

Is Advanced Automation Consistent with Sustainable Economic Growth in Developed World?

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Abstract. This paper investigates the impact of automation and new globalization phenomenon, outsourcing on sustainable economic growth. Its main scope is to analyze the impacts of automation technology and offshore outsourcing in manufacturing on a structural unemployment. Simultaneously, in the paper is given a special emphasis to the automation driven shrinking of the middle class in countries that are passing to the phase of deindustrialization. Finally, Three Laws of Automation in Manufacturing are formulated and few ideas and recommendations for the future are outlined.

Keywords: automation, overpopulation, outsourcing, robotic laws, service systems laws, automation laws.

1 Introduction

The purpose of this investigation is to assess the question: is automation the right strategy for the developed nations which practice relentless economic growth, regardless of social consequences? In order to answer this question some review of current automation trends is provided, their advantages and disadvantages are assessed, the automation and outsourcing's impact on industrial decline is addressed, which can lead to the judgment that automation is at the cross-roads. In order to apply wise automation, three laws of automation are formulated and conclusions are drawn, among one of them is the proposal for the development of Technosophy, which should be observed by all stakeholders of the wise automation technology and strategy.

Automation in manufacturing is rapidly unfolding, automated factories become a growing reality whether one likes it or not. This trend is logically associated with the substance of the global economic system that is set up in a manner to gain profit and in which automatic factories are inevitable. But the global economic system is also affected by complex social, political and strategic factors that are to a lesser extent predictable than technological changes.

For example, cost of computer and telecommunication technologies are decreasing dramatically while their speed is increasing exponentially and it is reasonably expected that these tendencies will continue in the future. Similarly, it is possible to

presage inter-sectoral shifts of the labor force in response to technological changes. The employment shift from agriculture sector to manufacturing that was initiated with the industrial revolution culminated in the 1950s and consequently began declining while the percentage of the labor force employed in services grew rapidly [17].

Analogically, when automated factories will be in developed countries widespread, then manufacturing employment will be dramatically reduced to the indispensable minimum and presently dominating sector of services will expand further. However, the inertial need for higher productivity in the service sector will further decrease traditional employment and would require new sources of generating work for those becoming unemployed through the widespread use of super-automation [16]. Moreover, employment in developed countries is endangered by subsequent phenomena that are connected with new forms of organizations such as telework, subcontracting, outsourcing, off shoring and others.

The problem is diversified in nature that requires not only specialized researches but also use of multidisciplinary approaches. In this paper we intend to explore selected aspect of automation in manufacturing as well mentioned phenomena in the organization of firms related to structural unemployment issues.

2 The Pros and Cons of Using Advanced Automation

The effects of a new technology and its importance to leverage economic growth have been a matter of dispute since the Industrial Revolution. In spite of that, at the beginning of the twenty-first century, it is not possible unambiguously to contain the effects of a new technology and automation, because impacts of technological changes are very complex including such factors as pollution, unemployment, and threats to privacy. Moreover, it has to be considered that technological changes often had different effects on various groups in the society and something is more important for some than for others.

Obviously, automation brings many advantages for manufacturers, especially in increasing production efficiencies and maximizing profits. Moreover, firms can achieve through automation many further effects such as error reduction, higher quality performance, reduction the need for work in harsh physical environments and others. In this connection, our intention in this section is to share some thoughts on this issue.

There is quite known fact presented for instance by Travers and Decker [23] that “jobless growth has been one consequence of new technologies the introduction of which has been accompanied by the globalization of capital, the internationalization of work, and the downsizing of government” However, this view is not fully shared among advocates of automation. For example, Brennan et al. [5] claim that “the high degree of automation in modern manufacturing systems, factory automation and control systems have become central to companies’ responsiveness, and arguably the key to competitiveness”. According to Groover [12] and Dorf & Kusiak [7] “some workers who qualify for jobs in today’s conventional factories will not qualify for indirect labor positions in highly automated factories and will not be employable”. But they add that “if companies do not automate their factories for the future, there is likely to be no future for these companies”.

