



Preparing the workforce for the Fourth Industrial Revolution *July 2018 update*

1. Introduction and overview

The world of work of 2020 and beyond will be significantly different from the workplace most of us know today. Therefore, it is crucial for leaders in government and the private sector to understand the major shifts resulting from the “*exponential pace of change (that is) disrupting every industry in every country (and) impacting every aspect of how we work and how we live, creating threats and opportunities*”. (Morgan, 2016) Similarly, the government, industry bodies and other policy makers must rethink the skills strategies that are failing to prepare the current and future workforce for the Fourth Industrial Revolution.

These exponential disruptions will not affect all industries and occupations to the same extent or at the same pace. However, ignoring the impact of the Fourth Industrial Revolution is as short-sighted as believing five years ago that the internet and electronic communication would have little impact on our work and lives.

The aim of this paper is to raise awareness of the areas in which our skills strategies are failing to prepare the workforce for the changes that we will experience in the next five to ten years. The paper:

- Explains the future world of work;
- The nature of the disruptive technologies of the Fourth Industrial Revolution and their impact on the work environment;
- Identifies some changes needed in workforce development strategies; and
- Concludes with a description of the skills that are required by the workforce beyond 2020.

References to interesting videos and websites as well as relevant publications are provided at the end.

2. The Fourth Industrial Revolution

2.1 Transition from the First to Fourth Industrial Revolutions

“The First Industrial Revolution used water and steam power to mechanize production. The Second used electric power to create mass production. The Third (the digital revolution) used electronics and information technology to automate production. ... (The Fourth is) characterized by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres. When compared with previous industrial revolutions, the Fourth is evolving at an exponential rather than a linear pace. Moreover, it is disrupting



almost every industry in every country. And the breadth and depth of these changes herald the transformation of entire systems of production, management, and governance. The bottom line, however, is the same: business leaders and senior executives need to understand their changing environment, challenge the assumptions of their operating teams, and relentlessly and continuously innovate." (WEF, 2016a) (Underlining added)

2.2 Disruptive Technologies of the new world of work

Major changes in the world of work are brought about by 'disruptive technologies', labelled as such because they significantly disrupt the global economy, how businesses operate and the way we work and live.

"... the acceleration of innovation and the velocity of disruption (brought about by these technologies) are hard to comprehend or anticipate and these drivers constitute a source of constant surprise, even for the best connected and most well informed. Indeed, across all industries, there is clear evidence that the technologies that underpin the Fourth Industrial Revolution are having a major impact on businesses." (WEF, 2016a)

Examples of these disruptive technologies are: (McKinsey Global Institute, 2013)

- Advanced robotics: increasingly capable robots or robotic tools with enhanced 'senses,' dexterity and intelligence can take on tasks once thought too delicate or uneconomical to automate;
- The 'internet of things': the network of physical devices, vehicles, buildings and other objects embedded with electronics, software, sensors, actuators and network connectivity that enable them to collect, exchange data and 'talk to one another';
- Artificial intelligence exhibited by machines that work and react like humans and are capable of speech recognition, visual perception, decision-making, problem solving and learning;
- Devices and physical systems that store energy for later use that could make electric vehicles cost competitive and bring electricity to remote areas of developing countries; and
- Drones, cloud technology, nanotechnology, virtual reality, software-based digital therapies, next-generation genomics, 3D printing and driverless vehicles.

These disruptive technologies are no longer science fiction. General Electric has designed robots that can climb and maintain wind turbines. A 3D printer in the Netherlands built a footbridge over a canal by using long robotic arms and lasers to melt the metal powder – without the help of human hands, girders or concrete foundations. Self-driving robots can deliver parcels and groceries anywhere within a three-mile radius using less energy than most light bulbs. Motor manufacturers are already road testing driverless cars, and the head of Ford predicts that in the future driving with a steering wheel will be "*as antiquated as wanting to ride a horse*". (The Edge Foundation, 2016) On 25 August 2016 Singapore launched a trial and "became the first country in the world to have on-demand driverless taxis – a new technology that is touted to disrupt the transport industry". (<http://www.straitstimes.com>)

2.3 Half-life of knowledge and skills

New knowledge is being created at an accelerating pace contributing towards the 'half-life' of knowledge and skills, which become obsolete at an equally rapid pace. The result is that there is too much knowledge for us to know everything we need to know, and we are so overwhelmed by the information overload that we find it difficult to sift out relevant information. At the same time, much of



what we know is no longer valid or relevant to our work, with the lifespan of our skills ever shrinking. We therefore find it increasingly difficult to maintain the level of knowledge and skills required in our current jobs – let alone the skills we will require in our future jobs.

