CHAPTER 8

Robotics, Artificial Intelligence, and the Evolving Nature of Work

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Introduction

In their thought-provoking paper Brynjolffson and McAfee (2015) ask the question 'Will humans go the way of horses?' and they have good ground to do so. Human labour has been largely replaced by machines in ways that consumers can understand and this has been going on for decades. For example, many will have a historical memory of going to a bank during the bank's hours of operation to make a withdrawal of cash. Now, consumers regularly go to machines to make cash withdrawals from the accounts and the labour for making the transaction is largely mechanized. While much work in the service industry is still based upon human labour, manufacturing is much more automated. While humans may still be needed to perform many commercial operations, human labour is much less critical than it had been at any time before in history.

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Recent advances in robotics, artificial intelligence, and automation technologies (RAIA) (Bhaumik, 2018; Miller & Miller, 2017; Neapolitan & Jiang, 2013; Russell & Norvig, 2016; Warwick, 2012) have allowed companies from various sectors of the economy to adopt RAIA in search of lower costs, faster production time, provision of consistent product quality, management of supply chain operations, etc. While initially it was the manufacturing that used industrial robots (Colestock, 2005; Cubero, 2007; Low, 2007; Pires, 2007), currently all other sectors of the economy and society intensively adopt RAIA technologies: from supply chain management (Min, 2010), agriculture (Driessen & Heutinck, 2015), autonomous vehicles (Maurer, Gerdes, Lenz, & Winner, 2016), and warfare (Crootof, 2015; Sparrow, 2007), through travel, tourism, and hospitality (Ivanov & Webster, 2018; Ivanov, Webster, & Berezina, 2017; Murphy, Hofacker, & Gretzel, 2017), education (Ivanov, 2016; Timms, 2016), journalism (Clerwall, 2014), provision of legal (Remus & Levy, 2015), and other services (Huang & Rust, 2018; Wirtz et al., 2018), to trading on the financial markets (Dunis, Middleton, Karathanasopolous, & Theofilatos, 2017), and implementing medical operations (Kaur, 2012; Mirheydar & Parsons, 2013; Schommer, Patel, Mouraviev, Thomas, & Thiel, 2017). Both large and small companies use chatbots to communicate and maintain their relationship with customers (Hill, Ford, & Farreras, 2015; Xu, Liu, Guo, Sinha, & Akkiraju, 2017). Social robots enter actively our lives (Agah, Cabibihan, Howard, Salichs, & He, 2016; Nørskov, 2016; Royakkers & van Est, 2016), and already redefine our understanding of 'sex' (Cheok, Devlin, & Levy, 2017; Lee, 2017). These brief examples reveal the overwhelming intertwining of RAIA technologies into the fabric of society, leading to huge transformations of the ways humans live, work, and do business (Makridakis, 2017; Talwar, 2015; Talwar, Wells, Whittington, Koury, & Romero, 2017). Some authors even state that economists and marketers need to broaden their definition of a 'consumer' to include robots in it (Ivanov & Webster, 2017).

The advances in RAIA technologies are expected to accelerate in the future and some researchers consider the possibility that artificial intelligence might at one point surpass human intelligence—a point of time usually referred to as 'technological singularity' (Callaghan, Miller, Yampolskiy, & Armstrong, 2017; Kurzweil, 2005; Shanahan, 2015). While we do not know whether silicon will surpass carbon in terms of intelligences and whether transhumanism and human augmentation through microchip brain implants is a viable future and not science fiction,

we are sure that technological advances in RAIA, Industry 4.0 (Andelfinger & Hänisch, 2017; Schwab, 2016; Skilton & Hovsepian, 2018), and the Internet of things (Sendler, 2018) are challenging the role of human labour as a production factor to a point when all or an overwhelming share of goods and services are delivered by RAIA technologies instead of human employees. Such an economic system is called 'robonomics' (Crews, 2016; Ivanov, 2017). Experts' opinions about that automated robot-based economy and society are not uniform. One group of researchers expresses explicit fear of AI technologies (Barrat, 2013; Bostrum, 2014; Crews, 2016; Leonhard, 2016), considers the self-aware AI as 'our final invention' (Barrat, 2013) and paints dystopian dooms-day Terminator-like scenarios for the human species. Others seem overly optimistic and perceive technology as the ultimate utopian solution to all human problems, including the merger between humans and machines (Kurzweil, 2005). The majority of authors, however, take a more pragmatic approach and see the opportunities that AI and robonomics as an economic system would create like extended life expectancy, improved health and quality of life, more time for activities people value, to name just a few (Brynjolfsson & McAfee, 2014; Frank, Roehring, & Pring, 2017; LaGrandeur & Hughes, 2017; Talwar, 2015; Talwar et al., 2017), although the expected radical abundance of goods and services that technology experts promise (Drexler, 2013) may not benefit all stakeholders.

