

EDUCATION FOR WHAT? HOW JOB AUTOMATION, CHANGING GENDER PREFERENCES AND REDUCED CORPORATE HIERARCHY AFFECT WORK

Ross Milburn

Open University Malaysia
rossmilburn@oum.edu.my

ABSTRACT

Educationalists worldwide are faced with many predictions of mass unemployment due to the rapid advancement of automation, especially AI (artificial intelligence). AI apparently has the potential to replace skilled workers, including millions of professional vehicle drivers, but also highly paid and educated “cognitive” workers such as managers, doctors and lawyers. This investigation includes a hypothesis that, when “technology-support” work is all automated, sufficient “human performance-related” occupations will be available, and that these will be protected from automation by strong social preferences. A second challenge for the current job market is the polarization between those who support the traditional female role of mother, primary child guardian and provider of caring service to the family, and those who seek absolute gender equity in identical occupational roles for men and women. The uncertainty about natural gender roles hinders solutions for the frequent breakdown of marriage, proliferation of single-parent families, and the failure of the birth rate to maintain the population. A third issue is uncertainty over the effect of the radical reduction in the hierarchical organization of business corporations. Closely related is the increase in workers who do freelance work rather than being employed. In the United States, this figure is about 36% and is expected to rise. Some writers predict that employment will be replaced by more entrepreneurial roles. The investigation will include the benefits and costs of such a change to companies and workers. These occupational trends will be investigated by literature surveys, qualitative research, including interviews of key specialists, and surveys of worker preferences on a multicultural basis. It is also hoped that this research can identify aspects of education that may facilitate the maintenance of good occupational opportunities in an era of uncertainty over the future availability of suitable work.

Keywords: Unemployment, Automation, Gender Roles, Gig Economy, Hierarchy, Vocational Education

INTRODUCTION

Artificial intelligence (AI) has already started to replace human workers, and make radical changes in the occupational landscape. China has recognized AI as a key technology and is investing heavily, and all Asian economies hoping to retain full employment will ascend the value chain from manufacturing – which must automate or die – to emerging human services that are hopefully out of reach of machine simulation. Open and distance learning (ODL) colleges must respond with agility to serve the emerging needs of workers and managers whose current specialist skills are threatened with automation.

It's worth pointing out, though, that AI can help ODL management cope with large-scale business tasks that can otherwise constitute a management burden. For example, while the

Asian education market is vast, it is heterogeneous and geographically spread. AI systems excel at processing large databases, such as analysing the learning requirements of millions of diverse individuals, and matching them to viable curricula. The same databases can be processed by AI systems to help turn people who need qualifications and skills into paying students.

The topic of the present study is to identify the long-term boundary between human work and automation, especially AI. Automation has been steadily replacing human workers for many years, starting with unskilled workers, then skilled craftspeople, such as welders, paint sprayers and assembly workers in factories. Driverless road vehicles are just one application of AI that could create large-scale unemployment just a few years ahead.

Most recently, AI systems have surpassed the human brain at several capabilities that were considered uniquely human, such as playing the games of chess and go, surpassing medical experts at interpreting patients' radiography images, and interpreting spoken languages. These technical advances raise the probability that robots and other forms of automation can not only replace skilled manual workers, but also tackle the main tasks of some highly educated professionals in cognitive occupations such as lawyers, doctors and stock analysts.

As a result of this success, specialists who develop automation are confident that their technology will advance indefinitely, and eventually outperform human workers in every respect. The possibility that AI systems can eventually surpass the human brain completely has resulted in a widespread fear that all forms of employment will be vulnerable to displacement by automation, resulting in mass unemployment and the failure of the market economy. Several major universities and other institutions have studied the potential of AI to replace jobs and generally agreed that existing AI technology has the potential to outperform human workers in up to half of human occupations.

Work in the past

In order to understand how automation and AI threaten to replace human workers, we need to consider the historical relationship between people and machines. The first factories with steam-powered machines were invented in England in the 18th century, and they caused unemployment among manual workers who had previously woven fabrics for clothing, made wooden furniture, worked on farms and served as blacksmiths making metal products by hand. In the 19th and 20th centuries, millions of workers in advanced economies lost their jobs in agriculture, but found new ones in manufacturing.

A later generation of workers lost their manufacturing jobs and found new ones in the service industries of the Information Age. In retrospect, we can see that as technology was continually developed, starting from the 18th century, innovations regularly enabled machines to displace large numbers of workers, causing temporary unemployment. However, each time, the innovations also increased productivity and wealth, which made possible increased production and new factories, which then created new jobs to replace those that had been lost. At the end of the 20th century, skilled human workers were being replaced by computers, expanding the economy and enabling workers to be retrained for service jobs that involved human interaction that could not yet be automated.

Some writers are optimistic that past experience will be repeated, whereby the displacement of human workers by AI will increase productivity, expand the economy and bring on another wave of new industrial jobs for people. But AI-based automation is now taking over tasks carried out by almost every kind of specialist worker, which means that new employment created by economic expansion is dwindling towards zero. The idea that technology will create a new wave of jobs is no longer valid because new industrial tasks created by innovation will also be automated. Furthermore, historical experience suggests that the introduction of such intelligent

technology may be very rapid. For example, in 1900, horses were in wide use in industrialized countries, but by 1910 they were a rare sight in large towns. Automation is extremely advantageous economically, and companies must generally embrace high productivity in order to survive.

One solution that has received widespread attention is the possibility of paying whole populations a Universal Basic Income (UBI), regardless of whether they can find work. This may be possible because even if most jobs are automated, productivity will rise, creating additional wealth. However, it is important to realize that human work is not just about earning money: the work that individuals do provides fulfilment and validation of their value to society, and therefore their social status. If the automation of most work prevented millions of people from serving others by doing socially useful tasks, the very purpose of human life would be diminished.