3. The unknown and unpredictable future world of work

The future world of work is unknown and unpredictable, as confirmed by the 2016 University of Oxford report: *The Future Is Not What It Used to Be*. In fact, it is incorrect to speak about the ‘future world’ because the future is already here. Mark Shuttleworth, successful entrepreneur and the first African in space warns: “*Technology and society are evolving so fast that you can’t rely on tradition and tried and tested techniques to teach you how to perform in the future*”.

3.1 Technology-driven changes in organisations and employment

Disruptive technologies are already having a significant impact on the nature of work, work relationships and organisations. These changes will also have a massive impact on society, contributing to large-scale job losses for workers who are not equipped with the right skills, as well as personal trauma and social unrest as employees struggle to cope with the uncertainty and instability of the new work environment.

3.2 Changes in the nature of work and occupations

The Fourth Industrial Revolution will have a wide-ranging impact on how and where we work, the occupations in which we work, our relationship to our ‘employer’, and the way we earn ‘our daily bread’. Studies of new employment in the United States between 2005 and 2015, found that about 94 percent of net new employment was from alternative work arrangements. (Deloitte, 2017: 36)

- **Existing occupations will disappear.** Travel and estate agents, postmen, lecturers, publishers of textbooks and many other occupations have had to fundamentally change their business models or find new ways of earning a living.
- **New jobs will emerge** that we cannot even imagine now. We are already grappling to understand new occupations such as the Director of Intellectual Capital, Ethical Hacker, Cybrarian, Cyber Lawyer, Information Security Auditor and occupations created by e-commerce.
- More **hybrid jobs** will develop that require an integration of skills from diverse domains: technical expertise (in one or more domains) integrated with expertise in data analysis, statistics, maths, design, problem solving and project management, as well as teamwork and creativity.
- We are beginning to see the **end of the fixed job description**. More jobs might have only the core functions described, with employees having to figure the rest out as they continuously adapt to new technology and the changing work context.
- More work will be done by **cross-functional project teams** working together in temporary relationships, and collaborating through virtual communication across time zones, space and organisational boundaries.
- A large part of the workforce is already moving into **jobs of short duration**, which require workers to be more flexible, multi-skilled and continuously learning new skills.
- More and more people will work in **virtual organisations** without a central office, an organogram or job description. Individuals with particular expertise will get together



temporarily in ad hoc working relationships to work on a project, with the relationship ending when the project is completed.

- **The ‘office’ won’t be the place you go to for work.** Less people will need to drive to a building to work during set office hours; they will join the new workforce whose ‘office’ is where they can interact with people across the world through devices connected to the internet.

We have to prepare the workforce to work with shifting, constantly changing and less prescriptive job descriptions – or possibly work without job descriptions as we know them. The same will apply to occupations, forcing us to accept broad occupational descriptions without clear and relatively stable sets of skills requirements. Careers will become increasingly unpredictable and undefined, and require us to explore multi-role, flexible career paths rooted in ongoing learning.

3.3 Changes in employer-employee relationships

Changes in the nature of work and jobs will inevitably result in a significant shift in employment patterns, with less permanent employer-employee relationships. We have already seen the end of one-job-for-a-lifetime with one employer, moving up the ladder to a senior position in the same occupation, and then retiring with a pension. A 2015 study of the International Labour Organization (ILO) confirmed that:

“Fewer than 45 per cent of wage and salaried workers are employed on a full-time, permanent basis and even that share appears to be declining. This means that nearly six out of ten wage and salaried workers worldwide are in either part-time or temporary forms of wage and salaried employment. Women are disproportionately represented among those in temporary and part-time forms of wage and salaried employment.”