Within this domain of thought, the future of human's work and the impacts of digitalization and automation on the labour market have received a great deal of attention by researchers (e.g., Alasoini, 2017; Association for Advancing Automation, 2017; Daugherty & Wilson, 2018; Ford, 2009, 2015; Frank et al., 2017; Harteis, 2018; Kaplan, 2015; Kauhanen, 2016; West, 2018). As a matter of fact, in a recent highly cited research, Frey and Osborne (2017) assess that 47% of US jobs are already susceptible to computerization. Some jobs are very obviously on the brink of extinction. For example, the most common job in 29 of the 50 states in the United States is the 'truck driver,' according to 2014 data (NPR, 2015) and the self-driving car/truck (a technology on the brink of being viable on the road) will almost immediately lead to the unemployment of these workers (Solon, 2016).

This raises justified concerns among researchers, politicians, and industry representatives how people, companies, economies, governments, and societies as a whole would need to adapt to the new technological, economic, social, and political realities that robonomics would create. For

example, in 2016, the Executive Office of the President of the United States, National Science and Technology Council, and the Committee on Technology published three documents intended to prepare the US economy for the age of automation: *The National Artificial Intelligence Research and Development Strategic Plan* (2016), *Preparing for The Future of Artificial Intelligence* (2016), and *Artificial Intelligence, Automation, and the Economy* (2016). In the same manner, in 2017, OECD published an extensive report dedicated to the implications of automation for businesses and governments (OECD, 2017), while the World Economic Forum published annual reports on the future of jobs (WEF, 2016, 2018).

This chapter contributes to the body of knowledge by elaborating on the impacts of RAIA technologies on the labour market and the nature of work. This chapter looks into such things as the employment dilemma (Giarini & Liedtke, 1996), an issue related to the human need to have productive work and the modern industrial capability for productivity. It also looks into the issue of the human Luddite possibilities, as humans should have a fear of being replaced by robots (Lehman, 2015; McClure, 2017). In addition, the chapter also looks into the issue of the ethical use of robots (Lin, Abney, & Bekey, 2014), as robots are not merely replacements of human labour but also entails a real impact upon the human population.

The Economics of Robotics and AI

The first element to look into is the issue of why RAIA technologies are being implemented. The obvious reasons for the implementation are the overlap between the technological abilities that now exist and the need for efficiency and cost-effective production. While the concept of the robot was invented in 1920 (NPR, 2011), the robot (and more importantly the intelligent robot) was a thing of the future and not entirely practical. By the 1980s, robots were being utilized widely in manufacturing, although service industries have generally lagged behind in the use of robots.

At its heart, the current robotic economy undermines the economic principle of the labour theory of value was ascribed to by such thinkers as Karl Marx, Adam Smith, and David Ricardo. While traditional economic theory identifies land, labour, and capital (and sometimes also 'enterprise' or 'entrepreneurship' as the factors of production), we see a shift in the stress on which of these factors is most critical. Traditional economic theory holds that human labour is a necessary factor for the production of

wealth, meaning that human labour is critical in the productive process, something that any casual reading of Marx makes very clear. However, with the rapid advances in robotics and artificial intelligence, human labour is much less stressed as a necessary input, and this will be increasingly true once robots are used to produce robots.

The widespread implementation of a robotic economy will lead to a new economic and social landscape in which there will be winners and losers. Since the technological capability to replace human labour with increasingly sophisticated technologies exists, those humans with labour to sell that can be replaced easily and cheaply with new technologies will be replaced, leading to a new political economy of robots (Kiggins, 2018). This will be a new world in which most labour in terms of production of goods and services is created by machines, meaning that humans will be increasingly marginalized from the productive process, although there is the enduring question of whether robots will largely be used as complements to human labour or substitutes to human labour (DeCanio, 2016).