In this investigation, we will attempt to provide new perspectives and information to contribute to understanding the future of work.

An opportunity to improve the quality of life for all human workers

Although the prospect of large-scale unemployment is worrying, one factor to bear in mind is that most employees in the industrial era do not like their jobs. A study by survey company, Gallup, shows that 26% of the five billion global adults have a good job which means 30 hours or more of paid work per week (Figure 1). But only 6% of those workers are engaged in their jobs, meaning that they use their strengths, know what is expected of them and believe their job matters. Of 3.2 billion adults who are working, or looking for work, only 6%, or 183 million people, have a good job in which they feel engaged (Figure 2). The conclusion must be that for the majority of people, the jobs created by industrialization have been unsuitable, and they would be better off doing something else. The central challenge is to identify suitable jobs for human workers in future, when AI and robots handle industrial tasks.

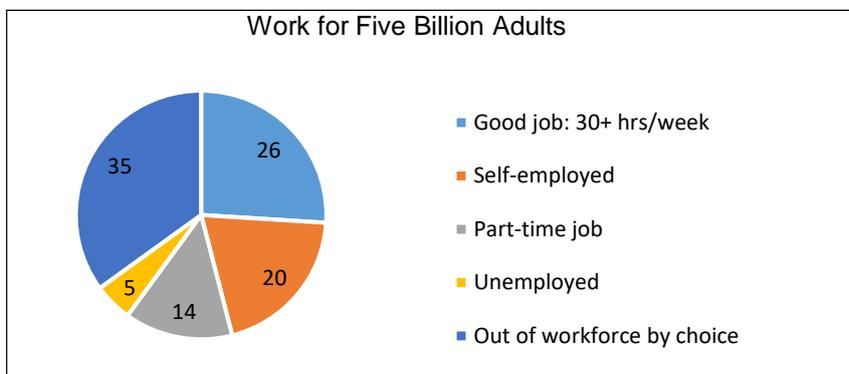


Figure 1: 26 percent of adults globally have a paid job for 30 or more hours a week

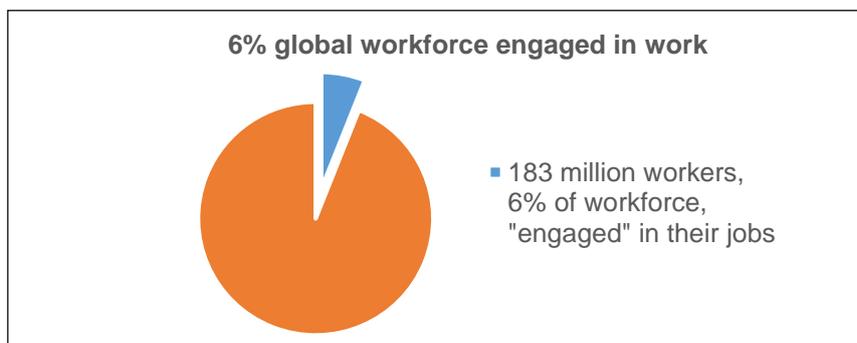


Figure 2: Only 6% of global workforce feel engaged in their jobs (Gallup survey)

LITERATURE REVIEW

Three major studies estimated the proportion of jobs that will be automated by AI and other new technologies. The most widely referred paper, by Frey and Osborne (2013), predicts that 47% of US jobs are at risk of automation in the foreseeable future. This was followed by a Working Paper from the OECD (Arntz, Gregory, & Zierahn, 2016) which concludes that the proportion of US jobs at risk of automation to be only 9%. The authors find fault with the research methodology of the Oxford paper, in that it appraised complete occupations, while automation applies to specific tasks, and an occupation may actually comprise multiple tasks, some of which cannot be automated at present.

The OECD study might be seen as too critical of the Oxford methodology. The OECD argument is that if a human occupation comprises more than one task, then automation of one task does not automate the whole occupation, so unemployment will not result. However, even if workers typically do several tasks, it is still true that automation of a single task will cause unemployment. For example, if driving vehicles, such as trucks, buses, taxis, forklifts and ambulances, comprises 5% of an economy, and driving is automated, then we can expect to see 5% of workers lose their driving jobs in due course. Drivers may be reassigned to other kinds of work but if 5% of tasks disappear, 5% of work disappears and therefore 5% of workers will lose that specific employment. A worker's employment contract can be rewritten by the human resource department in a couple of hours but only if suitable alternative work exists. Supporting this view is a third study, from global consultants PwC, which finds that 38% of US jobs are at risk of automation, a figure much closer to the Oxford study (Berriman & Hawksworth, 2017).

There is strong evidence that the advances already made in AI will enable a large proportion of occupations to be automated. Whether or not this results in mass unemployment, there will be major changes in the work that humans do over the following decades, and the purpose of this study is to forecast what kinds of work that will be.

Differentiating human work from AI tasks

Chinese industry is rapidly introducing automation, and Kai-Fu Lee, (Reeves, 2018), author of *AI Superpowers: China, Silicon Valley, and the New World Order*, predicts that robots are likely to replace 50 percent of all jobs in the next decade. According to Lee, AI is the "singular thing that will be larger than all of human tech revolutions added together, including electricity, [the] Industrial Revolution, the Internet, the mobile Internet – because AI is pervasive." There is strength in Lee's claim but his timescale of one decade may be premature, as technological goals often take longer than expected to materialize. Lee also expresses his belief that AI has limitations, in that machines cannot move people emotionally, and that service jobs should be considered first-class employment for humans. However, service industries comprise 80% of jobs in advanced economies, and other research has indicated that tasks such as food preparation and information services are even more vulnerable to automation than factory jobs.

