

# The Future of Work in the Digital Age: Understanding the Impact of Technological Change on Work



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October, 2019

NS is an international co-operation initiative led by the Honourable Jocelyne Bourgon P.C., O.C.



**PGI Working Paper:**

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**By: Marie Blythe-Hallman  
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## Table of Contents

<b>1.</b>	<b><i>A New Synthesis Initiative</i></b>	<b>1</b>
<b>2.</b>	<b><i>Artificial Intelligence, Machine Learning and Work</i></b>	<b>2</b>
	<i>2.1 The Techno-Pessimists and Mass Dislocation</i>	3
	<i>2.2 The Techno-Optimists and Limitless Opportunities</i>	5
	<i>2.3 “A Modestly Positive Outlook</i>	9
<b>3.</b>	<b><i>Patterns and Themes</i></b>	<b>11</b>
	<i>3.1 The Changing Nature of Work</i>	12
	<i>3.2 Job Quality in the Gig Economy</i>	12
	<i>3.3 Labour Market Income Inequality</i>	13
	<i>3.4 A Sense of Purpose</i>	14
	<i>3.5 The Inevitability of Technological Change</i>	14
	<i>3.6 A Role for Governments</i>	15
<b>4.</b>	<b><i>How Can Societies Prepare</i></b>	<b>15</b>
	<i>4.1 Preparing Individuals</i>	16
	<i>4.2 Preparing Families</i>	21
	<i>4.3 Preparing Communities</i>	24
<b>5.</b>	<b><i>Concluding Remarks</i></b>	<b>25</b>
	<b><i>Bibliography</i></b>	<b>26</b>

# 1. The New Synthesis Initiative

*The Future of Work in the Digital Age* is one in a series of working papers produced for the *Third Phase* of the New Synthesis (NS) Initiative<sup>1</sup>.

The NS Initiative is a *collaborative international research initiative* that was launched in 2009 with the explicit purpose of exploring the new frontiers of public administration to provide practitioners with a mental map adapted to the challenges of serving in the 21st century. Seeking insights from theory and practice, and testing ideas in a diversity of environments are a trademark of the NS Initiative.

Public administration has been lacking a *New Synthesis* that is able to integrate past practices of enduring value with new ones and better aligned to the challenges of serving in a global, hyper-connected world and in the midst of a technological revolution. *A broader mental map* and a *different approach to problem-solving* are needed to invent solutions to the increasingly complex problems governments are facing in practice.

The work of the *Initial Phase* of the NS Initiative revealed that people serving in government today are facing a combination of factors that is significantly different from those prevailing during the post-World War II period to the early 2000s; increasing complexity, hyper-connectivity, high uncertainty, a technological revolution, a digital and biological revolution, the acceleration of environmental changes, rapid changes to the nature of work, the impact of social media, and the like. These factors are transforming the economic, social, and political spheres of life in society. The pace of change is increasing and there is every reason to believe that *the velocity of change will continue to accelerate*.

The initial phase generated a conceptual framework that brings together the role of government, citizens and society in a dynamic and interactive system. The *NS Framework*:

- Expands the range of options open to government;
- Improves the likelihood of success of government actions and interventions;
- Brings special attention to society's resilience and adaptive capacity building; and
- Encourages system thinking and collective problem solving.

*The Second Phase* generated the *NS Exploratory Cycle*. This phase focused on what can be done to ensure that the capacity of government to invent solutions will keep pace with the increasing complexity of the problems we are facing as a society. Based on the work of 1,000 practitioners in a diversity of contexts and circumstances, this phase confirmed the importance of a broader mental map and of dynamic systems thinking to invent solutions, encourage collective problem solving and build the resilience of society. More than ever, *governing in the 21st century is a process of invention*; it is not a process of replication.

The second phase underscored the need to explore more deeply the importance of civic results to propel society forward in a period of unprecedented changes.<sup>2</sup> Civic results include but are not limited to:

<sup>1</sup> Jocelyne Bourgon, 2011, *A New Synthesis of Public Administration: Serving in the 21st Century*, Kingston: Queen's Policy Studies; Jocelyne Bourgon, 2019, "NS Research Program 2019" (unpublished). Also see website: <https://www.pgionline.com/>.

<sup>2</sup> Bourgon, 2011.

**Civic capacity:** The capacity of people, families and communities to take charge of issues and to initiate actions with others and with government in a manner that addresses their concerns and promotes the overall interest of society.

**Civic will:** The will to deploy capabilities to build and share a better future and to contribute to collective problem solving as member of a broader human community.

**Civic values (norms):** Shared values and normative behaviours that contribute to harmonious living and making society governable.

This is the focus of the *Third Phase* - to dive deeply into civic results and how they affect the overall functioning of a governing system.<sup>3</sup> The aim of the research is to generate a coherent and cogent synthesis of ideas and principles about what government can do to accelerate the

adaptive capacity and resilience of society and the capacity for collective problem-solving. The NS 2019 Research Agenda directs us to four questions in particular:

- What can government do to build the *collective capacity* of society to invent and share a better future together?
- What can government do to ensure that the *adaptive capacity* of society will keep pace with the increasing velocity of change?
- What can government do to enhance the *resilience of society* to adapt, evolve and prosper in unforeseen and unpredictable circumstances?
- What can government do to ensure that public institutions have the *capabilities* to successfully steer society through an unprecedented period of change?

## 2. Artificial Intelligence, Machine Learning and Work

Thought leaders tell us that we are in the midst of a *Fourth Industrial Revolution*, and that the changes it is bringing are “still hard to imagine and extremely difficult to address.”<sup>4</sup> The convergence of disruptive technologies, like artificial intelligence (AI), robotics, nanotechnology, genetics and 3D printing is causing an *exponential shift*, altering almost every facet of society, including the future of work.

While automating work is not new, what is different in the 21st century is that advancements in AI and other technologies are bringing about changes not only in the sphere of physical labour, but also in the field of cognitive tasks. In their book, *The Second Machine Age* (2014) MIT Professors Erik Brynjolfsson and Andrew McAfee argue

that “we are facing an unprecedented inflection point between the first machine age, based on the automation of physical tasks through mechanization, and a second machine age, based on the automation of cognitive tasks through digital technologies.”<sup>5</sup> While robots and computers are capable of performing a

<sup>3</sup> NS Research Program 2019.

<sup>4</sup> D2L, 2018, “The Future of Work and Learning in the Age of the 4th Industrial Revolution,” p.2, <https://www.d2l.com/wp-content/uploads/2018/01/The-Future-of-Work-and-Learning-D2L.pdf>, accessed Nov. 8, 2018.

<sup>5</sup> Erik Brynjolfsson and Andrew McAfee, 2014, *The second machine age: Work, Progress, and Prosperity in a Time of Brilliant Technologies*, W. W. Norton & Company.

range of routine physical work activities, they are increasingly able to accomplish cognitive tasks, such as making inferences, sensing emotion, and even driving. As McKinsey (2017) notes, there is certainty that the AI-fueled wave of automation will change the daily work activities of everyone in some fashion; what is less certain is the shape and scope of the disruption.<sup>6</sup>

Studies on the impact of job automation conducted over the past six years have been polarized around two perspectives: that which foresees limitless new opportunities, where technology unleashes a new era of prosperity, and workers displaced by technology find new jobs, resulting in higher average incomes; and that which foresees the dislocation of jobs on a massive scale. A third view is emerging which comes up in the middle, suggesting that the shape and scope of disruption is specific to the industry, the region and the occupation, and contingent on governments, industry and society to steer it toward a more positive outcome.

The work of the NS Initiative teaches us that a period of accelerating disruptive changes brings to prominence the need to *accelerate the adaptive capacity* of government and to build a *resilient society*. Indeed, as technological developments evolve at the pace of *scientific discoveries* the social sphere and governance systems do so at a much *slower pace*. While the future of work is unsettled, what is clear is that the digital revolution is generating disruptions and dislocations that exceed the absorptive and adaptive capacity of many governments. The first part of this paper explores research around the three possible futures, and draws out some of the key patterns and themes that are emerging around work in the digital

age. The second half of the paper explores some approaches and practices that governments can take, and have taken, to steer their societies through this unprecedented and highly uncertain period of change and reap the benefits of the digital age.

It is important to note that these forward-looking studies are based on a variety of predictive models, the results of which are informed by different definitions and levels of granularity around the activities, tasks, and occupations examined. This only adds to the complexity and uncertainty around understanding the future of work.

