000 jobs will be lost to robots (Shaiken, 1980).
- iii) In a study conducted at Carnegie-Mellon University in 1980, Ayres and Miller predicted that by the year 2000, the class of non-sensor-based robot would replace as

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many as 1 million manufacturing production workers. They also predicted that robots possessing some rudimentary tactile and vision sensing capabilities would replace about 3 million of these workers. Finally, they predicted that by the year 2025, all the 8 million manufacturing production workers could be expected to be replaced by highly sophisticated robots (Ayres and Miller, 1981).

iv) Another study performed by International Resource Development, Inc. in 1982 suggested that of the 32.1 million, then blue-collar workers in the United States approximately 13 million could be replaced by robots. Of these, about 25% would be retrained to program and maintain the robots (Klafter et al., 2006).

v) According to Professor Antonio Lopez Pelaez, a professor of sociology at Spain's National Distance Learning University, and co-author of the study on the future social impact of robots, jointly carried out with the Institute of Prospective Technological studies, it is predicted that 40% of armies will be automated with robot soldiers by 2020 "just as a car factory is today which will result in less human deaths during violent conflicts". Robots will be intelligent machines to be incorporated into both domestic and industrial life: they will help us to clean our houses, will milk our cows on farms, and will be programmed to work 24 h per day in factories without resting, with a yield equivalent to three day shifts. In addition, replacing human labor with robots will prevent workers from being exposed to dangerous stressful or unhealthy environments, thus reducing labor-related risks.

vi) There are a lot of fears associated with the growing presence of robots and automation, points out author Michael Fitzpatrick. Geoff Pegman, managing director of R U Robots says the idea that robots will bring about the collapse of civilization is ridiculous. However, he admits robots will have an impact on jobs.

Picture of the effect of replacement of human capacity with robots in Japan

The impact of the introduction of robots in the industrial activities of the Japanese economy and consequently the workers is just beginning to be felt. This is evident in the

reaction of various stakeholders of their industries and economic life. For instance:

i) According to an analyst, many of the largest labor unions in Japan have forced the government to undertake a study on this subject.

ii) The unions are frightened at the prospect of potential wide-scale job elimination. The reason for this concern is that companies that have ordinarily moved people displaced by robots to other areas of the same plant are now moving these people to new locations, some times in other cities.

iii) Japanese plant managers indicate that they are gradually finding it difficult to locate alternative jobs for the displaced workers and for new workers who desire to join the workforce. It is fairly clear that unemployment must someday begin to rise in Japan if automation continues to replace people without a corresponding increase in jobs.

Projections on the effect of the introduction of robots on job creation

Two schools of thought have projected views that tend to converge at a common point that in the long-run new jobs will be created.

i) From the pessimistic perspective, it is argued that according to history when machines were introduced at the beginning of the first industrial revolution; many jobs were lost for a significant period of time. However, in the long-run, the machines created many more jobs than were lost. It was so because new industries arose following demands of the new technologies. While workers in the traditional "cottage" industries lost their jobs, new jobs were created and people were trained for these (Klafter et al., 2006). George Brosseau of the National science Foundation of United State has been quoted as saying; "in the past, whenever a new technology has been introduced, it has always generated more jobs than it displaced. But we do not know whether that is true of robots technology. There is no question that new jobs will be created, but will there be enough to offset the loss" (Resenblatt, 1982).

ii) The optimists, on the other hand are more hopeful. James Albus of the National Bureau of Standards of United States has said that "robot create profits, profits create expansion in industry and expanding industries hire more people" (Albus and Brains 1981). Ayres and Miller (1981, 1982, 1983) have suggested that these new jobs will require workers who are significantly more skilled than before: for example, those who are capable of building, repairing and maintaining the robots. They also feel that a large number of jobs could be created if the robot revolution follows a course that is parallel to that of the computer, that is, if a market for the "home" (or "personal") robot develops.

Obviously, the mechanical efficiency of robot design, in addition to its ability to mimic human intelligence, makes it possible for one multipurpose industrial robot to take over the jobs of many humans. And so, the new jobs that will be created will likely not offset the loss. Moreover, the computer revolution addressed the improvement of human intelligence, creating new and faster ways of decision making still employing human agents to operate the computer systems. It is therefore, not likely that the robot revolution will follow a parallel course.