The relationship between employer and worker is shifting, with a larger part of the workforce being engaged in alternative work arrangements, such as freelancing or contract-based work, as well as people working for more than one organisation at the same time. This will be increasingly common in ‘the gig economy’: a labour market characterised by flexible, on-demand work in short-term contracts or freelance work. Workers are paid for each ‘gig’ they do, such as a car journey (UBER), letting a room to tourists (Airbnb), or delivering food (Mr Delivery) – but none of them will earn a regular salary.

The main benefit for organisations is that they will be able to benefit from a pool of highly skilled freelance specialists who they can draw in as needed, either to supplement internal expertise or as replacement for employed staff.

3.4 The job loss crisis

Job losses are the reality of the future workplace, no matter how many labour unions or political parties strike against it, or how many politicians promise job creation. Clem Sunter, scenario planner and futurologist (2015) confirms this trend:

“We have been saying for years that the world of work has changed forever and we are never going back to the mass employment conditions of the last century. Technology has driven a shaft through many jobs, companies are cutting back on their permanent work-forces by sub-contracting all their non-core activities to others and we now have the concept of on-demand employment where you are hired for a specific time to do a specific job”.



A 2016 World Bank Development Report found that the following percentages of jobs are at risk from automation: 85% in Ethiopia, 77% in China, 69% in India, 67% in South Africa, 65% in Nigeria, 35% in the UK, and 47% in the USA. (University of Oxford) A *Financial Times* article, Artificial Intelligence and Robotics, reports on a factory in China where nine robots do the work of 140 full-time workers. The article quotes a Hong Kong economist who states that “*industrial laggards in parts of Asia and Africa face a ‘race against the machines’ as they struggle to create sufficient manufacturing jobs before they are wiped out by the gathering robot army in China and beyond*”. (Bland, 2016)

4. Skills required by the workforce of 2020

The WEF (2016c) predicts that more than 35% of the skills considered important in today’s workforce will have changed within five years. “*What is certain is that the future workforce will need to align its skillset to keep pace.*” What skills will the workforce of 2020 and beyond need?

4.1 Preparing for a new partnership with machines

Technological literacy skills will be essential to “*use technology to create and capture value*”. (The Edge Foundation, 2016)

“We are on the cusp of a major transformation in our relationships with our tools. Over the next decade, new smart machines will enter offices, factories, and homes in numbers we have never seen before. They will become integral to production, teaching, combat, medicine, security, and virtually every domain of our lives. As these machines replace humans in some tasks, and augment them in others, their largest impact may be less obvious: their very presence among us will force us to confront important questions.

- *What are humans uniquely good at?*
- *What is our comparative advantage?*
- *And what is our place alongside these machines?*

In some areas, a new generation of automated systems will replace humans, freeing us up to do the things we are good at and actually enjoy. In other domains, the machines will become our collaborators, augmenting our own skills and abilities. ... We will be entering into a new kind of partnership with machines that will build on our mutual strengths, resulting in a new level of human-machine collaboration and co-dependence.” (Institute for the Future, 2011)

4.2 Combining technological and human skills

Knowledge is very important in the Knowledge Era to deal with the disruption of the Fourth Industrial Revolution, but not just any knowledge: we need knowledge of technical domains. A study showed that it is not the technology that contributes most to productivity improvement, but the knowledge of how to make the best use of technology in particular work contexts. A self-driving car doesn’t have the knowledge or understanding required to respond correctly to a traffic light – it relies on the knowledge that has been embedded into the car.

“The real challenge for workers may lie not in being replaced by a machine but in how to reskill to work side-by-side with the new tools and capabilities that advanced technologies bring.” (Deloitte, 2017: 197)



The Deloitte research (69 & 83), confirmed that the reconfiguration of jobs, occupations and careers clearly require us to rethink the types of skills needed in this rapidly changing work environment and highlighted the following skills:

- **Technological fluency** will be essential: i.e. a detailed working knowledge of how technological capabilities can drive new revenue and open fresh opportunities, being able to identify future disruptive opportunities opened up by emerging innovation and using that foresight to create sustainable competitive advantage.
- **Skills in STEM fields** (science, technology, engineering and maths), statistics, project management and logical thinking are now prerequisites for most positions, even those in marketing, finance and HR. STEM skills are 40% more important than physical strength and our ability to manipulate objects.
- **Uniquely human skills**, such as communication, interpretation, design, synthetic thinking, and the ability to set context and define business problems, will be important alongside skills in the STEM fields.