Kai-Fu Lee's global view is insightful and will stir people from complacency, but his claim that machines cannot move people emotionally is questionable. If an AI-driven diagnostic computer tells a patient that he or she has cancer, the news is certain to generate emotion. The same applies if an AI investment advisor tells a client that he has just made half a million dollars in the stock market. Perhaps Kai-Fu Lee was really implying the irrefutable point that AI systems don't feel any emotion, undoubtedly a limitation.

A book that captures the competition between humans and AI is *Race Against the Machine* (Brynjolfsson & McAfee, 2012). These authors believe that computerization is bringing deep changes but has limitations. "Computers are now great pattern recognizers, but lousy general problem solvers, and, for all their power and speed, today's digital machines have shown little

creative ability.” That’s true now, of course, but creativity is based not on magic but on the manipulation of data and that is something computers do better than people. Given sufficient data and the right algorithms for trial-and-error reasoning, AI systems may eventually be as creative as humans, and thousands of times faster.

Brynjolfsson and McAfee (2012) also suggest that humans are losing a race against the machines, but that if we understand the issues, human workers can race ahead with machines, instead of racing against them. We strongly disagree with the view that humans can partner AI systems in this way. Our experience of automation shows clearly that although small groups of specialists are required to support the operation of computers, the work itself is done solely by the computers, and the people who previously did the work are fired or moved to other kinds of work. It is meaningless to talk about the relatively slow human brain working with a computer that is 10,000 times faster and that never stops for a break. If humans are to continue to work, they must find tasks where computers cannot compete with them – and that rules out any tasks based on computation. Hence, the reason for this study.

An article from global management consultants, McKinsey, *where machines could replace humans – and where they can’t (yet)* by Chui, Manyika and Miremadi (2016) identifies the types of tasks that current AI can and cannot do, and examines the industrial sectors to determine what proportion of their work can be automated. Approximately 59% of work in the manufacturing sector can be automated but what is of greater significance is that the service sector, which accounts for 80% of US jobs, is also vulnerable. For example, 73% of activities in the accommodation and food service industries could be automated with existing technology. Although such investigations help us to anticipate the future, it is impossible to predict the scope of new technologies or the dates that they may be adopted. Furthermore, new developments in AI will relentlessly widen the scope for replacing human workers with machines. The only certain limitation to AI is if humans have good reason to decide that some work should be done by humans rather than machines. The McKinsey study, like others, does not examine in detail the reasons why some human occupations will never be automated.

Two books that describe the work of Stone Age humans, *Affluence Without Abundance: The Disappearing World of the Bushmen* (Suzman, 2017) and *Stone Age Economics* (Sahlins, 1972), do not mention AI. It may prove useful to bear in mind that several billion humans work for a living in the modern world, yet only 10,000 years ago, all our ancestors lived as hunter-gatherers, and there were no jobs and no industries, not even agriculture. Yet these people – genetically modern humans, much like ourselves – managed to migrate across the whole of planet Earth, without technology other than stone tools and control of fire. According to these two books, these prehistoric people “worked” for only 15 hours a week, a fraction of the time spent by modern humans at their jobs, or working in their homes. Therefore, it may be wise to take into account the types of work undertaken by human ancestors in order to clarify the kinds of work for which humans are best adapted based on their evolutionary history.

Discovering gender-based work preferences

In the present study, the view is taken that men and women appear to be adapted to significantly different occupations, because of their minor physical and mental differences, and also because in preindustrial societies, for millions of years, the two sexes spent most of their time in distinctly separate social roles. The reason why this is important is because the ultimate goal of an individual’s life is not merely to be economically productive, but primarily, to be “self-actualized” according to the principles expounded by the US psychologist, Abraham Maslow, who created the well-known diagram called Maslow’s Hierarchy of Motivations. If men or women are prevented for economic or cultural reasons from working in their preferred occupations for equitable remuneration, then self-actualization may be thwarted.

However, if men and women do, on average, prefer rather different occupational activities, only individuals can determine what these preferences should be. To understand the strength of feeling against social coercion influencing occupational choices, consider a paper entitled, "Do Men and Women Have Different Jobs Because of Their Biological Differences?" (Messing, 1982) which states: "Allegedly for their protection, women are relegated to jobs supposedly adapted to their unique physical capacities and excluded from jobs which are said to endanger their health. So-called women's jobs are claimed to reflect women's "natural" qualifications in requiring less strength, more dexterity, less emotional stability, and in involving less risk for potential offspring. But it is impossible to demonstrate scientifically the existence of biological differences between women and men which suit either sex for particular jobs." Messing (1982) points out that unhealthy working conditions are damaging to both sexes, and claims that gender-based job allocation serves employers' interests by justifying low salaries and boring tasks for women.

However, a recent paper by Gershoni and Pietrokovski (2017) has proven that men and women differ in ways that might affect their preference for certain occupations. Entitled, "The landscape of sex-differential transcriptome and its consequent selection in human adults," it claims that although men and women have almost identical genomes (total gene sets), there are 6,500 examples of different traits in men and women that arose through Sexually Differentiated Expression of the same genes. The researchers report that human sexual dimorphism (differences) has been demonstrated for diverse traits such as brain anatomy and development, behaviour, mortality, longevity and morbidity, and distribution and metabolism of fat creation. Physical performance capabilities and pain response have also been shown to differ between men and women. Men and women also have dissimilar disease susceptibilities. The research explains why congenital diseases or infertility that affect only one sex are not eliminated due to natural selection. In simple terms, they can be passed on to offspring through the other partner, and therefore maintain a high population frequency. Thus, genetics show that women are not merely specialized for giving birth, but also for a lifestyle that supports the traditional domestic role of females. This is relevant to the current study's research objective of identifying any gender-based preferences that are needed to enable workers to be self-actualized in their working lives.