We think, that the right question which should be contested is “What is probability that for companies that will prefer the conventional factory model will have no future?”. To find a satisfactory answer to this question in a direct way is rather impracticable. But we could indirectly investigate relevant potential differences between the conventional factory model and the automated factory. The automated factory can be viewed for this purpose as an integration of new advanced manufacturing technologies (AMT), not all of which are computerized, through computer hardware, software, and databases with computer-controlled machine tools, automated material handling and robotics to form a highly automated and flexible manufacturing system [4]. We can certainly assume, that automated factory at least from competition point of view ranks to a position of World Class Manufacturing (WCM) or World Class Factory. Generally, a status of WCM can be achieved by two concepts: Advanced Manufacturing Technology and Manufacturing Excellence (ME), as it is depicted in Fig. 1. This persuasion is shared, for example, by Hammond [13] who pointed out, apart from other incentives, that “By not ruling out any means to attain competitive advantage, U.S. industry will again attain its position as a World Class Manufacturer.

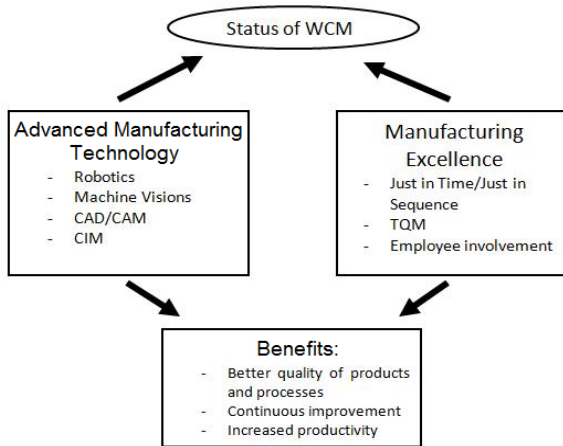


Fig. 1. Two routes to achieving WCM status (adapted from [13])

In generally, separate ways to WCM are characterized as follows. First of them is based on implementation of AMT that includes such tools as robotics, machine vision, computer integrated manufacturing and other automated technology and presents the technical route to achieve the WCM status. For the second way that is also called soft technology, it is necessary to adopt such tools as Just in Time/Just in Sequence, TQM and Employee Involvement methodology. These concepts provide soft enhancements of hard technological solutions.

One of the things that differentiate these two concepts is the necessary level of investment. Naturally, an adoption of AMT involves a high level of investment in contrast with an introduction of Manufacturing Excellence, for which only a considerable managerial effort has to be provided. The major effectiveness indicators

of the AMT project are costs and benefits. The problem is that while the costs are ordinarily easily quantifiable, the benefits are often very difficult to quantify. Chen and Small [6] in this sense emphasize importance of strategic benefits such as; early entry to market, perceived market leadership, or improved flexibility, but simultaneously they note that they are not readily convertible into cash values.

Ingersoll engineers in 1985 [19] came up with a set of surprising results from a survey of British manufacturing regarding the risk of introducing new technology in manufacturing firms. They recognized only an 18% rate of success in firms that went for the high technology option; 34% rate of success in firms that invested to the medium level of technology; 60% rate of success in cases when companies underwent only partial equipment change with reorganization; and with an 84% success rate in firms that staked mainly on organization changes, introducing only a minimal changes in equipment. The results obtained may be graphically presented as it is shown in Fig. 2.

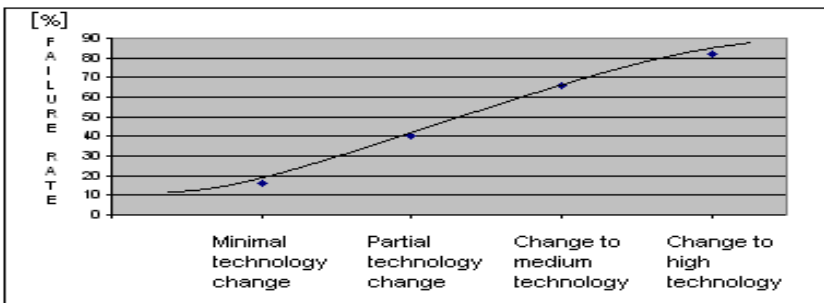


Fig. 2. Assessing the failure rate of introducing new technology in manufacturing industry (adapted from [17])

To prevent a potential risk related to low rate of return of AMT-oriented investment for firms, Schonberger [20] recommends investing in the simplest equipment possible and improving present equipment before considering new equipment and automation. Summarily, a highly anticipated comparison of these two concepts based on decisive criteria is shown in Table 1.