## 2.1 The Techno-Pessimists and Mass Dislocation

A common thread in the literature on the future of work in the digital age predicts massive job losses as AI replaces human labour. Estimates range from nine percent to 50 percent of human occupations at risk of being lost to automation. The seminal study on the impact of automation on jobs conducted by Frey and Osborne (2013) first sounded the alarm bell. Ranking 702 professions according to their probability of being automated, from the least susceptible to the most susceptible, they concluded that approximately 47 percent of American jobs were at risk of being replaced by automation between 2023 and 2033. The labour market shift would likewise be broader in scope and occur at a much faster pace than those in previous industrial revolutions.<sup>7</sup> Moreover, the trend would be toward greater job polarization, with growth taking place in high-income cognitive and creative jobs and low-income

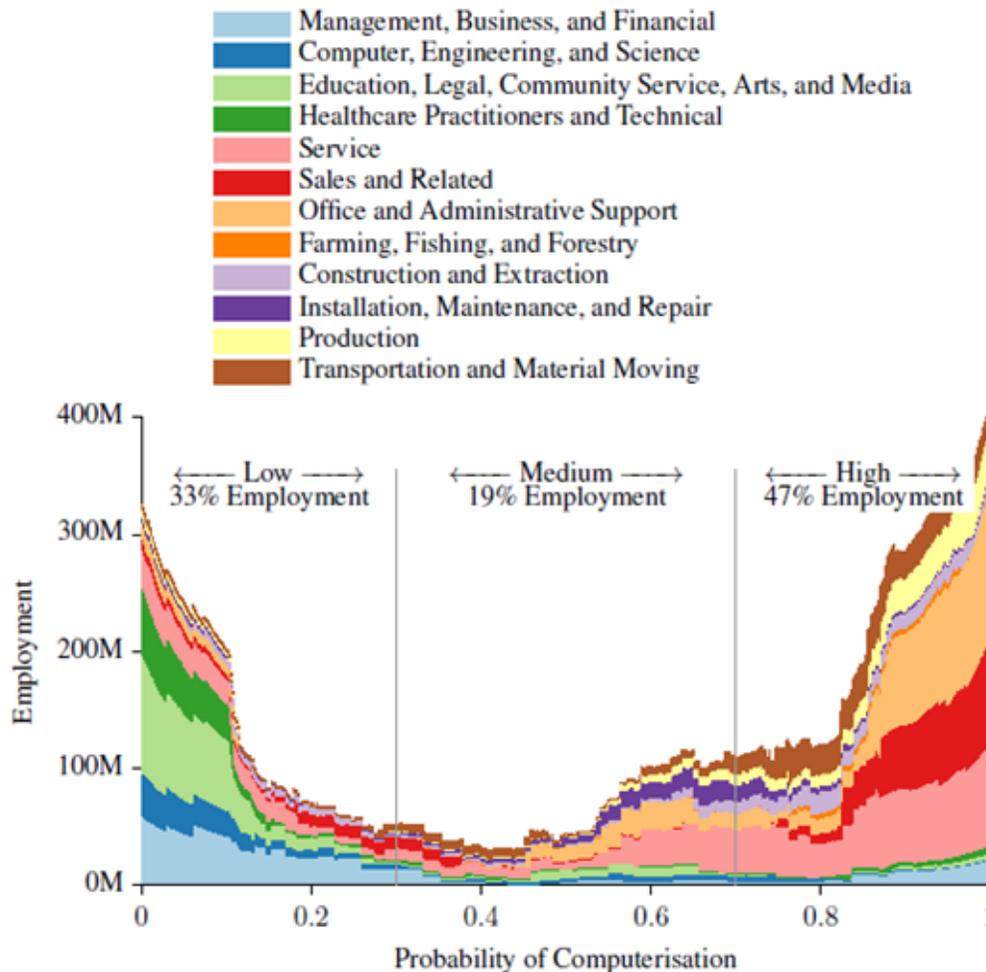
<sup>6</sup>James Manyika, Michael Chui, Mehdi Miremadi, Jacques Bughin, Katy George, Paul Willmott, and Martin Dewhurst, 2017, "Harnessing automation for a future that works," (January), McKinsey Global Institute, <https://www.mckinsey.com/featured-insights/digital-disruption/harnessing-automation-for-a-future-that-works>, accessed March 21, 2019.

<sup>7</sup>Carl Frey and Michael Osborne, 2016. "The future of employment: How susceptible are jobs to computerisation?," *Technological Forecasting and Social Change*, Elsevier, vol. 114(C), pages 254-280.

manual occupations, but greatly diminished for middle-income routine and repetitive jobs. Those most at risk included workers in transportation and logistics occupations, office and administrative support workers, labour in production occupations, as well as those in the service industry, where much of the previous job growth had occurred (see Figure 1).<sup>8</sup>

Subsequent studies and papers confirmed these findings. Several follow-up studies applied this model to other countries, with similarly alarming results (Finland - 35%, Germany - 59%, Europe - 45-more than 60%).<sup>9</sup> Building on their original work in 2016, Frey and Osborne examined jobs at risk in 50 countries and concluded that on average 50 percent of jobs in OECD countries were prone to automation. This number was particularly high in India (69%) and China (77%).<sup>10</sup>

**Figure 1: Employment Affected by Computerisation**



Source: Frey and Osborne, 2017

<sup>8</sup> Frey and Osborne, p.268.

<sup>9</sup> See study by Melanie Arntz, Terry Gregory and Ulrich Zierhan, 2016, "The Risk of Automation for Jobs in OECD Countries," OECD, <https://www.oecd-ilibrary.org/docserver/5jlz9h56dvq7-en.pdf?expires=1553457230&id=id&accname=guest&checksum=2AB7AB65603A6B5428731BE014A6A50A>, accessed March 6, 2019.

<sup>10</sup> Carl Frey and Michael Osborne, 2016, "Technology at Work v2.0: The future is not what it used to be, Citibank," Citi GPS: Global Perspectives & Solutions, [https://www.oxfordmartin.ox.ac.uk/downloads/reports/Citi\\_GPS\\_Technology\\_Work\\_2.pdf](https://www.oxfordmartin.ox.ac.uk/downloads/reports/Citi_GPS_Technology_Work_2.pdf), accessed March 21, 2019.

A study commissioned by the OECD (2016) suggests that it is unlikely that entire occupations would be automated, as occupations are likely to contain “tasks” that are difficult to automate. Using Osborne and Frey’s model but substituting “tasks” as its unit of analysis, these researchers concluded that *nine percent of tasks were automatable*.<sup>11</sup> Using the same data, a more recent OECD study (2018) suggests that *almost half of all jobs* are at risk of being significantly affected by automation. Roughly 14% of workers in OECD countries were at risk of having most (70%) of their tasks automated over the next 15 years, while another 32% could face substantial change in the tasks required in their job and, consequently, the skills required.<sup>12</sup> The study found that the sectors most at risk include manufacturing, agriculture and some service sectors. The highest risk is concentrated in routine jobs with low skill requirements and often low wages, with jobs in agriculture and manufacturing most affected. The lowest risk applies to a broader range of jobs from professionals to social workers.<sup>13</sup> Labour market entry may be more difficult for young people as student jobs and entry-level positions have a high risk of automation.<sup>14</sup>

The conclusions of these studies are not without weaknesses. These studies focus on job displacement and do not take into consideration the positive employment effects that AI could bring, such as the creation of new jobs. Likewise, the focus on occupational and sub-occupational levels leads to conclusions that over-estimate job

loss. Nonetheless, they are still frequently cited, despite later studies that provide a more nuanced understanding of the impact of automating technologies on the jobs.<sup>15</sup>

## 2.2 The Techno-Optimists and Limitless Opportunities

Citing historic evidence which shows that previous waves of job automation generated more jobs and higher incomes, the techno-optimist literature assert that AI is likely to improve productivity and economic growth over a wide range of sectors in the economy. While technology can be disruptive, they argue that it always ends up improving productivity and increasing wealth, and in turn, leading to greater demand for goods and services and new types of jobs to satisfy it. As the European Commission (2018) points out in its review of literature on job automation, “[e]ver since the Industrial Revolution, and despite many subsequent waves of innovation and mechanisation, human employment and incomes have strongly increased, not decreased.”<sup>16</sup> The techno-optimists foresee limitless opportunities in newly emerging job categories and prospects that improve workers’ productivity and liberate them from routine work. Studies by Deloitte (2017) and McKinsey (2017) are examples of this perspective. This quote in Deloitte’s 2017 report *Forces of change: The Future of*

<sup>11</sup> Arntz Gregory and Zierahn, 2016,

<sup>12</sup> OECD, 2018, “Policy Brief on the Future of Work: Putting faces to the jobs at risk of automation,” (March), p.1, [www.oecd.org/employment/future-of-work.htm](http://www.oecd.org/employment/future-of-work.htm), accessed Dec. 4, 2019.

<sup>13</sup> OECD, p.1.

<sup>14</sup> OECD, p.1.

<sup>15</sup> For example, a more recent study by D2L (2018) on the critical need for an upskilling and reskilling strategy, draws on the findings of these studies, focusing particularly on the impact of automation on middle-skilled jobs.

<sup>16</sup> European Commission, 2018, “Artificial Intelligence A European Perspective”, (Dec) ,p.,.77, file:///C:/Users/NSW1/Desktop/Governing%20in%20a%20Digital%20Age/Future%20of%20Work/ai-flagship-report-online.pdf, accessed March 6, 2019.