Additional evidence that men and women differ significantly in the genetic traits that influence occupational choice is provided by *The Blank Slate*, a book by a leading US cognitive psychologist, Pinker (2002). According to Pinker, "All cultures divide their labour by sex, with more responsibility for childbearing by women, and more control of the public and political realms by men. The division of labour emerged even in a culture where everyone had been committed to stamping it out, the Israeli Kibbutz." In all cultures, men are more aggressive, more prone to stealing, violence, and rape. Since women have to invest more calories in creation of their offspring, they also invest more in nurturing the offspring. Males are more sexually competitive because multiple mating increases the offspring of males but not of women. During evolution, men did most of the hunting, and needed to navigate a wide territory, and research shows males are superior at rotating and using mental maps. Pinker's (2002) well-respected views support the concept of male and female work preferences.

A paper based on feminist ideas that are more compatible with scientific knowledge is *Unpaid Work and the Economy: Linkages and Their Implications* (Hirway, 2015). It is about the very significant percentage of productive work, in all societies, that is mainly done in the home, such as preparing meals, providing care to children and the elderly, and cleaning the house. The central issue raised by this work is that it is unpaid and distorts our view of the wider economy, which it clearly helps to support. A second issue is that women do more unpaid work than men, which reduces the total earnings of women and handicaps their performance in the market economy.

The goals of Hirway's study are related to what is seen as the anomalous position of modern women, who have to cope with both their dominant role in bearing and raising children, and providing domestic care to husbands and other family members, in addition to any professional work that they do in the market economy. Writes Hirway (2015): "This unequal distribution of work is unjust, and it implies a violation of the basic human rights of women." Research such as this paper is being taken seriously, and the United Nations has produced documents proposing ways in which unpaid domestic work can be recorded as part of the production output of national economies. However, it is acknowledged that not all personal services of care can be regarded as part of market economy and there is a limit to the degree that state-hired professional care-givers can replace the work of family members.

Regarding the studies cited above, this study recognizes that family life is of central importance, and that both men and women must be satisfied that their collaboration is equitable, harmonious and sustainable. Therefore, this study will research the "ideal" preferences of men and women in their familial roles, taking into account the need to provide children with a safe and fulfilling environment, and also to identify gender roles that suit the sexual specialization that may well affect the occupational preferences of men and women. These preferences have been largely ignored since the Industrial Revolution, because of the urgent need to earn a living by "getting a job" but as AI forces societies to redefine the nature of work, more emphasis is likely to be given to the self-actualization of the individual.

Investigating the effect on the work market of reduced hierarchy

The 17th century Industrial Revolution comprised huge factories, driven by steam power, and thousands of workers who were pressurized into giving up their craft skills and being centralized in organizations managed by steep human hierarchies. But, today, large organizations are already highly automated, and have many fewer employees, who are carefully selected for their specialized skills and education. The hierarchies have been flattened and those responsible for creative roles often work in small autonomous teams. As human labour is reduced by automation, more workers have part time or contingent responsibilities, and many become freelancers or entrepreneurs with startups.

In the United States, the proportion of self-employed workers is about 40% and growing fast. With the new miniaturized production technologies, one-person businesses or those with a handful of workers, can replace much of the traditional economy. Whereas a large, centralized company can automate its processes and replace most of its employees, tiny companies can use AI but its owners and directors are unlikely to automate their own jobs.

The capital required for production processes (publishing, 3D printing, local power generation, website creation and management) is no longer a barrier to business startups, and this further supports the decentralization of the human workforce. Internet business platforms such as eBay, Uber, Air BnB and the many travel companies, support millions of local autonomous workers.

The replacement of jobs by autonomous entrepreneurs is the subject of *The End of Jobs: Money, Meaning and Freedom Without the 9-to-5*, (Pearson, 2015). The book's primary theme is that the traditional view of entrepreneurship as a high-risk adventure compared to the long-term security of employment has been reversed by economic conditions and new technology. The author makes a compelling case that entrepreneurship is not only relatively easy and cheap now but also secure because it is based on personal skills that are transferable between opportunities. In contrast, writes Pearson (2015), even white collar jobs are being rapidly replaced by automation, while there is a surfeit of graduates looking for work, and communications technology has made it possible to utilize cheap white collar skills online anywhere in the world.

Now, writes Pearson, the most effective way for individuals to leverage their ability is by the pursuit of entrepreneurship, which comprises complex work that cannot yet be automated. Managing complexity and chaos is the challenge that requires entrepreneurs. Learning that skill is the only path to security for graduates who discover that their degrees are now commonplace, while their jobs are being decimated. If Pearson (2015) is correct, the most secure form of work in the future will be entrepreneurship because entrepreneurs are less likely to be forced out of work by automation, especially in occupations where human relations or human creativity still has an edge over AI.

Education will be vital in preparing students for the new work environment

State education has often been about moulding students to become desirable employees, while reformers tend to see innovative education as more likely to be about helping individuals to reach self-actualization. One country, Sweden, has apparently altered its education system from favouring socialist passivity to teaching a robust entrepreneurship, according to a paper entitled, "In the Name of Liberation: Notes on Governmentality, Entrepreneurial Education, and Lifelong Learning" (Dahlstedt & Hertzberg, 2013). This paper describes a radical shift in educational policy introduced by the right-wing Swedish government in the 1990s, which has the ambitious task of teaching entrepreneurship in order to remould Swedish citizens from their previous hindsight culture in which students learned a passive role and which contributed to the development of learned helplessness under a centralized welfare state. In contrast, as the pursuit of entrepreneurial behaviours became a mainstream goal of Swedish education, it was hoped that it would produce ideal citizens, primarily active, motivated and able to take responsibility for themselves and their welfare.