Another political and economic trend that will impact upon the new economy is a by-product of the globalized economy. Since economies are now interconnected as never before and there are massive advantages to those who conquer a market early, since markets tend to be big and the ability to penetrate such markets. What we can expect in markets is the markets will increasingly gravitate towards 'winner-take-all' markets (Brynjolfsson & McAfee, 2014). There are a number of reasons for this, including the digitalization, improvements in communications (and transportation), and the increased importance of networks and standards. In other words, the economy is now different, as global markets enable consumers to have access to information with regards to goods and services and information costs with regards to products and transportation of products is dropped, and networks enable the spread of information and good and services as never before. Economies of scale develop, enabling the establishment of near monopolies, as penetrating markets outside of prevailing channels and networks becomes increasingly difficult for start-ups.

The value of labour and the way that labour is treated can be understood by its value in the market. The relationship between increased labour productivity and wages in the United States tell an interesting story. While the data in the United States show massive increases in productivity per worker since the 1950s, by the mid-1970s, increases in salaries have not kept up with increases in productivity (Watson, 2018). It seems that companies see

no need to compensate workers for their productivity, resulting in an outcome that has a massive impact upon the economy and society, people who are employed and productive but do not experience salary/wage increases as a result of their labour. It is also suggestive that workers are so productive that there are underemployed populations driving the real wages down. What is most interesting is that this is occurring in economies in which there are demographic declines, meaning that the available labour pool is generally shrinking and will continue to shrink. Another issue is the question of the sustainability of such economies, as machines do not consume many goods nor services, unlike humans (Ford, 2015, p. 196). This means that economies may suffer in the future, as machines do not consume the way that humans do. Manufacturers may be producing high-quality goods at a low price per unit, but the question remains who will be able to purchase the goods and services, when salaries remain relatively flat in many countries.

Directions of RAIA Impacts on the Labour Market

For us human mortals living today, we will have to contend with the massive changes that robotics and artificial intelligence will do to the labour market in the next 10, 20, or more years. While we understand that in 100 years, the production and service landscape will change dramatically because the capability of technologies that we now are impressed with will seem very primitive, we have to prepare for the nearer future. In the nearer future, we can expect some major impacts that are almost predictable, such as the automation of a great deal of the transportation with self-driving trucks and cars. At any rate, there will be an impact upon different countries in different ways based upon the country's current level of development and social/technological factors. There will also be some impact upon social structures and the mobility of populations, as well as the mobility of production. At any rate, legislation will have to change a great deal and the legal/political elements as well.

The first and major impact of technologies will be the elimination of jobs via automation (Frank et al., 2017), although there will be many jobs lost, there will also be the creation of new jobs and the changing face of other jobs. Some publications have discussed various solutions to how technological unemployment can be dealt with (Stevens & Marchant, 2017; Swan, 2017). Many of the jobs we now see exist in the market will be changed a great deal with many jobs being de-skilled, re-skilled, or

upskilled in terms of their tasks associated with them. There is also a geographical element to this, as well. There is an indication that automation of many tasks may enable production to take place in places in which labour costs are notoriously high such as Germany, where shoe production is now taking place (Wiener, 2017) presumably because the other factors of production are equal to or lower than in Asia and labour costs approach zero because of automation. Production may return to the Western economies, as labour costs will largely be bypassed and production may now be done in ways that lower transportation costs.

Another major impact that will occur is the quality of the jobs that persist. Humans will likely continue to do some of the work that robots and computers will not yet be able to do and some of the jobs are rather surprising. For example, while we can reasonably expect that artificial intelligence can handle most of service complaints and inquiries from humans, most robots have a hard time doing some activities that many humans find very simple, such as opening doors. It seems that there will be a need for humans to do many of the physical tasks that machines cannot do or at least do well, although it is possible that social changes may work in ways to bypass this. For example, while currently no robots can change the sheets on a bed well, it is possible that hotels in the future could hand guests clean sheets and insist that the guests make their own beds, bypassing the need to pay for human labour to change the sheets on the bed. Such a social/cultural shift may be accepted by hotel guests, if there are cost advantages.