Work, encapsulates this thinking:

“...the advent of artificial intelligence (AI) makes it possible - indeed, desirable to reconceptualise work, not as a set of discrete tasks laid end to end in a predefined process, but as a collaborative problem-solving effort where humans define the problems, machines help find the solutions and humans verify the acceptability of those solutions.”<sup>17</sup>

In its 2017 report, *A Future that Works*, McKinsey takes a slightly different approach from the studies noted above. Using data from the Department of Labour, McKinsey analyses over 2,000 work activities in 800 occupations across the U.S. economy, noting that automation’s potential to impact work is in the realm of activities rather than occupations. The study developed a framework of 18 capabilities that cover five broad areas to assess automation potential: sensory perception, cognitive capabilities, natural language processing, social and emotional capabilities, and physical capabilities.

The study concludes that given current technologies, *less than 5 percent of occupations are candidates for full automation, but almost every occupation has partial automation potential*, from landscape designers to CEOs, to a greater or lesser degree: “about 60 percent of all occupations have at least 30 percent of activities that are technically automatable.”<sup>18</sup> The outcome: “[m]ore occupations will change than will be automated away.”<sup>19</sup>

Rather than replacing occupations, the study concludes that people will perform activities that complement the work that machines do and vice versa. McKinsey notes that this will require a change in “mindsets and culture,” where “‘co-workers’ include not only other people, but also machines,” and activities continue to evolve. Workers will need to be continually retrained, while others will have to be redeployed.<sup>20</sup>

Activities most at risk of automation include performing physical activities or operating machinery in a predictable environment (81%), which is most prevalent in the manufacturing, accommodation and food service, and retail sectors, and make them among the most vulnerable sectors to automation. Collecting and processing data is the second most readily automatable activity (69%), which is common to almost all sectors, occupations and wage-levels, from data entry clerks to investment bankers. The risk of automation is significantly lower for cognitive activities like interfacing with stakeholders, applying expertise to decision making, planning, and creative tasks, or managing and developing people (see figure 2).<sup>21</sup>

Automation is sometimes depicted as affecting particular groups of workers depending on their wage levels. The results of this study note that while there is a negative correlation between wage rates and automation potential, this is subject to variation. While low-skill, low-

<sup>17</sup> Deloitte Insights, 2017, “Forces of change: The Future of Work,” p.6, [https://www2.deloitte.com/content/dam/insights/us/articles/4322\\_Forces-of-change\\_FoW/DI\\_Forces-of-change\\_FoW.pdf](https://www2.deloitte.com/content/dam/insights/us/articles/4322_Forces-of-change_FoW/DI_Forces-of-change_FoW.pdf), accessed March 6, 2019.

<sup>18</sup> McKinsey, 2017, *A Future that Works: Automation, Employment and Productivity*, McKinsey Global Institute, p32, [https://www.mckinsey.com/-/media/McKinsey/Featured%20Insights/Digital%20Disruption/Harnessing%20automation%20for%20a%20future%20that%20works/MGI-A-future-that-works\\_Full-report.ashx](https://www.mckinsey.com/-/media/McKinsey/Featured%20Insights/Digital%20Disruption/Harnessing%20automation%20for%20a%20future%20that%20works/MGI-A-future-that-works_Full-report.ashx), accessed March 20, 2019.

<sup>19</sup> McKinsey, 2017.

<sup>20</sup> McKinsey, p.111.

<sup>21</sup> McKinsey, p.43.

wage work could be automated, the study also found that middle-skill and high-paying, high-skill occupations also have potential for automation.<sup>22</sup>

While McKinsey notes that half of today's work activities could be automated by 2055, the pace of automation is contingent on a range of variables, including the pace of technological development, the cost of technology, the availability of skills and competition for labour, and social and regulatory acceptance.<sup>23</sup> Likewise, the pace of automation and its impact on workers will vary across and within sectors, occupations, activities, and wage and skill levels.

The study acknowledges that the scale of shift in the labour market is not without precedent: "Automation will cause significant labor displacement and could exacerbate a growing skills and employment gap that already exists between high-skill and low-skill workers...[M]any occupations could be partially automated before they are fully automated, which could have different implications for high and low-skill workers. Especially for low-skill workers, this process could depress wages unless demand grows."<sup>24</sup> However, this is tempered

by historical precedence; "large-scale historical structural shifts in the workplace where technology has caused job losses have, over time, been accompanied by the creation of a multitude of new jobs, activities, and types of work."<sup>25</sup> It further notes the dynamism of labour markets.

The McKinsey study is optimistic about the potential for automation to close the gap on economic growth. Humans are still needed in the workforce: "the world's economy will actually need every erg<sup>26</sup> of human labor working, in addition to the robots, to overcome demographic aging trends in both developed and developing economies." As a result, a surplus of human labour is less likely than a deficit, although the nature of work will change.<sup>27</sup> While the study offers no prescriptions, it envisions a broad role for governments in seeing this through; putting in place policies to encourage investment and market incentives to encourage continued progress and innovation, as well as rethinking education and training, income support, and safety nets, and transition support for those dislocated.

<sup>22</sup> McKinsey, p.39.

<sup>23</sup> McKinsey, 2017a, "A Future that Works Executive Summary," McKinsey Global Institute, p.12, <https://www.mckinsey.com/-/media/mckinsey/featured%20insights/Digital%20Disruption/Harnessing%20automation%20for%20a%20future%20that%20works/MGI-A-future-that-works-Executive-summary.ashx>, accessed March 23, 2019.

<sup>24</sup> MGI, 2017a, p.14.

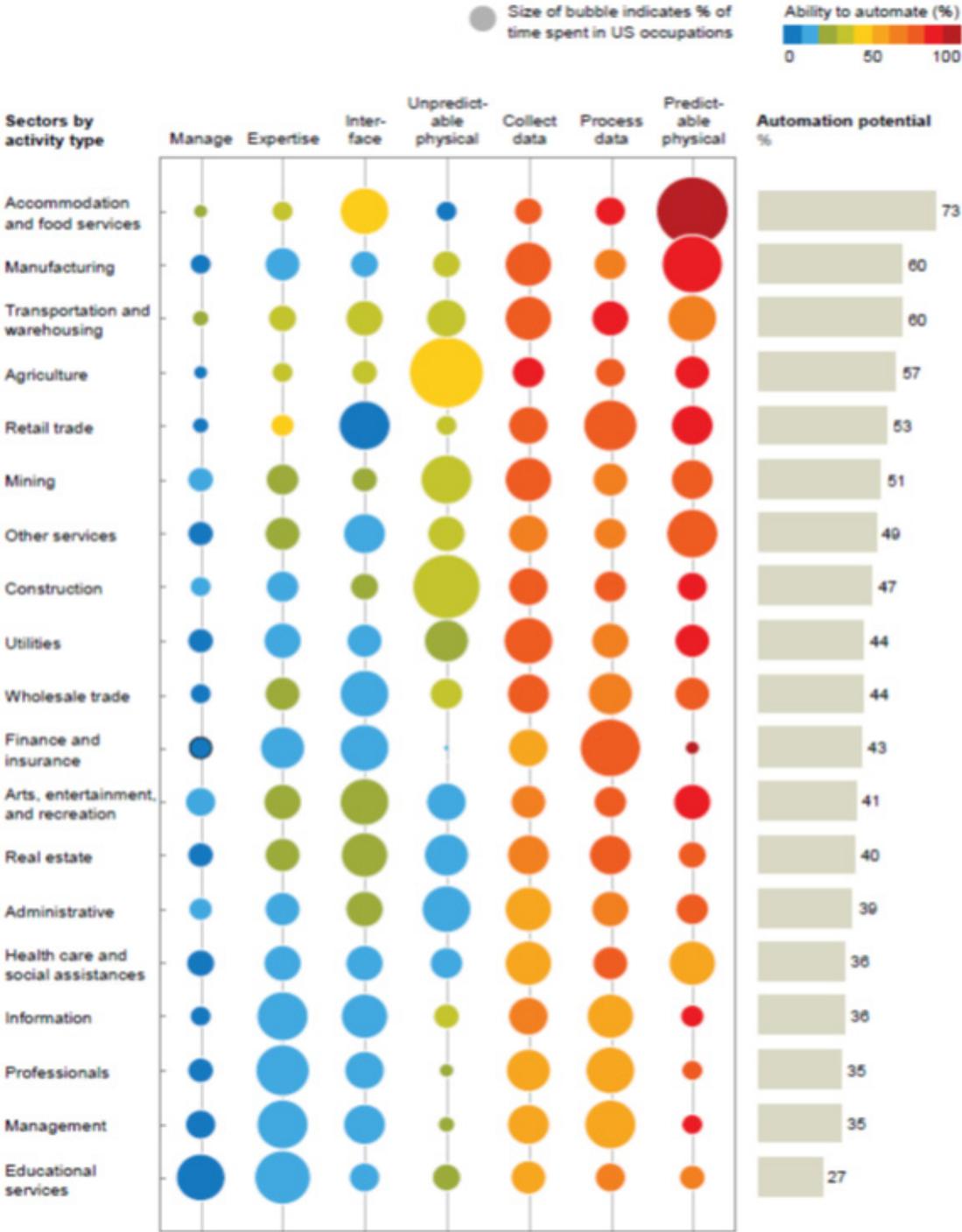
<sup>25</sup> MGI, 2017a, p.14.

<sup>26</sup> Note that "erg" refers to a unit of work or energy.