The scope of learning outcomes was broadened with emphasis on the promotion of values including creativity, independence, flexibility, initiative, problem-solving skills, and self-confidence. This paper suggests that the Swedish educational model was influenced by the French Philosopher, Michel Foucault, who used the term "governmentality" to describe government of society in a broad form, which includes the moral aspects of behaviour, the responsibilities of state authorities and the responsibility of citizens to manage their own lives. Thus the title of this paper, which refers to the "liberation" of citizens who are made more proactive by liberal education, which at the same time enables individuals to contribute more effectively to economic growth and job creation under the capitalist system.

It seems inevitable that state education, with its high levels of inertia, cannot be reformed rapidly. Yet overall, the education sector worldwide incorporates a large variety of innovative approaches that can act as a laboratory for new initiatives. It seems certain that the advance of AI throughout society will stimulate a great deal more of these initiatives. As the global economic system is shaken by the disruptions caused by AI's churning of labour markets, the demands on education may alter radically. If the jobs called technology-support work disappear as rapidly as expected, the demand for education may diverge in two directions. The first is to teach people who work in service industries related to human performance (professional sport, entertainment, art, education and mentorship). The second direction is to teach future workers who handle the relationship between the human species and the enormous and diverse industries of the future. These industries will be almost entirely managed by AI systems from day to day, but their goals will be determined by human needs. The needs for the basic industries that construct the infrastructure of civilization, and provide the food, clothing and dwellings in which people live, will be the main task. In addition, automated industries, will enable the development of small-scale local production facilities that will enable individuals and local groups to produce customized products for niche markets. Just as print on-demand books and e-books can be published by individuals, many manufacturing and process industries are expected to follow a similar decentralized pattern.

Perhaps another role for education will be to harmonize the moral values of different, competing human cultures. Morality is the basis for law, and if we wish to have a peaceful future and universal human rights, the same values need to be first agreed upon globally by the human species, and then taught to every new child from birth.

The pace of technological advances is likely to accelerate and this will give impetus to the need for lifelong learning, which will probably require a major expansion in the number of people in teaching occupations. At the core of all learning is the relationship between humans and society that cannot be taught by machines.

METHODOLOGY

Predicting the future of human occupations is necessarily difficult and inexact. The main trend, from general industry jobs to what we call human performance work, has already started, and it is planned to assess its progression from analysis of government databases in the leading industrial economies. In order to learn more about customer preference for the human performance of key work roles, customers will be surveyed to obtain typical responses to services provided respectively by AI and human workers. Ultimately, customers, not suppliers, control the market and are therefore the gatekeepers of human values, and such research is expected to reveal the boundary between human and AI task-roles.

To investigate the trend away from employment towards autonomous roles such as freelance work, gig economy and entrepreneurship, researchers will again utilize government occupational statistics to identify the trends in these work roles. This will be supported by in-depth interviews of HR specialists from both government agencies and commercial enterprises. A key objective of this investigation is to determine whether or not the trend away from the hierarchical wage labour of the era of general industry work will actually provide workers with greater opportunity to select their preferred vocational work and pursue the ideal of self-actualization.

Our third investigation is to determine whether the switch to human performance work and the resulting greater freedom to match individual aptitudes and preferences can resolve the dilemma facing women who are commonly obliged to handle both professional work roles and unpaid domestic responsibilities such as childbirth, childcare and caring services. The detection of changes in gender-influenced occupational preferences is controversial, especially for women, because studies repeatedly conclude that female job selection is influenced by social stereotypes, and the distortions created by economic incentives. However, it is hoped that qualitative research, based on in-depth interviews, focusing not on the existing work choices, but on the ideal aspirations of individual men and women, may provide insights into any genuine occupational preferences that arise from the evolution of sexual specialization.

FINDINGS AND DISCUSSION

It is useful to remind ourselves that the powered machines that created the wealth of modern civilization are a very recent invention, starting with the Industrial Revolution in the United Kingdom, about 1700. When all the productive industries are automated, in about 2050, we will be able to see that the era of general industry employment was just a brief interruption in human activities, after which the species will return to more human daily activities. In 1700, the machines were primitive steam-driven equipment that required large numbers of men, women and even children, to maintain and utilize their productivity. But, during the industrial era, the gradual advancements in machine design, and especially the automation created by computers, have constantly enabled machines to operate with less human support. As this process is

completed, hundreds of millions of people will lose their jobs and it is not clear how the market system can continue unless alternative forms of paid work can be found.