4.3 Ten essential cognitive and human skills

The Institute for the Future (2011) described ten skills that will be essential for the workplace of 2020:

1. Sense-making: the ability to determine the deeper meaning or significance of what is being expressed;
2. Social intelligence: the ability to connect to others in a deep and direct way, to sense and stimulate reactions and desired interactions;
3. Novel and adaptive thinking: proficiency in coming up with solutions and responses beyond that which is rote or rule-based;
4. Cross-cultural competency: the ability to operate effectively in different cultural settings;
5. Computational thinking: the ability to translate vast amounts of data into abstract concepts and to understand data-based reasoning in order to make sense of this information;
6. New-media literacy: the ability to critically assess and develop content that uses new media forms, and to leverage these media for persuasive communication;
7. Transdisciplinarity: i.e. literacy in and the ability to understand concepts across multiple disciplines: *“Many of today’s global problems are just too complex to be solved by one specialized discipline (think global warming or overpopulation). These multifaceted problems require transdisciplinary solutions. While throughout the 20th century, ever-greater specialization was encouraged, the next century will see transdisciplinary approaches take center stage”*;
8. Design mindset: *“recognizing the kind of thinking that different tasks require, and making adjustments to their work environments that enhance their ability to accomplish these tasks”*;
9. Cognitive load management: *“the ability to discriminate and filter information for importance, and to understand how to maximize cognitive functioning using a variety of tools and techniques”*; and
10. Virtual collaboration: the ability to work productively and drive engagement as a member of a virtual team.



4.4 Entrepreneurial skills

Entrepreneurial skills will be essential for the future workforce and economic growth. Clem Sunter (2015) advocates “*opening the floodgates of entrepreneurship in this country*”. He stressed that we must prepare people to create their own work instead of preparing them for the job market:

“Schools don’t have entrepreneurial programmes so they’re still training kids for the job market that existed in the 70’s and 80’s. I find it incredible that educational institutions like business schools, universities, primary and secondary schools, haven’t seen this flag of the changing nature of work. ... I believe that today, eighty percent of the jobs in the world are being created in small businesses (with less than 100 employees), either independently or in the kind of ‘Uber’ network. ... If you want to bring the unemployment rate down from 25 to 10%, you’re going to have to create millions of new businesses, which can each create 10 to 20 jobs in a business rather than creating 100,000 to 200,000 jobs in a big business.” (Sunter, 2016)

China has already opened these floodgates, “*embracing mass innovation and entrepreneurship to seize the opportunities of the new development paradigm by nurturing an environment that encourages new ideas, tolerates mistakes, and supports new businesses*”. (http://www.china.org.cn/business/2016-06/28/content_38761716.htm: Innovation, Entrepreneurship drives 4th Industrial Revolution)

5. Preparing the workforce for the new world of work

5.1 Implications of the Fourth Industrial Revolution for skills development

Governments, employers and educational institutions need to adapt their workforce skills strategies to ensure that they equip the workforce to be productive in the new world of work. Key question to consider are:

- What jobs will there be in each industry in 2020-2030 and which jobs will have disappeared or have been radically altered?
- Which full-time and temporary workers will organisations need in 2020 and what range of skills should they have?
- How should we prepare the workforce for productive partnerships with machines?
- What assumptions about work, jobs and skills development are preventing us from preparing the workforce for the workplace that will be exponentially disrupted by new technology?
- How do we need to reconceptualise training for occupations if many occupations will disappear or be significantly changed by the time students graduate?
- How do we prepare the workforce for multiple career changes that cut across occupational boundaries?
- What should we be ‘teaching’ if we cannot transfer everything that is known, and if what is taught becomes outdated within a short period?
- How do we equip people with the skills they will need to use technology that hasn’t even been conceptualised yet?
- What do we need to do differently to create more entrepreneurs for a world of declining formal employment?