<sup>27</sup> James Manyika, Michael Chui, Mehdi Miremadi, Jacques Bughin, Katy George, Paul Willmott and Martin Dewhurst, 2017a, "A Future that Works: Automation, Employment and Productivity Executive Summary", McKinsey Global Institute, p.,29, [https://www.mckinsey.com/-/media/McKinsey/Featured%20Insights/Digital%20Disruption/Harnessing%20automation%20for%20a%20future%20that%20works/MGI-A-future-that-works\\_Executive-summary.ashx](https://www.mckinsey.com/-/media/McKinsey/Featured%20Insights/Digital%20Disruption/Harnessing%20automation%20for%20a%20future%20that%20works/MGI-A-future-that-works_Executive-summary.ashx), accessed March 23, 2019.

Figure 2

Technical potential for automation across sectors varies depending on mix of activity types



SOURCE: US Bureau of Labor Statistics; McKinsey Global Institute analysis

## 2.3 “A Modestly Positive Outlook”

A third perspective presented by Klaus Schwab (2016), economist and founder of the World Economic Forum, in his book the *Fourth Industrial Revolution* and World Economic Forum (WEF) reports *The Future of Jobs* (2016, 2018) suggests that the two scenarios described above are not inevitable; rather, the outcome is likely to be somewhere in between, and what the 2016 WEF Report calls “a modestly positive outlook.”<sup>28</sup> The findings of these studies, based on input from Chief Human Resources Officers of leading global companies about how jobs in their industries will change over a five-year period, predict areas of job decline as well as emerging professions. The latest WEF Report (2018) tracks expected changes into 2022 and covers 20 economies and 12 industries.

As in the McKinsey study, these reports suggest that “the reality is highly specific to the industry, region and occupation in question as well as the ability of various stakeholders to manage change.”<sup>29</sup> While potential exists for technological change to improve quality of life and achieve economic growth, this perspective also acknowledges the risks for greater inequality, widening skills gaps, and broader polarization, and thus, the need for a steady hand to guard against worst-case scenarios and support those caught in the transition. The 2018 WEF Report further cautions that, “the window of opportunity for governments and business to proactively manage this change is rapidly closing.”<sup>30</sup>

According to the 2018 Report, businesses are expected to expand adoption of big data analytics (85%), the Internet of Things and app- and web-enabled markets (75%), and Machine Learning (72%) by 2022. Despite the media hype, use cases for humanoid robots is low (23%) as compared to a growing interest in a broader range of recent robotics technologies, among them stationary robots, non-humanoid land robots, fully automated aerial drones, machine learning algorithms and artificial intelligence.<sup>31</sup>

What does this mean for the future of work? According to the findings, while some jobs will increasingly become redundant, this is offset by new professions. Roughly 75 million jobs may disappear, while 133 million additional new roles may emerge. At the same time, approximately 50 percent of existing core jobs will remain relatively stable up to 2022.<sup>32</sup>

Jobs expected to experience increasing demand in the next five years include technology-based roles, like data analysts and scientists, software and applications developers, and Ecommerce and social media specialists. Roles that depend on human skillsets are also expected to grow, including customer service workers, sales and marketing professionals, and specialists in organizational development, training and people and culture. There is also accelerating demand for new specialist roles related to emerging technologies, among them, AI and Machine Learning specialists, Big Data specialists, and robotics engineers.<sup>33</sup>

<sup>28</sup> World Economic Forum, 2016, *The Future of Jobs: Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution*, [http://www3.weforum.org/docs/WEF\\_Future\\_of\\_Jobs.pdf](http://www3.weforum.org/docs/WEF_Future_of_Jobs.pdf), accessed Feb.2, 2019.

<sup>29</sup> WEF, 2016, p.v.

<sup>30</sup> World Economic Forum, 2018, *The Future of Jobs Report*, p.vii, <https://www.weforum.org/reports/the-future-of-jobs-report-2018>, accessed Feb.2, 2019.

<sup>31</sup> WEF 2018, p.6.

<sup>32</sup> WEF, 2018, p.8.

<sup>33</sup> WEF 2018, p.9.

Jobs expected to become redundant include routine-based, middle-skilled white-collar roles, such as data entry clerks, accounting and payroll clerks, secretaries, bank tellers and cashiers, as well as auditors, accountants and lawyers, which reflects trends in banking (ATMs), consumer sales (self-checkout kiosks) and other sectors.<sup>34</sup>

**Table 3: Examples of stable, new and redundant roles, all industries**

Stable Roles	New Roles	Redundant Roles
Managing Directors and Chief Executives	Data Analysts and Scientists*	Data Entry Clerks
General and Operations Managers*	AI and Machine Learning Specialists	Accounting, Bookkeeping and Payroll Clerks
Software and Applications Developers and Analysts*	General and Operations Managers*	Administrative and Executive Secretaries
Data Analysts and Scientists*	Big Data Specialists	Assembly and Factory Workers
Sales and Marketing Professionals*	Digital Transformation Specialists	Client Information and Customer Service Workers*
Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products	Sales and Marketing Professionals*	Business Services and Administration Managers
Human Resources Specialists	New Technology Specialists	Accountants and Auditors
Financial and Investment Advisers	Organizational Development Specialists*	Material-Recording and Stock-Keeping Clerks
Database and Network Professionals	Software and Applications Developers and Analysts*	General and Operations Managers*
Supply Chain and Logistics Specialists	Information Technology Services	Postal Service Clerks
Risk Management Specialists	Process Automation Specialists	Financial Analysts
Information Security Analysts*	Innovation Professionals	Cashiers and Ticket Clerks
Management and Organization Analysts	Information Security Analysts*	Mechanics and Machinery Repairers
Electrotechnology Engineers	Ecommerce and Social Media Specialists	Tellermasters
Organizational Development Specialists*	User Experience and Human-Machine Interaction Designers	Electronics and Telecommunications Installers and Repairers
Chemical Processing Plant Operators	Training and Development Specialists	Bank Tellers and Related Clerks
University and Higher Education Teachers	Robotics Specialists and Engineers	Car, Van and Motorcycle Drivers
Compliance Officers	People and Culture Specialists	Sales and Purchasing Agents and Brokers
Energy and Petroleum Engineers	Client Information and Customer Service Workers*	Door-To-Door Sales Workers, News and Street Vendors, and Related Workers
Robotics Specialists and Engineers	Service and Solutions Designers	Statistical, Finance and Insurance Clerks
Petroleum and Natural Gas Refining Plant Operators	Digital Marketing and Strategy Specialists	Lawyers

Source: Future of Jobs Survey 2018, World Economic Forum.

Note: Roles marked with \* appear across multiple columns. This reflects the fact that they might be seeing stable or declining demand across one industry but be in demand in another.

Not surprisingly, the skills required to perform most jobs will shift significantly, an average of 42% in core skills between 2018 and 2022.<sup>35</sup> While the demand for manual skills and physical abilities continues to decline, proficiency in new technologies, as well as human skills like analytical thinking, complex problem-solving, creativity, persuasion, and leadership are becoming increasingly important.

<sup>34</sup> WEF, 2018, p.9.

<sup>35</sup> WEF, 2018, p.viii.

Today, 2018	Trending, 2022	Declining, 2022
Analytical thinking and innovation	Analytical thinking and innovation	Manual dexterity, endurance and precision
Complex problem-solving	Active learning and learning strategies	Memory, verbal, auditory and spatial abilities
Critical thinking and analysis	Creativity, originality and initiative	Management of financial, material resources
Active learning and learning strategies	Technology design and programming	Technology installation and maintenance
Creativity, originality and initiative	Critical thinking and analysis	Reading, writing, math and active listening
Attention to detail, trustworthiness	Complex problem-solving	Management of personnel
Emotional intelligence	Leadership and social influence	Quality control and safety awareness
Reasoning, problem-solving and ideation	Emotional intelligence	Coordination and time management
Leadership and social influence	Reasoning, problem-solving and ideation	Visual, auditory and speech abilities
Coordination and time management	Systems analysis and evaluation	Technology use, monitoring and control

Source: Future of Jobs Survey 2018, World Economic Forum.

In contrast to studies that foresee the replacement of existing occupations and job categories, the findings of the WEF Reports suggests a deepening of the trend toward robotics and machine learning *augmenting* tasks performed by workers. On average, machines and algorithms will increase their contribution to specific tasks by 57% by 2022. “Even those work tasks that have thus far remained overwhelmingly human—communicating and interacting (23%); coordinating, developing, managing and advising (20%); as well as reasoning and decision-making (18%)—will begin to be automated (30%, 29%, and 27% respectively).”<sup>36</sup> The impact of these changes is a shortening of the “shelf-life” of employees’ existing skill sets, and the need for reskilling in new tasks.<sup>37</sup>

The findings of the 2018 Report also indicate a shift away from full-time employment toward flexible, contract-based work. Almost

50% of companies expect that automation will lead to some reduction in their full-time workforce by 2022. In addition, many expect to engage workers in a more flexible manner, utilizing remote staffing beyond physical offices. Between one-half to two-thirds are likely to use temporary workers, freelance workers and specialist contractors.<sup>38</sup>

To protect against a worst-case scenario, this perspective provides a role for industry to support the workforce through the development of an augmentation strategy designed around the complementarity of human and machine labour and a lifelong learning system; for workers to develop a mindset of agile learning; and for governments to create an enabling environment to assist these efforts, as in updating education systems and labour policies.