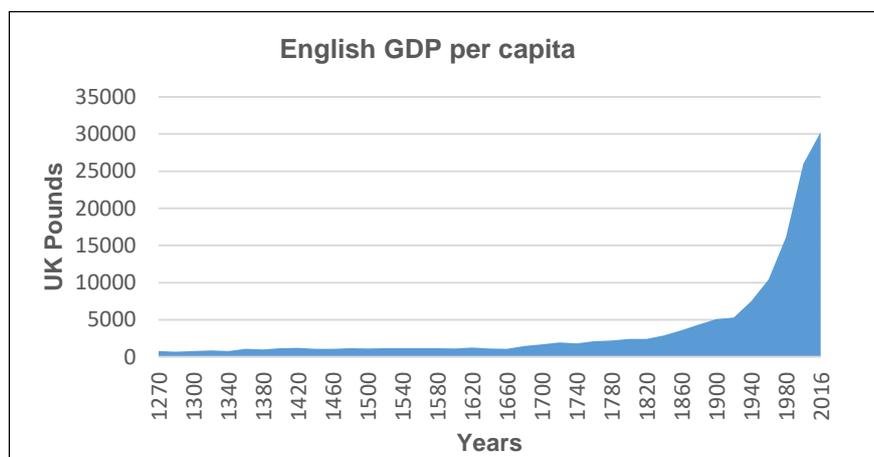


Figure 3: English GDP per capita, from 1270 until 2016

Figure 3 shows the English gross national product per capita from the 13th century until the present. In the first 400 years, the economy was based on men and women using only hand tools, and it can be seen that the economy did not grow significantly during this period. In the 18th century, steam engines and many other machines were invented, and in the 19th century, the first factories were built. Machine production caused the economy to grow right up to the present time.

At first, the machines were primitive, and the factories required a large number of human workers to maintain output. As the machines were improved, they required fewer workers to maintain output, so the working population was spread over a large number of factories and industries, increasing the standard of living. However, by the end of the 20th century, automation, including AI, could almost entirely replace human workers, and mass unemployment seems possible.

We can conclude from Figure 3 that the output of individual human workers tends to be constant while the output of machines has risen due to technological advances. Figure 4 shows the constant output of a human worker in GDP per capita, plotted as a percentage of the total GDP per capita. Before the Industrial Revolution, human workers created 100% of the output, and then this percentage fell as the machines were improved. The human contribution falls towards zero, indicating that all industries based on technology will be totally automated in the near future. Therefore, if we consider that the Industrial Era is the period between 1750 and 2050, then the ratio of human workers to machines fell continually, reaching close to zero when the machines were completely automated.

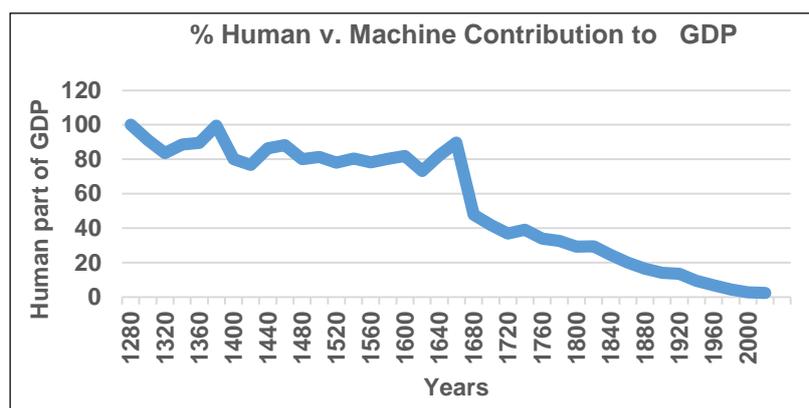


Figure 4: Human workers output as a percentage of English GDP

AI will eventually outperform humans in any occupation

Up until the 18th century Industrial Revolution, human work was based on the intelligence of the human brain, plus the strength of human muscles. Machines quickly outperformed human muscles by thousands of times, and other machines, including computers and especially AI systems, have outperformed the human brain in computation and some forms of decision making. Furthermore, AI is now the focus of intense worldwide research, so it is reasonable to believe that AI will soon outperform human workers in all those occupations that are based on technology, computation or other systematic forms of logic.

As a result of these predictions, many thinkers feel that mass unemployment is likely in the near future. However, the Industrial Era, in which humans have been dominated by machines, and mostly worked at tasks related to technology and production, is really just a passing phase in human history. As we have seen, complex machines were only invented in the Industrial Revolution, starting about 1750, and this era will end about 2050, when most machines will be entirely automated and self-maintaining. After that time, humans must return to more natural kinds of work, and cease to sacrifice human nature to the blind demands of technological progress.

The definition of work

When we discuss the meaning of work, we generally restrict the meaning in three ways. First, we think of working for other people, especially companies that need human labour to produce their goods or services. Second, we naturally assume that work is something we do in return for wages. Third, we may think that work is something that we would not do out of free choice – we do it only to earn our living.

However, the dictionary definition of work is simply the expenditure of mental or physical energy in order to obtain some kind of benefit. Therefore, work in principle describes all purposeful human activity (but not accidents), because all purposeful activity is intended to obtain an advantage of one kind or another. It is useful to remind ourselves of three points:

- (1) Although many people dislike their work, work can range from tasks that are intensely fulfilling and enjoyable, to tasks that seem like a form of torture;
- (2) Work can be carried out to benefit the worker, or other people; and
- (3) Work can be carried out for payment or charity.

However, in this paper, “work” is mainly used to mean activity that can earn remuneration in a market economy. For example, ball games as leisure activities reward players with fitness and social bonding, but in the context of professional sport, footballers earn remuneration as part of the labour market.

The work that only humans will do

When researchers assume that all human occupations can be replaced by AI or robots, they believe that business enterprises will always have the right to replace human workers when automation can do the same work to the same or a higher standard, and at a cost that makes the change profitable. This is not the case, however – in a free market, business enterprises cannot automate occupations unless the customer will accept the change.

First, consider a manufacturer of smartphones who employs human workers to assemble the devices. Suppose robots become available that can assemble the phones more perfectly and reliably at a lower cost. Will the end customer object to the change to robotics? No, of course not. The customer for a smartphone, or any other manufactured product, is indifferent to the manufacturing process unless it is harmful to the user.