5.2 Outdated educational systems

“Our educational institutions were established, decades or even centuries ago, to provide for mass education for stable careers. The short half-life of learned skills and the rapidly evolving technological work landscape raise the need for new models that support ongoing training and education.” (Deloitte: 40-41) “As rapid technological and marketplace change shrinks the useful lifespan of any given skill set, workers will need to shift from acquiring specific skills and credentials to pursuing enduring and essential skills for lifelong learning. (Deloitte: 37)

“If you’re training people for a job that’s already been invented, or if you’re going to school in preparation for a job that’s already been invented, I would suggest that you’re going to have problems somewhere down the road.” (Deloitte: 97)

5.3 Are we training people for a world that no longer exists?

The disruptive changes that will result (*are resulting*) from the Fourth Industrial Revolution, urge us to consider whether our education and training is preparing the workforce for a world that won’t exist in 2020. Clem Sunter (2015) has strong views on this:

“.. schools and universities are still preparing their students for the market that prevailed fifty years ago. They have not woken up to the changing reality of business and the fact that technology has disrupted all of their cherished academic assumptions about what you should be taught to be a success in life”.

“We are currently preparing students for jobs that don’t yet exist, using technologies that haven’t been invented, in order to solve problems we don’t even know are problems yet. ... The amount of new technical information is doubling every 2 years. By 2010 it (was) predicted to double every 72 hours. For students starting a 4-year technical degree this means that half of what they learn in their first year of study will be outdated by their third year of study.” (Rose: <https://www.youtube.com/watch?v=XVQ1ULfQawk>)

5.4 Policies and systems to promote lifelong learning

The Institute for the Future (2011: 13) stresses the need for workers of the future to be adaptable, lifelong learners.

“To be successful in the next decade, individuals will need to demonstrate foresight in navigating a rapidly shifting landscape of organizational forms and skill requirements. They will increasingly be called upon to continually reassess the skills they need, and quickly put together the right resources to develop and update these.”

Josh Bersin (in Deloitte: 68-69) warns that people should be prepared and guided “through working lives in which they learn, work, learn, work, and cycle through career stages many times”. We should think about our careers as a series of waves from post-education to pre-retirement, in which we continuously reinvent ourselves.

“We’ll catch a wave and ride it until it crests, and then, as it calms on the beach, we paddle out and catch the next one. In each new wave, we gain new skills and new experiences, retraining and educating ourselves along the way.”



Eric Hoffer's warning is now more relevant than ever: *"In a time of drastic change it is the learners who inherit the future. The learned usually find themselves equipped to live in a world that no longer exists."* (Hoffer, 1973) Charles Darwin taught us that it is not the strongest of the species that survive, nor the more intelligent, but the ones most responsive to change.

Lifelong learning does not mean continuously attending courses to get credits on the National Qualifications Framework! It requires pursuing formal and informal learning opportunities throughout life. It is essentially learning that is flexible, diverse and available at different times and in different places, aimed at the continuous development and improvement of the knowledge and skills needed for employment and personal fulfilment.

6. Conclusion

Government and policy makers, employers and industry-based organisations must heed the warnings of the WEF, ILO, Clem Sunter and other experts on the impact of the Fourth Industrial Revolution and recognise the urgent need to review government strategies for preparing the workforce for this revolution. The review will have to initiate substantial changes to strategies and programmes for equipping the workforce for the unpredictable and disruptive technology-driven world of work that we will be entering within the next five to ten years.

"The future of work is unfolding rapidly. Today, none of these constituencies – individuals, businesses, public institutions is prepared for the potentially turbulent and painful transition and possibilities ahead. ... Individuals, various forms of organizations, and public policy makers (have) to proactively navigate the future of work and come together and act now to make the transition as positive, productive, and smooth as possible... Public institutions need to proactively prepare for educational challenges, including funding for ongoing education, programs to mitigate transition costs, and updating regulatory frameworks to support new types of work and workers and a more entrepreneurial economy."

(Navigating the Future of Work, Deloitte University Press, July 2017: 42-43)

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Video links

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<https://www.youtube.com/watch?v=SCGV1tNBoeU>
- Industry 4.0: Integrated Industry reaches the next level [4:00]
<https://www.youtube.com/watch?v=ccB6e18VwsQ>
- The 5 Trends shaping the Future of Work [3:35]
<https://www.youtube.com/watch?v=LrhmHbDLM8o>
- The 4IR and the future of jobs [4:28]
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- Did you know? New world of work & technology [7:00]
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