Problems of the introduction of robots into the workplace summarized

A number of problems obviously have started becoming evident following the introduction of the robot technology into the industries. Among these problems include:

- i) Creating unemployment among unskilled and semi-skilled workforce in the industrialized nations at increasing proportion.
- ii) Besides creating unemployment, some rather unique problems for workers who remain unemployed will be created. McVeigh points out that in the future, such workers may be forced to interact with machines, not other human beings (McVeigh, 1983). He predicts that this situation may cause worker alienation since communication with others in a work situation is important in relieving monotony and making time pass more quickly on the job (Klafter et al., 2006).
- iii) McVeigh states that new and old workers will have to compete in a 'new system of labor' where human beings and robots work together, the human being will be forced to compete with an entity that: does not tire; does not seek or obtain wage increase and fringe benefits such as paid holidays and vacations; does not go out on strike or slow down due to disagreements; does not argue or debate the supervisor's ideas (Kurzwell, 1999).

Proposed proactive measures for combating the effect of the introduction of robots into the workplace

Different study groups, prominent among them are Ayres and Miller (1981), in their results have upheld some of the

proposal hereunder presented for dealing with the effects of the introduction of robots in the workplace. They are not exhaustive but shall serve as guide to any comprehensive solution strategy putting into consideration the peculiar social challenges of robotics as well as geographical location in our world:

- i) Industries should identify categories of jobs and workers that will be adversely affected by robots. It is important for this identification to be done well in advance of the reduction and/or elimination of workers due to robots introduction.
- ii) Industries, governments and unions should cooperate in long-range planning of employment needs.
- iii) These groups should identify and publicize the emerging jobs and corresponding skills. It will help create the necessary and sufficient awareness regarding changing pattern in the job market among job seekers especially young people so that they can acquire marketable skills.
- iv) Education and training curriculum should be re-engineered and established to help in training and retraining of the workforce both displaced and required workers.
- v) Industries and governments should create facilities to locate suitable jobs for displaced workers and to help pay for their relocation. Of course, this assumes the availability of additional jobs.
- vi) Workers and employers should partner to finance a sound national job security fund which would be used to fund redundancy/displacement benefits. This can be applied to transportation, maintenance and retraining of such workers.

Conclusion

The presentation of statistical figures and facts as well as predictions and projections, many of which have been vindicated by time with the foregoing discussions tends to make it evident that robots are displacing and will keep displacing workers. The perspectives we presented brought to light both the pros and cons of robots on our social life. There is high potential for robot installations in many countries following the current global trend. Robot density figures have been on the increases since their introduction into the workplace and so are obvious signs of gradual and growing displacement of humans. Some new jobs are being created by introduction of robots into the workplace. Nevertheless, these new jobs will demand significant amount of training and retraining because of their high technical nature. Further implication of the robot revolution is that workers may find themselves with more leisure time. It has been suggested that this would stimulate growth in industries related to recreation (Klafter et al., 2006). In fact, a prediction made by Dubin (1956), "that the importance of work for people as a

'central life interest' may decline as robots replace them" may become a reality as the result of the use of this technology.

RECOMMENDATIONS

It is the strong view of the authors that robots should not be introduced in the workplace with impunity. There ought to be a comprehensive appraisal of the effects of robots in every specific workplace followed by a corresponding strategy to address exhaustively the possible social problems identified prior to their introduction in the given workplace. Governments should demand from each firm wishing to introduce robots a comprehensive report of its overall strategy as it affects humans before giving approval for robots in that workplace. A situation where firms pursue their profit-maximization goals blindly, glossing over their backlash on society especially in the context of robots in the workplace should be declared unacceptable by the United Nations. This will make it binding on nations to take the interests of all stakeholders into consideration before approving each use of robots in the workplace. This is a very important social responsibility of governments and to neglect it to court disaster in the decades ahead. Further study on average number of humans displaced per multipurpose industrial robot introduced in the workplace is recommended. This will bring to light the rate at which robots are displacing humans in the workplace. It is still an ongoing debate among experts and academics regarding the increased use and social impacts of robots on society.

Also, experts have been continually exploring the issues related to what ethics should be there to govern the use of robots, their behavior, whether robots might be able to claim any kind of social, legal or ethical rights.

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