Table 1. Comparison between the AMT route and ME route

CRITERIA	AMT-oriented approach	ME-oriented approach
Managerial effort	Lower	higher
Level of investment	Higher	Lower
Negative environmental impact	Higher	Lower
Rate of unemployment	Higher	Lower
Benefits	comparable	

Thus, a dependence of the competition ability on the extent of investment to the AMT and extend of managerial effort to ME, respectively, can be modeled as depicted in Fig 3.

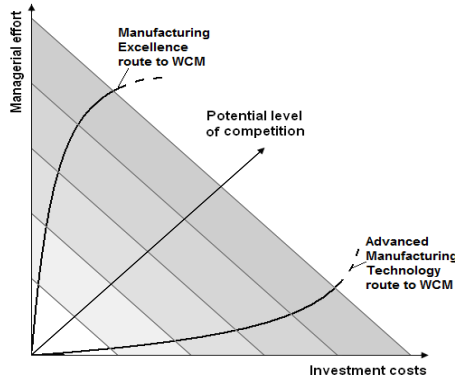


Fig. 3. Model of a dependency of the potential level of competition on the optional routes

Assuming results of comparison of values from Table 1, it is quite evident that debatable quoted above opinion: “if companies do not automate their factories for the future, there is likely to be no future for these companies” has a low probability of being true. But, even though, investing into advanced manufacturing technologies (ATM) and in general in automation is potentially risky, the technically-oriented approach remains only a promising one. Needless to say that these two approaches are frequently mixed what can be optimal solution to attain expected positive results.

3 Automation and Outsourcing’s Impact on Industrial Decline

In the last 50 years one can recognized the following approaches towards automation: (a) developing separate components of automated systems, which can fit in most of integrated configurations; (b) developing flexible integrated systems which can optimize overall performance; (c) developing data mining systems, which generate knowledge rules about their functionality and can control adaptively according to new emerging situations. However, in the 2000s, along with the advanced applications of the Internet in manufacturing (d) a new trend of outsourcing takes place, particularly in countries such the U.S., United Kingdom, and to certain degree in Germany, where the expensive labor is being replaced by less costly labor in developing countries such as China and India.

In effect, a concept of automation in so far advanced countries (mentioned above) is marginalized, since these countries are passing to the phase of deindustrialization. Consequently, a reform of the manufacturing industry is now a core strategy for government and private sector. In this context a new term “the automation of custom manufacturer” is introduced and new CIM concepts and technology-intensive industrial structures are anticipated. What factors will motivate decisions for automation in the near future? Three decades ago, there were a number of economic and social factors that provided motivation for automation in manufacturing such as, increased productivity, lowering high cost of labor, avoiding labor shortages, improving the use of expensive raw material by better engineering and automation, reducing manufacturing lead time, reducing of in-process inventory [11].

Will they be the same as before? In our opinion, following reviews of automation in the last 100 years will look not at the technical advantage of automation but at its social implication. Mostly it will be looked into following factors:

How automation results in the subjugation of the human beings by machines in times of population growth?

How reduced labor force by automation impacts unemployment rates?

How automation reduces purchasing power of eliminated labor force employed in manufacturing?

Thomas Friedman [10] in his best-selling book “The World is Flat” noticed that the transfer of services and manufacturing from the developed to developing nations also transfers wealth. As a result of it, the world becomes economically “flat.” It is interesting to notice that the main tool of this flattening process is the Internet, which was not developed because it was financed by wise capital, as it is true in many other technologies. In fact, the Internet was developed by the military and scientific community.

With off-shore outsourcing strategy and free trade policy of the Global Economy, more and more western businesses are closing up shops in the United States (about 40,000) in Germany and the United Kingdom as well, and moving elsewhere (mostly to Asia), taking millions of jobs with them. The result is a sharp drop in American middle class’ standard of living. This was a proud fruit of successful 200+ years of the American Way of handling economic development. Suddenly, these two hundred years of steady climbing to the highest standard of living (by a large country) in the world are put in a reverse gear and leading to the Big Crash 2008-2011 of the American middle class. It leads to a national divide between the global elites (a New Ruling Class) and those have been left behind.

Needless to say that exporting jobs to Asia and Mexico, the corporate elite is destroying the American dream and profiting from the exploitation of sweatshops. Abandoned by their government, American workers (and English ones too) are being forced to compete with cheap Third World labor and are inevitably losing out (Buchanan, 1998).