Second, consider a company that organizes a professional sport such as soccer. It is likely that in the near future, it will be possible to programme robots to play football better than human players. Will the customers object to this change? Absolutely, yes! The function of a football match is to provide entertainment (and information that is needed for biological reasons) about the relative athletic and mental attributes of communities and of humans with varying physiological traits. (Note that robots will play football occasionally, but this will usually be a competition between humans who design or programme the robots. Humans are always interested in human competition but competition between machines as an entertainment has no future).

The same considerations will apply to entertainment. Although it will be possible to create robots who can sing, dance, act, even do stand-up comedy, as well as most human performers, customers will not wish to pay for substitutes. The same is true of some forms of education. Although automation can make a great contribution to many forms of self-learning, it would clearly be undesirable to allow robots to try to socialize and educate small children in a kindergarten. Another category of occupation that cannot be automated is art. Real art, including fine movies, for example, are really a form of implicit communication about life, from the human artist to the audience. If art is created by automated systems, it is no longer genuine art, although it may be entertainment or decoration.

It can be concluded that some human occupations, including professional sport, entertainment, education, and art, are only valuable in the marketplace if they are performed by humans. Whether robots could or could not be programmed to replace humans is irrelevant in these cases.

How will these occupations provide enough jobs?

If we accept that certain occupations must be performed by humans to satisfy customers who control the market, a new question arises whether this class of occupations can provide enough work for all humans when all the industries that create resources have been automated. The answer is that this is one of the subjects of the present investigation. It should be noted, though, that the industries that provide most work today are based ultimately on machines and technologies that did not exist at all until the 18th century. So, prior to that Industrial Revolution, humans had managed to fill their time for two million years of the evolutionary period, without this kind of advanced technology – therefore, we can presumably survive without technology-support work.

Table 1: Human occupations that will not be automated

Some human occupations that will not be automated
<p><i>Designer:</i> When a designer creates the concept of a new artefact, or makes a prototype, AI can be used to explore thousands of variations (iterations) of the design, in order to optimize it for production. In future, AI systems equipped with enough data may propose new inventions, but it is likely that humans will retain the ultimate control over artefacts that are actually needed and wanted.</p> <p><i>Professional sportsperson:</i> The human species has always had a need for athletic contests to maintain cultural memes about health and social status based on athleticism.</p> <p><i>Professional entertainer:</i> Singing, orchestral music, dancing, acting, comedy, etc.</p> <p><i>Artist:</i> Art in movies and videos, literature, sculpture, painting, photography, etc.</p>
<p>Educator in many domains</p> <p><i>Infant education:</i> Infants who can only be taught by their peers and human teachers, not machines, because they are learning socialization.</p> <p><i>Philosophy:</i> The path to self-actualization in a competitive society.</p> <p><i>Sports:</i> Coaching for professionals and amateurs.</p> <p><i>Entertainment:</i> Teachers of music, dance, comedy, acting, etc.</p> <p><i>Psychiatry:</i> Teaching contentment and self-actualization through wisdom, rather than drugs. Similar to philosophy, but for people who have encountered problems due to stress.</p> <p><i>Eugenics:</i> Advisor to parents about the genetic knowledge that will be used to avoid hereditary diseases, and to promote a healthy, thriving, human species.</p>

Discovering gender-based work preferences

The second objective of this investigation is to consider the occupational roles of men and women throughout prehistory and history, and to survey the ideal occupational preferences of the two genders. It is useful, for example, to answer the question to what degree do modern humans decide their occupations on the basis of aptitude and personal interest, and to what degree do economic pressures force individuals to prioritize income over passion.

Let's remind ourselves of how our early ancestors lived. The first people on earth, according to anthropologists, lived in Africa about 1.7 million years ago, and people continued to live in small bands of hunter-gatherers until about 10,000 years ago. This means that all men and women have worked in entirely different roles for about 1.7 million years – about 99.99% of the history of humans – while in a few modern industrialized countries, the two genders have worked in almost identical roles for only about 70 years since World War Two. During the hunter-gathering phase, men and women spent much of their time in separate groups, carrying out the different social and work functions for which they were extremely well adapted by evolution. For example, men did most of the hunting, protected their families and slightly dominated in managing relations with other groups. Women controlled domestic affairs, gave birth, did more than half of the child raising and gathered essential plant food. Both these gender roles were essential to maintaining human communities, and therefore the sexes were of equal status, according to anthropological research (Sahlins, 1972).

Separate traditional male and female roles continued through the agricultural age, but in the 19th century, the birth rate of industrialized nations dropped sharply, and in the 20th century, women began to go out to work in the same labour market as men. The policies of modern governments have altered the incentives for women, who now have a choice between earning similar salaries to men in a career, or doing what is considered as menial unpaid work, giving birth to, and raising, children. The birth rate is now radically below replacement level, marriage rates have dropped greatly, and normal family environment for children is no longer possible for the majority of people in the most industrialized societies. The question raised by these changes is whether women – or men – want these changes, or whether modern work preferences are the result of bad economic planning. Giving birth and raising children are arguably the most important “tasks” that anybody can do, yet they are unpaid, which represents an anomaly in the labour market.