Because of the disruption of advanced robotics and artificial intelligence into the production of goods and services, humans will likely have to find a niche in the world's gig economy. Since human labour will be increasingly relegated to physical or mental tasks that humans can still perform better than machines, humans will have to hustle, doing jobs that machines cannot yet do well nor as effectively as machines. One of the problems that will be a political outcome of this is that many people will be reliant upon short-term tasks and jobs that may exist below the radar of tax authorities and do not supply the human with the legal and social protections that a person would have with a full-time job that exists above the board. How males and females will work under these conditions and survive under such conditions will be interesting, but it is so far unknown how the sexes will either react or flourish under such unstable and shifting work environments (Schwab, 2016).

The class differences will increase, as has been the case in nearly all developed countries in recent decades, since labour will consist of skilled knowledge-based workers and less-skilled workers. Those that are less skilled will constantly run into competition with robots and artificial intelligence that will undermine the value of labour (Economic Times, 2018). There will be some specializations that remain difficult to replace with robots or artificial intelligence, and these positions will continue to function, although there will be downward pressures upon such jobs, as the demand remains equal, the supply of labour for such jobs will decrease the returns for those working such jobs. However, those who feel secure with skills and are knowledge workers should not feel too secure, as there are technological changes that can make their labour redundant. For example, university professors now teach many online courses. Such courses are generally done for the convenience of the students, but there are risks for the teachers, as many courses may rely on exams/tests that are multiple choice and can already be graded with very basic computer technology, and it may not be long before computers can grade and give intelligent feedback to students on essays (see also Ivanov, 2016).

We can also expect that the disruptions that will take place will have a massive reaction among the public and there should be political responses. Since humans may be less key to the production of goods and services and many humans will be replaced with robotic/AI labour, what should be done to sustain the economy and sustain the political economy? A likely answer spoken about is guaranteeing humans a universal basic income (Santens, 2017; Sheahen, 2012). This income would have the stabilizing impact by ensuring that human consumers can purchase the goods and services that a largely automated economy would produce. Paying for such a plan would require a different form of taxation from how taxation is now considered, as a great deal of taxation in economies stems from the taxation of the wages of working people. So with a reduction in the number of humans working and paying taxes on their incomes and the reduction of jobs, entire new systems of taxation will have to be created. The current economy and its laws presume human labourers paying taxes upon their salaries and presumes that such human labour is necessary to sustain economies. Laws also presume that people are engaged in full-time employment in which people have stable incomes and benefits, meaning that many of the laws that now exist regulating labour presume an old-fashioned industrial model of labour. But the new economy, to a large extent, depends upon gigs and short-term contracts and laws have not kept up with these changes.

Staying Competitive on the Labour Market

The future, at least the near future, is one that requires a skilled workforce. Table 8.1 lists the top ten job skills the World Economic Forum (2018) feels the workforce should have in 2020. The list of skills seems to be uniquely intellectual and emotional in nature. There is no mention of physical strength or physical agility. According to the World Economic Forum (2018), the skills needed are intellectual and emotional in nature, including solving complex problems, critical thinking, and coordinating with others.

These key skills identified by the World Economic Forum presumes that the competitive advantage that humans have over robots and artificial intelligence is not based upon physicality but upon intellectual capabilities and the ability to interpret the emotional landscape of the workplace. The development of such skills would reasonably thought to be developed by people through education/training, experience, and naturally occurring intellectual ability. What this implies is that education will have to work in ways to cultivate those talents that only humans at this point in time can develop in ways that are useful in the economy (creativity, complex communication skills, emotional intelligence, etc.). The need to further develop these very human capabilities will have to depend upon an educational system that is based upon an old industrial model from a previous century, presuming a tiered system of education that would build skills that are permanent. The new economy will likely need a new approach to education, one that is based upon the development of human skills rather than building of knowledge and will have to retool to consider the needs

Table 8.1 Top ten job skills needed in 2020

Rank	*Skill*
1.	Complex Problem Solving
2.	Critical Thinking
3.	Creativity
4.	People Management
5.	Coordinating with Others
6.	Emotional Intelligence
7.	Judgement and Decision Making
8.	Service Orientation
9.	Negotiation
10.	Cognitive Flexibility

Source: World Economic Forum (2018)

of people in the workforce who will have to pick up new skills to be relevant in a flexible and changing economy. Since many employees will change jobs and industries, they will need relevant education that will enable them to have relevant skills in the new positions that they take in different companies and fields. Companies will also have to pick up some of the responsibility for the training and retraining of employees and such responsibility should not be the sole responsibility of universities, entities comfortably insulated from the economy in many respects.