### 3. Patterns and Themes

While this body of research offers different hypotheses and predictions about the impact of technological change on the future of work, some general patterns and themes are emerging. This section provides some thoughts.

<sup>36</sup> WEF, 2018, p.10.

<sup>37</sup> WEF, 2016, p.3.

<sup>38</sup> WEF, 2018, p.13.

## 3.1 The Changing Nature of Work

The Fourth Industrial Revolution, characterized by the convergence of disruptive technologies is impacting the kinds of jobs that people do, and how they perform them. While predictions differ about breadth and scope, the literature suggests that there will be job displacement.

The research suggests it is not so much the occupations that are candidates for automation as it is the individual tasks and activities that make up the jobs. Latest figures suggest that only 5% of occupations have the potential to be fully automated, while 30% of the activities in 60% of the jobs could be automated. Nevertheless, the automation of tasks and activities will profoundly impact the nature of work; technological change will call for new kinds of work, as others become obsolete. This has already started to take place.

While predictions vary about when we can expect this to take place, the latest figures suggest 2055. This is variable, however, contingent on the jurisdiction, the sector and the occupation.

Sectors particularly vulnerable to automation include the manufacturing, agriculture and service sectors. Occupations at risk of automation, either in part or fully, include transportation and logistics occupations, production and manufacturing occupations, those in the service and retail industries, as well as routine-based, middle-skilled white-collar roles, such as data entry clerks, secretaries, bank tellers and cashiers, as well as accountants and lawyers. Young people may be disproportionately affected when entering the labour market, as student jobs and entry-level positions have a high risk of automation.

Jobs expected to experience increasing

demand include new and emerging technology-based professions, such as data scientists, Ecommerce and social media specialists, robotics engineers and Machine Learning specialists. Roles that depend on human skillsets, such as analytical thinking, complex problem-solving, creativity and persuasion are also expected to grow, among them customer service workers, sales and marketing professionals, and specialists in organizational development, training and people and culture.

Aging populations should also generate higher demand for healthcare and home workers. We may see a return of the domestic worker as older people need support at home.

The pace of technological change will continue to accelerate, and with it bring a continuous cycle of change. The nature of work will change, with automated beings and humans co-working together in some fashion. Jobs, tasks and activities will constantly evolve, while workers will be subject to consistent upskilling and reskilling to keep pace.

It seems clear that the types of jobs that are being created are not the same as those at risk of being lost, which also suggests that the workers affected by job loss in declining activities may not be those benefitting from the job opportunities emerging in expanding areas. This raises questions about the extent to which reskilling and upskilling can or will support transitions to new activities, tasks or jobs.

## 3.2 Job Quality in the Gig Economy

Accompanying changes to occupations is the move away from more traditional forms of employment to the on-demand employment of the *gig economy*. The gig economy, also known as the *platform*

economy or on-demand economy, is characterized by independent workers holding contracts for multiple employers at one time, as opposed to traditional employment where full-time employees work for one employer. As Schwab (2016) notes, “[t]he emergence of a world where the dominant work paradigm is a series of transactions between a worker and a company more than an enduring relationship was described by Daniel Pink 15 years ago in his book *Free Agent Nation*. This trend has been greatly accelerated by technological innovation.”<sup>39</sup> Currently in the U.S. and Europe, approximately 20 to 30 per-cent of the working population participates in the gig economy.<sup>40</sup> Internationally, the gig economy is growing at approximately 14 percent annually.<sup>41</sup>

The gig economy presents many advantages to business - with self-employed workers, businesses do not have to pay minimum wages, employer taxes or social benefits. As Daniel Callaghan, chief executive of MBA & Company in the UK explains “[y]ou can now get whoever you want, whenever you want, exactly how you want it. And because they’re not employees you don’t have to deal with employment hassles and regulations.”<sup>42</sup>

While the flexibility, mobility and freedom of the gig economy presents an opportunity for many work-ers, it also comes at a price, with precarious forms of self-employment of limited duration, and lacking a sense of job security. As D2L (2018) describes, “[w]here the traditional employment structure has provided workers with a degree of certainty, opportunity, and protections, those within

the gig economy frame-work are generally on their own...[G]ig workers have less social protection in the form of rights, are responsible for their own training and skill development, face weaker or less obvious career advancement opportunities, and are struck with greater insecurity about their financial positions. With skills being their most marketable commodity in a highly competitive marketplace, gig economy workers will find it essen-tial to adapt quickly and continually enhance their skillsets to meet the needs of the labour market on an ongoing basis.”<sup>43</sup>

The research in this area raises important questions about the nature of future forms of work, about our relationship to work and the “social fabric” in which it is embedded; about its ability to empower individuals or tether them to unregulated virtual sweatshops; about the absence of labour rights, bargaining rights and job security as “potent source[s] of social unrest and political instability,” fragmentation, isolation and exclusion; about the role of new institutional frameworks; and about the ability of societies to adapt and the role of governments in enabling societies to do so.<sup>44</sup>

### 3.3 Labour Market Income Inequality

The impact of automation technologies on income inequality is an important question that is not addressed well in the predictive studies. A look at the economics literature suggests that technological progress can lead

<sup>39</sup> Klaus Schwab, 2016, *The Fourth Industrial Revolution*, Switzerland: World Economic Forum, p.49.

<sup>40</sup> Otto Kässi and Vili Lehdonvirta, 2016, “Online Labour Index: Measuring the Online Gig Economy for Policy and Research,” MPRA Paper No. 74943, quoted in D2L, p.6.

<sup>41</sup> Richard Fry, 2015, “Millennials Surpass Gen Xers as the Largest Generation in U.S. Labor Force,” Pew Research Center, <http://www.pewre-search.org/fact-tank/2015/05/11/millennials-surpass-gen-xers-as-the-largest-generation-in-u-s-labor-force/>, quoted in D2L, 2018, p.6.

<sup>42</sup> Quoted in Schwab, p.50.

<sup>43</sup> D2L, 2018, p.6.

<sup>44</sup> Schwab, p.49.

to income inequality and that labour market polarisation plays an important role. As the research suggests, labour market polarisation is likely to occur because tasks not easily performed by AI tend to be at both the high and low ends of the skills spectrum, while AI tends to replace humans in tasks in the mid-skill category. Studies on the U.S. suggest a link between job polarisation and the polarisation of wages and working conditions (Acemoglu and Autor 2011; Autor and Salomons 2017). A study of Europe suggests similar findings (Goos 2014). Advances in technology led to increased demand for well-paid, high-skilled and low-paid low-skilled jobs, while the demand for middle income jobs has declined.<sup>45</sup>

The literature also observes that, despite labour demand in high and low paying jobs, technological progress leads to increasing wages in high-paying jobs that require skills complementing AI (Deming 2017), and pushes wages down further in lower paying jobs (Autor and Salomons 2017).<sup>46</sup> The gig economy further contributes to this trend.<sup>47</sup>

The literature also suggests that AI as a general-purpose technology (GPT) may be “inequality diminishing,” “disrupt[ing] the spiral of labour market polarisation.” As the McKinsey (2017) and WEF studies (2016, 2018) indicate, “AI may now be able to perform

tasks at a higher end of the skill spectrum, such as the classification of case documents for lawyers or the reading of medical images.”<sup>48</sup>

### 3.4 A Sense of Purpose

The literature also highlights the intrinsic value of human work. As Schwab (2016) suggests, “[t]echnology enables greater efficiency, which most people want. Yet they also wish to feel that they are not merely part of a process but of something bigger than themselves.”<sup>49</sup> As Korinek and Stiglitz (2017) note, “jobs provide not only income but also other mental services such as meaning, dignity and fulfilment to humans.”<sup>50</sup> What happens if there is insufficient demand for labour? Stevenson (2017) suggests that policies may be needed to promote other fulfilling ways to spend time.<sup>51</sup>

### 3.5 The Inevitability of Technological Change

Underpinning this literature is the notion that technological development has “its own agency and power,” and that it is “shap[ing] our society in ways that we are unable to properly trace or control.”<sup>52</sup> The

<sup>45</sup> European Commission, p.82.

<sup>46</sup> Bertin Martens and Songul Tolan, 2018, “JRC Digital Economy Working Paper 2018-08, Will this time be different? A review of the literature on the impact of Artificial Intelligence on Employment, Incomes and Growth,” p.18, JRC Technical Reports, [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=3290708&nbsp](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3290708&nbsp), accessed March 6, 2019.

<sup>47</sup> Martens and Tolan, p.18.

<sup>48</sup> Martens and Tolan, p.19.

<sup>49</sup> Schwab, p.51.

<sup>50</sup> Anton Korinek and Joseph Stiglitz, 2017, “Artificial Intelligence and Its implications for Income Distribution and Unemployment,” NBER Conference, The Economics of Artificial Intelligence, (Dec), <https://www.nber.org/chapters/c14018.pdf>, accessed March 6, 2019.