Global and stateless corporations are profitable, but the competitiveness of the people, business, and communities rooted in the U.S. economy is relentlessly deteriorating. American (and to certain degree English and German as well) workers, from the unskilled to highly educated engineers and research scientists, have been set adrift in a sea of dog eat-dog competition that guarantees a substantial drop in their living standards [9].

Outsourcing and off-shoring can be compared with traditional market competition expanded in a global economy, and enabled by an increasingly robust information infrastructure. Market economies are relentless in their drive for efficiency and productivity. Historic barriers of transportation logistics, off-site management, and knowledge transfer have been greatly reduced by information and transportation technologies. There are obvious short-term financial benefits available to companies by moving well defined systems and processes to lower cost areas of the world. Short-term effects on developed societies are less attractive than they are to companies, with less available jobs and fewer opportunities. Long-term consequences for everyone are open to debate, and potentially foreboding.

Forrester Research estimated in 2004 that American companies will move 3.4 million jobs offshore by 2015. About a third of those jobs pay \$46,000 per year or higher [3]. Labor union AFLCIO [1] estimates that the United States lost about 2.7 million manufacturing jobs between January 2001 and August 2004 (AFLCIO, 2007). The U. S. Government Accounting Office indicates that services associated with off-shoring grew from \$21.2 billion in 1997 to about \$37.5 billion in 2002, an increase of more than 76 percent. But exports from the U. S. of those same types of services also increased by over 48 percent [14].

Fig. 4 describes the long-term effects of continued job losses from off-shoring. Short term profits for U.S. companies improve from lower costs but long term effects of a less complex economy resulting from the loss of the country's manufacturing base, the proliferation of low paying service jobs, a shrinking middle class, and large trade deficits produces a new world economic order in which the United States will play a much less prominent role. In this scenario, the country experiences lower national security becomes a follower rather than a leader in technology and education, experiences a decline in standard of living for its citizenry, and has to contend with a much more radicalized political structure.

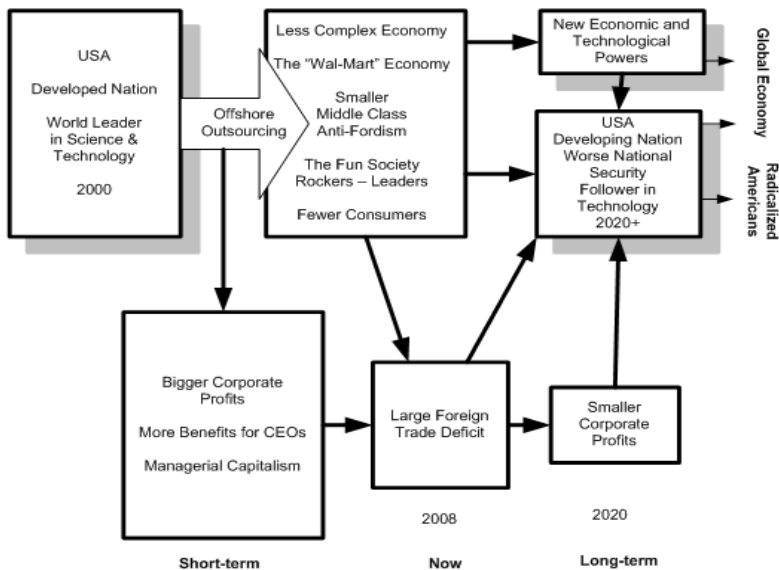


Fig. 4. A model of the consequences of off-shore outsourcing for the U.S. [21]

The following conclusions on off-shore outsourcing can be offered:

- Outsourcing needs sophisticated management that balances short-term profit with long-term investment in competitive position.
- Manufacturing and information technology off-shore outsourcing is a potential strategic threat for the American economy and society.

4 Automation at the Crossroads

A number of important questions one can ask and reply about the effect of automation on society in developed countries:

a) Will automation raise standard of living? Perhaps moderate automation could. But today in developed economies we deal with the declining automation due to the trend of outsourcing manufacturing and service to less developed nations where labor cheaper than automation. As the result of it, the middle class is declining in these nations and its standard of living.

b) Does automation create unemployment? Yes, it creates unemployment in developed nations. But because automation's processes are outsourced they can be instantly online controlled by the Internet from the developed countries.

c) Will more skill be demanded or less? In developing nations, the deindustrialization reduces complexity of economy which as service-oriented does not need high science and engineering-oriented skills. In developing nations automation-oriented priority is not the issue, since cheap labor competes with westernized automation.

d) Will workers get more satisfaction from their jobs? No, since they move to service positions, which do not require intellectualization of their work.