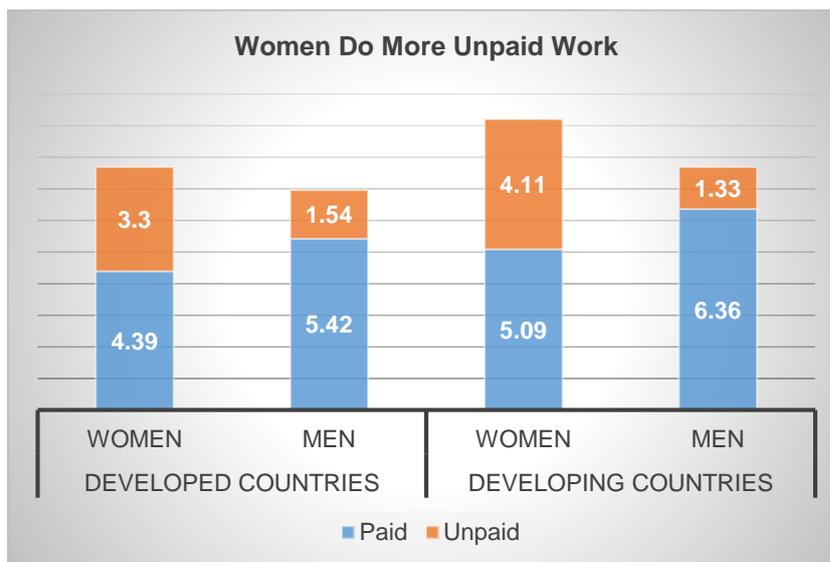


Figure 5: Women do more unpaid work (Data from: UN Women, 2016)

To solve this problem of modern society, it is necessary to determine whether the identical work roles of males and females is really a useful and natural adaptation, or one that is enforced by technological accident, like, for example, pollution.

Our second research objective is to discover whether men and women would prefer to work mainly in their traditional gender roles, provided that the economic system supported natural human social relationships. There is strong opposition to this view from those pursuing gender equality. One paper states, "But it is impossible to demonstrate scientifically the existence of biological differences between women and men which suit either sex for particular jobs." (Messing, 1982). However, there are a great number of scientific studies which show that men and women are specialized for different kinds of work. A single paper (Gershoni & Pietrokovski, 2017) reports the discovery of 6,500 genes that generate different traits in males and females. While we know that men and women have similar intelligence and capabilities, if they are adapted by nature to occupy slightly different roles, then understanding these factors may be important to the job satisfaction of both sexes.

There is much evidence that women in many societies are dissatisfied with their dual role, as they are pressurized to remain unpaid primary caregivers in the home, even though they work in the job market alongside men. Some women feel that men should share domestic work equally. Another view is that men and women should both be paid for domestic work, but it is not clear who should pay for it. A major aspect of domestic work is childbirth, breast-feeding and childcare, which may stretch over long periods. The economic disincentives facing women who only work in the home is also related to the drop in human reproduction rates in industrialized societies, which threatens the long-term existence of such populations.

The global value of women's work may well be higher than that of men's work, but much of the work done by females is not paid, and traditionally, women have played a more subordinate role in the economy than men. Men are also dissatisfied with the loss of many industrial jobs that were traditionally taken by males. Some men complain that welfare systems increasingly replace the traditional role of husbands in the family.

As we enter the era in which automation will eliminate most industrial occupations, all societies will have to consider how to migrate to new working patterns. This could involve radical changes to the work done by men and women, and perhaps to the organization of family life.

When these changes come, the adjustments made to occupational roles will also be deeply affected by the needs of society to maintain a stable family environment for the raising of children. Ultimately, the limiting factors are unlikely to be wealth, or productivity, which are likely to expand rapidly in the era of automated industrial production; the limiting factor will be the biologically based preferences of men and women to live in a society with a stable family environment that will support the best possible nurturing of children.

Investigating the effect of reduced hierarchy on the work market

The third objective of the OUM study is to investigate the consequences of reduced hierarchy throughout the business world, with the tendency for highly collaborative working groups with little or no formal hierarchy to replace the traditional command structure of large corporations. Apparently associated with this flattening of enterprises is the steady increase of gig economy, comprising contingent or on-demand work, freelancing, consultancy, and entrepreneurial start-ups.

Questions related to this trend include whether freelance workers can acquire multiple clients and insure themselves against the total loss of income accompanying loss of employment. Another question is whether workers who give up employment and participate directly in the market can experience more vocational passion or self-actualization as a result of free choice. An issue that concerns the whole of society is whether a decline in employment and an increase in people working autonomously in the market as freelancers or entrepreneurs will increase the unity of the whole business workforce, by abolishing class divisions between employees and employers. The antagonism between trade unions and management that still persists today surely had its foundation in the hierarchical early factory system, which Karl Marx criticized as based on the exploitation of the proletariat by the bourgeoisie.

Education will prepare students for the new work environment

Education has a vital role to play in easing in societal changes brought about by the end of the Industrial Era, and the loss of millions of jobs to automation. The Industrial Era has greatly raised the standard of living for developed societies, but the cost has been that many people have to do work that is dirty, dangerous or dull (see Figure 6).



Figure 6: Technology-support work is often dirty, dangerous or dull, such as coal miner (left), deep-sea diver (centre) and retail cashier (right).

It seems likely, however, that the range of paid occupations available to the next generation will be greatly altered by the impact of AI and other automation technologies. This and the accelerating rate of change of technology will oblige all societies to review their educational

resources. Meanwhile, the absence of specific knowledge about the likely changes to the market for work presents a challenge to educational planners.

CONCLUSION

The main objective of this investigation is to determine the most likely changes in human occupations that will result from the global application of advanced automation technologies, especially AI. In the findings and discussion part of this study, we predicted that AI systems will eventually replace almost all workers in technology-support occupations but human workers will retain human performance-related occupations. It is hoped this study will identify some of the issues raised by radical occupational change that can be addressed by new kinds of education. Mandatory state education is a global standard that was formulated for the 19th century Industrial Revolution to provide obedient workers for European factories and armies. Modern schools have improved but the basic model has never been radically reformulated. As we near the end of the Industrial Era, it is appropriate to consider how education can assist in alleviating the effect of rapid changes in the market for human workers.

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