<sup>51</sup> Betsy Stevenson, 2017, “AI, Income, Employment, and Meaning”, in A Agrawal, J Gans, and A Goldfarb (eds), *The Economics of Artificial Intelligence: An Agenda*, <https://www.nber.org/chapters/c14026.pdf>, accessed March 6, 2019.

<sup>52</sup> Anna Nguyen, 2019, “Book Review of *Technology and the future of work: the impact on labour markets and welfare states*, by Brent Greve, Cheltenham, UK, and Northampton, MA, Edward Elgar Publishing, 2017, ISBN 978-1-78643-428-9,” *Information, Communication & Society*, Vol.22, no.1, p.152, DOI: 10.1080/1369118X.2018.1499795, accessed March 23, 2019.

role for society is thus to adapt, rather than steer its development to the benefit of society.<sup>53</sup> The literature then leads to questions about how to support those who will be left behind.

### 3.6 A Role for Governments

Despite arriving at different conclusions about the impact of these technologies on work, many of these studies propose similar measures to bolster the adaptive capacity of societies in order to keep pace. Some of these measures include reskilling and upskilling (D2L 2018; Frey and Osborne 2016; MGI 2017; Schwab 2016; WEF 2016, 2018; Brynjolfsson and McAfee 2014), and social and redistributive policies, such as a universal basic income and guaranteed employment (Martens and Tolan 2018, Brynjolfsson and McAfee 2014).

## 4. How can societies prepare?

While the impact of the *digital revolution* on the future of work may not be of the magnitude that the techno-pessimists predict, history shows us that it will likely eliminate jobs in some occupations, create new jobs in others, and call for entirely new skillsets. The changes taking place will affect almost everyone in some way. Therefore, “resilience and the adaptive capacity of society are essential to forge a system of governance adapted to the challenges of the 21st century” (Bourgon, 2011:89) .

The third phase of the NS Initiative is intended to generate *useful* and *usable insights* to help practitioners think through challenges, and set a course adapted to their context and circumstances. While the research on the future of work in the digital age leaves us with a somewhat unsettled feeling - that we are living in uncertain times, that the future of work is not clear, and that we will need to invent our way through - it also shares some certainties. That the new normal is change. Skills, jobs, and forms of employment are changing and will continue to do so. And that governments have a role to play. With this imperfect knowledge in a context with a high degree of uncertainty about the future, governments must set a course. Governments are searching for a mix of actions that taken together may help their societies to adapt to a fast-changing landscape, reap the benefits that a digital world has to offer and prevent, to the extent possible, some of the most detrimental

impacts for society.

What can they do to bolster the adaptive capacity and resilience of society? Adopting a deliberate, organized, systematic, multi-dimensional approach that focuses on individuals, families, and communities will be key for governments navigating the digital world. Engaging people, families, and communities provides the capabilities and energy to bring about change, lead public transformation and propel society forward. Governments can help individuals prepare for evolving career paths that weave them in and out of training and reskilling, reduce the risks for families of a changing employment landscape, and support communities in building a diverse work base. Some measures include ongoing education and training, social protections that offset transition costs, and labour regulatory frameworks fit for the digital age.

<sup>53</sup> Austan Goolsbee, 2018, “Public Policy in an AI Economy” (No.w24653) National Bureau of Economic Research, <https://www.nber.org/papers/w24653>, accessed March 6, 2019.

## 4.1 Preparing Individuals

Investing in people, their knowledge, know-how and capabilities is key to preparing individuals for the workplace of the future and equipping them with the tools they need to do future work. As Professors Susskind and Susskind (2018) observe in *The Future of the Professions*, this involves raising awareness among workers that the traditional career path is moving away from lifelong work, that new roles are likely, and that training in these new roles requires skills and capabilities “quite unlike” those that we currently train people for.<sup>54</sup> As Professors Brynjolfsson and McAfee (2018) note in *The Second Machine Age*, the result is that individuals “will need to be more adaptable and flexible in their career aspirations, ready to move on from areas that become subject to automation and seize new opportunities where machines complement and augment human capabilities.”<sup>55</sup> Transitioning jobs, sectors and geographies over the course of one’s career will be the norm, and lifelong learning the entry point to successful transitions.<sup>56</sup>

Lifelong learning encompasses early childhood education through to adult learning, the foundation of which is developing the necessary skills to succeed in life: the focus

on young people involves imparting ‘the knowledge, skills and attitudes necessary for emerging opportunities in work while adult learning plays a crucial role in helping those already in the labour force acquire needed skills.’<sup>57</sup>

### Developing Mixed Skillsets

While STEM (Science, Technology, Engineering, Mathematics) remains the backbone of learning in the digital age, several studies suggest that the digital world depends on workers with a diverse set of skills.<sup>59</sup> Studies emphasize the importance of new ICT competencies needed to work effectively in a digital context as specialists, as well as a basic level of digital literacy as a user of digital technologies.<sup>59</sup>

More significantly, however, is a broad category of *soft skills* that is growing in importance, which, in the past, have often taken a back seat to technical and job-specific skills.<sup>60</sup> In its White Paper on the future of skills, D2L (2019) underscores the importance of *soft skills* - “those that contribute to adaptability, interpersonal interactions, and resiliency.”<sup>61</sup> These skills, which D2L refers to as *durable skills*, “are

<sup>54</sup> Daniel Susskind and Richard Susskind, 2018, “*The Future of the Professions*,” *Proceedings from the American Philosophical Society*, Vol.162, No.2, June, p.135, <https://www.amphilsoc.org/sites/default/files/2018-11/attachments/Susskind%20and%20Susskind.pdf>, accessed Mar 8, 2019.

<sup>55</sup> Brynjolfsson and McAfee, 2014.

<sup>56</sup> Nicolas Mialhe and Cyrus Hodes, 2017, “Making the AI Revolution Work for Everyone: A Report to the OECD” (March), The Future Society, AI Initiative, p.26. <https://www.tuftsgloballeadership.org/sites/default/files/images/resources/Mialhe%20Reading.pdf>, accessed Dec.7, 2018.

<sup>57</sup> OECD, 2019a, “Preparing for the changing nature of work in the digital era”, *OECD Going Digital Policy Note*, OECD, Paris, [www.oecd.org/going-digital/changing-nature-of-work-in-the-digital-era.pdf](http://www.oecd.org/going-digital/changing-nature-of-work-in-the-digital-era.pdf), accessed June 11, 2019.

<sup>58</sup> See for example, D2L, 2019, “The Future of Skills in the Age of the 4th Industrial Revolution,” <https://www.d2l.com/future-of-work/>, accessed June 11, 2019; OECD, 2019d, “OECD Skills Outlook 2019: Thriving in a Digital World,” OECD Publishing, doi: 10.1787/df80bc12-en, <https://www.oecd-ilibrary.org/docserver/d2a805cf-es.pdf?expires=1568478314&id=id&accname=guest&checksum=AFEC85DF0AD1888EB8179B7E39FCAACO>, accessed June 11, 2019; World Economic Forum, 2018, *The Future of Jobs*, [http://www3.weforum.org/docs/WEF\\_Future\\_of\\_Jobs\\_2018.pdf](http://www3.weforum.org/docs/WEF_Future_of_Jobs_2018.pdf), accessed Feb. 2, 2019.

<sup>59</sup> OECD, 2019d.

<sup>60</sup> D2L, 2019, p.5.

<sup>61</sup> D2L, 2019, p.3.

the cognitive and non-cognitive skills necessary to engage in, interact with, and adapt to any work environment” including systems thinking, creativity, originality, adaptability, active learning, emotional intelligence, communication, collaboration, and leadership, as well as global competence, the ability to operate within an increasingly complex and globalized world.<sup>62</sup> The World Economic Forum further notes the importance of an orientation to service.<sup>63</sup>

In contrast to job specific skills, soft skills are “timeless,” and can be found across a range of disciplines and careers:

“The life-long relevance of these skills also far supersedes the half-life of job skills, some of which are only relevant for 12 months...Further underscoring their value, employees who have the underlying durable skills can be taught and retaught job skills more easily as needs, jobs, and careers change over time.”<sup>64</sup>

But as D2L (2019) notes, soft skills require a different mode of teaching than strictly technical or job specific skills: “they are more difficult to train for and are not easily assessed. While transient job skills can often be acquired independently and then assessed for mastery, durable skills require continuous coaching, mentoring, and feedback to understand, apply, and master.”<sup>65</sup>

## Reskilling and Upskilling Workers

The *Future of Jobs Report* (2018) notes that by 2022, roughly 54% of all employees will be in need of “significant re-skilling and upskilling” to bridge the widening skills gap as a result of the adoption of new technologies.<sup>66</sup> Those most at risk are low-skilled workers<sup>67</sup>, who, as the OECD (2019) study *Going Digital* notes, “often face greater urgency to up-skill or re-skill because their jobs are more likely to be affected by automation, as more routine-intensive occupations frequently require lower skills.”<sup>68</sup>

The OECD Working Paper on *Automation, Skills Use and Training* (2018) further notes that “[t]his is a group that receives very little retraining from their own employers.”<sup>69</sup> Just 40% receiving training in the workplace compared to 73% of high-skilled workers.<sup>70</sup> Training outside of the workplace is likewise low: “workers with the highest risk of automation [are] about twice less likely to participate in formal education and 3.5 times less likely to take part in distant learning.”<sup>71</sup>

These studies suggest a role for adult training policies to facilitate the transition of workers most affected by digital transition to better jobs.<sup>72</sup> Training policies that are aligned to the labour market can

<sup>62</sup> D2L, 2019, p.3.