However, certain automation of global information systems provides manufacturing and service jobs in developing countries. Because distance is "dead" and electronic management of global, dispersed enterprises is possible. This is considered by the developing nations as the historic justice accomplished and the problem of the North-South colonial issues is being resolved.

The real danger is not that automation and robots will make us mad with power, or that human-like humanoids will themselves become super intelligent and take over the world. The consequences of their introduction will be subtler. Inexorably, we will interact more with machines and less with each other. Already, the average American worker spends astonishingly large percentages of his/her life interfacing with machines. Many return home only to log in a new.

Human relationships are a lot of trouble, forged from dirty diapers, lost tempers and late nights. Machines, on the other hand, can be turned on and off. Already, many of us prefer to forge and maintain relationships via e-mail, chat rooms and instant messenger rather than in person. Despite promises that the Internet will take us anywhere, we find ourselves - hour after hour - glued to our chairs. We are supposedly living in a world with no borders. Yet, at the very time we should be coming closer together, it seems we are growing further apart. Humanoids may accelerate this trend (Ethical Considerations, [8]).

In 1942 – Isaac Asimov [2] wrote "Runaround," a story about humanoid robots which contained the "Three Laws of Robotics":

1. A robot may not injure a human, or, through inaction, allow a human being to come to harm.
2. A robot must obey the orders it by human beings except where such orders would conflict with the First Law.
3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

In 2009-Andrew Targowski [22] defined Laws of Service:

1. Do not develop service systems without human presence.
2. Do not develop service systems which harm society.
3. Do not develop service systems which endanger human race.

Law I protects people against passivity. Law II protects society against structured unemployment. Law III protects the human race against the bifurcation into two kinds of species.

This paper authors (Targowski & Modrák) offer the following Laws of Automation in Manufacturing:

- Law I. Do not implement high automation technology before you are not sure that same goal can be achieved by another means.
- Law II. Do not implement automation technology with aim to totally eliminate human presence in manufacturing process.
- Law III. Do not develop automation which harms society or endanger human race.

It would be necessary to organize a forum for suggestions which could improving the laws and promote their applications. Thereafter it would be useful to open even wider forum for discussion, making preconditions and recommendations how future manufacturing systems should be developed and managed in a responsible manner for the good sake of Society.

5 Conclusion

According to known facts, factory automation caused during the last decade worldwide decline in manufacturing jobs, not only in developed countries but in developing countries as well in a uniform manner. Hence, the laws of Robots, Service and Automation Systems should be implemented into society undertaking as follows:

1. The automation systems are one of the most complex systems in civilization which triggered tremendous developmental trends in science and technology in the 20th century. They looked very promising at their early stages, but later provide many doubts about their positive role in Society.
2. The automation systems designed for better effectiveness and reliability & quality are as long positive as long they do not harm and endanger human beings and society.
3. The presented Laws of Robotics, Service Systems, and Automation should be included in codes of ethics of appropriate professional associations.
4. The governments should established national policies for applying these Laws of Robotics, Service and Automation.
5. The professional education should include in its research and teaching these Laws of Robotics, Services, and Automation as securing ones of societal well being and civilization sustainability.

In order to integrate all these laws into one coherent discipline, a new one should be pursued. Perhaps it should be covered by Technosophy, which should investigate *wise engineering* for *wise civilization*. Technosophy is relatively a new term which is needed to identify a purely techno-scientific approach to technology. According to Levy & Junkar [15], Technosophy suggests the need to develop wisdom to accompany the science of technical artifacts. This kind of engineering should be only developed today and aimed at the sustainability of our civilization in times of shrinking strategic resources of the planet. It is widely known that population

becomes too big to sustain our western styles of life, even in short-term future. Therefore, many leading corporations comprehended these challenges and adopted sustainability planning over the past few years as a tool to achieve strategic dominance [18]. Hence, the future is now and Technosophy is, in our opinion, needed today as never before.

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