Apart from how individuals and how the educational systems will have to change, industry will also have to change. In the short run, for companies to stay relevant and competitive, companies will have to invest in robots and artificial intelligence. While such investments may require investments upfront, such investments will assist in the transition to the new economy, despite the risks and hiccups in the system. The changeover for most industries is a sure thing. While adopting some technologies later may offer some advantages, adopting early may enable the customers and workforce to adjust to the new realities and work in ways that are more effective and efficient.

Conclusion

Humans have been on the Earth for quite some time and we hope that the species will persist. While humans probably will not go the way of the horses (Brynjolffson & McAfee, 2015), there are massive changes caused by technological advances that humans need to be aware of and must adjust to. First, we expect that humans will be removed increasingly from the production of goods and services. Human labour will remain one the factors of production but is decreasingly the key component in the production process. The qualities that the human labourer has and brings to the table in the factors of production will remain the ability to create, to interpret, and to work with others. The human will also be prized in the near future for the physical ability to do things that many robots have a hard time doing well and quickly (opening doors, walking, and other physical things), the human will remain a great multi-purpose tool that can negotiate the geography of a house or office space. But the flooding of labour markets with labour displaced by robots and artificial intelligence will mean that such physical jobs will be flooded.

For humans, those lacking the skills to compete in the new economy will be competing against each other. Skills that so far are unique to

humans will have to be developed for many workers to remain relevant. Problem solving, emotional intelligence, interpersonal communications, and other skills that humans can do well if they are sophisticated enough to do it will enable humans to remain relevant in the new economy. But the traditional establishments that train humans will have to adjust to the needs of the new economy and the demands upon workers.

Second, the political and legal system has to take account of the new economy. As labour becomes more flexible and concentrated upon gigs and contracts, governments and taxation systems have to keep up with the new economic reality. From the perspective of the government, the traditional way of taxing working people will be less prevalent and the persistence of the gig economy/sharing economy will mean that taxation systems will have to be amended to remain relevant in an economy that has changed. Taxation will change and keeping the new economy stable and healthy will have to rely on different thinking. With a large number of workers who are not needed, guaranteeing that people have a reliable way of living, especially if they are not needed in the workforce, is a necessity. One easy way to adjust for this is the guarantee of a minimal income for all, an idea that may seem radical but has a long history and has become quite popular to speak about in recent years (see, for example, Caputo, 2012; Stern, 2016). The stability of the political economy rests upon the need to have consumers who use products and services and the lack of the need for much of the labour available in the economy means that much of the workforce will be competing for de-skilled jobs and with people who have lost their jobs due to increasing robotization of the workplace.

Finally, there is the major concern about the assumptions of the human's ability to be able to be relevant in the new economy. While the World Economic Forum (2018) can identify skills needed in the workplace, it is a question as to whether all humans have the ability to develop skills that are needed by industry. While there are some who may contend that IQ is a meaningful concept (Gould, 1996), most agree that there is variation in each human's ability to absorb, retain, and process information. Unless it is found that all humans have roughly the same intellectual capacity to develop the skills needed for the new economy, it would seem that many would be excluded from the new economy, simply because of their incapacity to develop the skills needed. It could be, then, that a substantial portion of humanity could be excluded from the new economy, simply because of a lack of the ability to develop the skills needed to compete as a human in the economy.

In conclusion, humans are entering a new age, an age of mechanical reproduction that is unlike anything envisioned before. While humans may remain a factor of production, they may be decreasingly critical in terms of the terms of physicality of work and even more critical in terms of the intellectual needs of the workplace. At any rate, the role of the human will be different. As a result, many of the institutions that are part of the economy, such as government and education, will have to change to be relevant and consistent with the needs of a society that has an increasingly automated productive base.

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