<sup>63</sup> World Economic Forum, 2018, p.12.

<sup>64</sup> D2L, 2019, pp.3-4.

<sup>65</sup> D2L, 2019, p.4.

<sup>66</sup> World Economic Forum, 2018, p.ix.

<sup>67</sup> Labour shortage is particularly acute in low skilled jobs such as healthcare aids, restaurants and tourism industries, etc.

<sup>68</sup> OECD, 2019e, *Going Digital: Shaping Policies, Improving Lives*, OECD Publishing, Paris, p. 8, <https://doi.org/10.1787/9789264312012-en>, accessed June 11, 2019.

<sup>69</sup> L. Nedelkoska and G. Quintini, 2018, “Automation, skills use and training”, *OECD Social, Employment and Migration Working Papers*, No. 202, p.9, OECD Publishing, Paris, <https://doi.org/10.1787/2e2f4eea-en>, accessed June 11 2019.

<sup>70</sup> OECD, 2019e, p.8.

<sup>71</sup> Nedelkoska and Quintini, 2018, p.9.

<sup>72</sup> OECD, 2019, *OECD Skills Outlook 2019*.

ensure that gaps in current and anticipated skills are addressed, and in turn, “learners [can] see returns in terms of wages and employment opportunities to their participation.”<sup>73</sup> Studies likewise call on the workplace to broaden reskilling and upskilling efforts to include all workers. As the *Future of Jobs Report* (2018) notes, doing so would “increase the availability of future skills and address impending skills scarcity.”<sup>74</sup>

Some countries offer financial incentives to workers and employers to facilitate reskilling and upskilling. As Neufeld et al (2018) point out, “upgrading skills and taking time off to do so needs to be financially viable for people. Those with the greatest need for upgrading their skills - particularly those in non-standard employment, workers in small- and medium-enterprises, or the non-employed - often do not have access to necessary financial resources to invest in their skills.”<sup>75</sup>

One measure that is increasing in popularity is *individual training accounts* which provide workers with the flexibility to develop their own training programmes. In France, the *Compte Personnel de Formation* (CPF) provides workers with funding to take up to 150 hours of training over the course of their working life which is not attached to any employment contract.<sup>76</sup>

Similarly, *Singapore’s SkillsFuture Initiative* provides students and workers at all stages of their career with the opportunity to upgrade their skills. Citizens age 25 and up receive \$500 in credit, and periodic top-ups

to pay for approved work-related skills courses. Likewise, grants are available for SMEs to upgrade their workforce. The online portal features online courses, personalized recommendations, as well as digital certificates that prospective employers can access. As of 2018, 285,000 Singaporeans had used their credits.<sup>77</sup>

*Ireland’s Springboard+ Upskilling Initiative*, co-funded by the Government of Ireland and the European Social Fund (ESF), offers over 9,000 funded placements in 288 courses leading to certificate, degree and masters levels in areas with current employment opportunities. Most courses are part-time for a maximum of 12 months and are open to all eligible applicants whether employed, unemployed, formerly self-employed, or returning to the labour market.

### Investing in Lifelong Learning

Targeting reskilling and upskilling to vulnerable workers can help address skills shortages in the short term. A longer-term approach would focus on making education and training widely available to all citizens over the course of their lifetime, regardless of income or age. Some studies of the future of work, such as D2L (2018, 2019), the *Future of Jobs Report* (2016, 2018), and McKinsey’s *Job’s Lost, Jobs Gained* (2017) suggest that an overhaul of the traditional “front-end learning model” is needed to respond to the new employment landscape of constantly changing skillsets and evolving career paths.<sup>78</sup> These studies propose a model of *life-long learning*, either alongside compulsory

<sup>73</sup> OECD, 2019b, “Well-being in the digital age,” OECD Going Digital Policy Note, OECD, Paris, [www.oecd.org/going-digital/well-being-in-the-digital-age.pdf](http://www.oecd.org/going-digital/well-being-in-the-digital-age.pdf), accessed June 11, 2019.

<sup>74</sup> World Economic Forum, 2018, p.23.

<sup>75</sup> Max Neufeld, Florian Ranft and Jacqueline O’Reilly, 2018, “Conclusion: Political realities and a reform agenda for the digital age,” in *Work in the Digital Age: Challenges of the Fourth Industrial Revolution*, Edited by Max Neufeld, Jacqueline O’Reilly and Florian Ranft, Rowman and Littlefield: NY, p.547.

<sup>76</sup> Neufeld et al, 2018, p.537.

<sup>77</sup> Faris Mokhtar, 2018, “Over 285,000 Singaporeans benefitted from SkillsFuture Credit since its launch,” <https://www.todayonline.com/singapore/over-285000-singaporeans-benefitted-skillsfuture-its-launch>, accessed Sept. 13, 2019.

education or as a replacement, which enables people to acquire skills and to reskill and upskill as needed. It is seen as flexible, accessible and centred around the learner's experience.<sup>79</sup> Skills acquisition is a continuum, where “students open the door to one pathway, [and] the doors to others do not close irrevocably.”<sup>80</sup>

The precise contours of lifelong learning will differ from country to country, and likewise depend on the engagement and support of key actors, including governments, employers and workers, labour organizations and associations, and educational institutions to define its scope. However broad the scope, lifelong learning offers several intervention points.

Many agree on the importance of *early childhood education*, as well as integrating the development of future skills into *primary and secondary education* to guard against losing a generation of young people to low competencies in key skills. The OECD study,

*Measuring the Digital Transformation* (2019), underscores the importance of educating early on in the development of cognitive and problem-solving skills: “[s]tudents aged 15 years who are top performers in science, mathematics and reading in the OECD Programme for International Student Assessment (PISA)<sup>81</sup> can be considered to be among the best equipped to adapt to the scale, speed and scope of digital transformations. In 2015, about 15% of 15-year-olds were top performers in OECD countries with notable cross-country differences. Their share reached 26% in Japan and Korea, but remained below 5% in Chile, Turkey and Mexico.”<sup>82</sup>

Sweden is integrating digital skills into the classroom, including coding in math and science courses, and critical thinking in social studies and religion classes.<sup>83</sup> Through Estonia's **ProgeTiger** program, preschool, primary and secondary students are learning computer coding.

<sup>78</sup> See for example, James Manykia, Susan Lund, Michael Chui, Jacques Bughin, Jonathan Woetzel, Parul Batra, Ryan Ko, and Saurabh Sanghvi, 2017e, “Jobs Lost, Jobs Gained: Workforce Transitions in a Time of Automation,” <https://www.mckinsey.com/-/media/mckinsey/featured%20insights/Future%20of%20Organizations/What%20the%20future%20of%20work%20will%20mean%20for%20jobs%20skills%20and%20wages/MGI-Jobs-Lost-Jobs-Gained-Report-December-6-2017.ashx>, accessed March 6, 2019; OECD, 2017, “Future of Work and Skills,” Paper presented at the 2nd Meeting of the G20 Employment Working Group, 15-17 February 2017, [https://www.oecd.org/els/emp/wcms\\_556984.pdf](https://www.oecd.org/els/emp/wcms_556984.pdf), accessed March 8, 2019; D2L, 2019, “The Future of Skills in the Age of the 4th Industrial Revolution,” <https://www.d2l.com/future-of-work/>, accessed June 11, 2019; OECD, 2019d, “OECD Skills Outlook 2019: Thriving in a Digital World,” OECD Publishing, doi: 10.1787/df80bc12-en, <https://www.oecd-ilibrary.org/docserver/d2a805cf-es.pdf?expires=1568478314&id=id&accname=guest&checksum=AFEC85DF0AD1888EB8179B7E39FCAAC0>, accessed June 11, 2019; World Economic Forum, 2018, *The Future of Jobs*, [http://www3.weforum.org/docs/WEF\\_Future\\_of\\_Jobs\\_2018.pdf](http://www3.weforum.org/docs/WEF_Future_of_Jobs_2018.pdf), accessed Feb. 2, 2019.

<sup>79</sup> D2L, 2018, p. 14.

<sup>80</sup> Simeon Djankov and Federica Saliola, 2019, “The Changing Nature of Work,” *Journal of International Affairs* 72, no. 1 p. 65, <https://www.jstor.org/stable/26588343>.

<sup>81</sup> The OECD Programme for International Student Assessment (PISA) has been undertaken every three years since 2000. Students included in the assessment must be enrolled in school and have completed at least six years of formal schooling, regardless of the type of institution, programme, or full-time or part-time attendance. More than 500,000 students across 72 countries and economies took the two-hour test in 2015.

<sup>82</sup> OECD, 2019c, *Measuring the Digital Transformation: A Roadmap for the Future*, OECD Publishing, Paris, p. 190, <https://doi.org/10.1787/9789264311992-en>.

<sup>83</sup> Mark Scott, 2019, “Sweden tries to make digital lightning strike twice: The Nordic country bis revamping its education system to create a second generation of tech savants,” April 19, <https://www.politico.eu/article/sweden-education-system-digital-revamp-coding-stockholm-school/>, accessed Sept. 16, 2019.

Studies likewise highlight a variety of measures for bringing tertiary education in line with lifelong learning. The introduction of *apprenticeship* programs such as those in Germany and Switzerland - where roughly 30 percent and 70 percent of students, respectively, are educated in vocational programs<sup>84</sup> -- could perform a valuable function preparing youth for future jobs. The transition from school to work is “a pivotal moment for young people, but one in which many of them are left behind.”<sup>85</sup> The OECD working paper on “Automation, Skills Use and Training” (2018) indicates that teen jobs are particularly vulnerable to automation, and that the “warnings in some developed countries that teen jobs have been harder to come by in recent years should be taken seriously.”<sup>86</sup> In the German and Swiss apprenticeship programs, students spend part of their time attending high school and part of their time working and earning at an employer in preparation for future jobs.

Breaking down degree programs into *stackable micro-credentials* can provide students and workers with “clear on and off ramps to the education system.” Micro-credentialing allows workers to drop into the education programs to acquire specific skillsets without having to commit to multi-year degree programs or leave their jobs.<sup>87</sup> Students can likewise leverage micro-credentialing as they chart their individual education paths.<sup>88</sup> The state of New South

Wales in Australia adopted a stackable program model for vocational and educational training that allows students to build their own program.<sup>89</sup>

*Incorporating soft-skills into tertiary education*, where they have traditionally come second to the development of job-specific knowledge and skills, to ensure their continued development from the primary and secondary levels. In 2012, Hong Kong added an additional year of general education to undergraduate programs, focusing on problem-solving and critical thinking.<sup>90</sup>

*Rethinking Program Delivery* with the support of digital tools can help educational institutions “personalize the learning experience...in a manner that is affordable and scalable.”<sup>91</sup> Technology can likewise help engage a wider population of students and workers. For instance, *Blended Learning*, a combination of online and in-person learning, and *Distance Learning* including Massive Online Open Courses (MOOCs) and Open Universities can help address issues of access, affordability, personalization, time to completion.<sup>92</sup> In 2018, XuetangX, China’s biggest MOOC and blended learning portal, was used by 10 million students.<sup>93</sup> Likewise, *Competency-Based Education* (CBE) enables students to accelerate through a program where they already possess the knowledge and skills, while spending more time on the skills that they lack.<sup>94</sup> At

<sup>84</sup> McKinsey, 2017e, p.112.

<sup>85</sup> Global Commission on the Future of Work, 2019, “Work for a brighter future,” International Labour Organization: Geneva, p.32, [https://www.ilo.org/wcmsp5/groups/public/---dgreports/---cabinet/documents/publication/wcms\\_662410.pdf](https://www.ilo.org/wcmsp5/groups/public/---dgreports/---cabinet/documents/publication/wcms_662410.pdf), accessed September 9, 2019.

<sup>86</sup> Nedelkoska, and Quintini, 2018, p. 115.

<sup>87</sup> D2L, 2018, p.15.

<sup>88</sup> D2L, 2019, p.10.

<sup>89</sup> D2L, 2019, p.10.

<sup>90</sup> Djankov and Saliola, 2019, p.65.

<sup>91</sup> D2L, 2018, p.15.

<sup>92</sup> D2L, 2018, p.15.

<sup>93</sup> Djankov and Saliola, 2019, p.65.

<sup>94</sup> D2L, 2018, p.14.

Sinclair Community College in Canada, CBE students completing degree programs in Computer Information Systems finish 35% faster than non-CBE students.<sup>95</sup> Finally, *Work-Integrated Learning*, like vocational programming, provides on-the-job and experiential learning opportunities alongside school-based learning. For instance, Shopify, an e-commerce company based in Canada, in partnership with Carleton and York Universities established the Dev Degree, a software developer degree program. The program blends classroom learning with practical work experience, an important pillar of which is developing soft skills alongside technical skills. Shopify pays for the student's tuition and students earn a competitive salary for their work-integrated learning.<sup>96</sup>

A comprehensive approach to *career support for students and workers*, combining personalized counselling and placements with digital services could ease labour market transitions. Likewise, AI and other digital technologies can be harnessed to *improve and personalize job search and hiring processes*, improving labour supply and demand matching, shortening search times between jobs, and reducing periods of unemployment. AI has already begun to streamline job search and training; for instance, the LinkedIn platform uses AI to help recruiters find the right candidates and to connect candidates to the right jobs, drawing on the user's profile and activity data.<sup>97</sup>

### Some Considerations

Reskilling and upskilling opportunities need to be available to all workers, not just those in standard forms of employment.

Quality assurance of learning institutions, programmes and courses, as well as portability of skills will increasingly become important considerations in the digital age. Updating and/or establishing mechanisms for quality assurance of institutions, programs and credits, as well as standards for assessing and recognizing skills and credentials acquired in non-formal settings are key.<sup>98</sup>

Unions and employers' associations possess deep knowledge of industries and service sectors, and can play an important role in understanding skills demands, aligning training to labour market needs, and identifying key challenges.

## 4.2 Preparing Families

Preparing families for the digital age means that no one is left behind. As the Global Commission on the Future of Work (2019) writes, "Work sustains us. It is how we meet our material needs, escape poverty and build decent lives. Beyond our material needs, work can give us a sense of dignity, belonging and purpose...Yet work can also be dangerous, unhealthy and poorly paid, unpredictable and unstable."<sup>99</sup> Social support systems and regulatory frameworks play a fundamental role in protecting workers and their families from the exigencies of work. Crafting these institutions and ensuring they are fit for the digital age are some measures that governments can take to contribute to the adaptive capacity and resilience of their societies.

### Rethinking Social Protection

<sup>95</sup> D2L, 2019, p.10.

<sup>96</sup> D2L, 2019, p.12.

<sup>97</sup> OECD, 2019, *Artificial Intelligence in Society*, OECD Publishing, Paris, p.109, <https://doi.org/10.1787/eedfee77-en>.

<sup>98</sup> Global Commission on the Future of Work, 2019, pp.30-1.

<sup>99</sup> Global Commission on the Future of Work, 2019, p.18.

Systems of social protection currently in place in many OECD countries are based on the notion of a stable employee-employer relationship. However, in the future fewer workers will be engaged in standard forms of employment; an increasing number of workers will hold more than one job and source of income, with no statutory working hours or minimum wages. Even now social support systems are a “poor fit” for non-standard forms of work.<sup>100</sup> As the OECD paper on the *Future of Work and Skills* (2017) indicates, “in over half of G20 countries with available data, the self-employed currently have no access to unemployment benefits, while in most other countries they face different rules from standard workers with regards to old age and invalidity as well as health benefits.”<sup>101</sup>

Societies will need to examine how to adapt social support systems to ensure adequate protection for all workers in the new world of work. Governments can put in place a variety of measures to guard against the potential for dislocation in the digital age. Social protection schemes can be adapted to include income and employment support for non-standard workers, either as voluntary coverage or directly incorporating them into current schemes. Tying social protection entitlements to the individual rather than their work status or history would facilitate transitions between jobs, ensuring accessibility and portability of benefit entitlements from one job to another. For instance, the *individual activity accounts* discussed above are both portable and flexible.

Some studies propose introducing a *Universal Basic Income* (UBI), a guaranteed minimum

income supplement aimed at every individual, independent of income or employment status, the appeal of which rests on the absence of any conditions or reciprocal responsibilities. The OECD (2017) “Future of Work and Skills” study suggests that in some countries, a basic income guarantee could have “the advantage of filling the gaps left by existing social security systems while also offering a simpler alternative to the complex mixture of in- and out-of-work benefits.”<sup>102</sup> Brazil’s Bolsa Familia conditional cash transfer program provides individuals with a basic income independent of their employment status.<sup>103</sup>

The 2019 *World Development Report* proposes a *reformed social insurance scheme* for all workers: “guaranteed minimum insurance with subsidized coverage against impoverishing losses, a mandated savings and insurance plan, and a voluntary savings option.” The governments of Costa Rica and Thailand currently subsidize coverage for self-employed, and informal sector workers, respectively.<sup>104</sup>

### Updating Labour Market Regulations

As is the case with current social support systems, existing labour market regulations “often fail to protect most workers when informality is the norm and work is often out of reach of the authorities.”<sup>105</sup> These labour market regulations— developed in the industrial era, and based on a different conceptualization of the worker, employment, and the workplace— are often unclear about who would qualify, if at all, for employment standards or

<sup>100</sup> OECD, 2019a, “Preparing for the changing nature of work in the digital age.”

<sup>101</sup> OECD, 2017, “Future of Work and Skills, p.16.

<sup>102</sup> OECD, 2017, “Future of Work and Skills,” p.17.

<sup>103</sup> OECD, 2017, “Future of Work and Skills,” p.17.

<sup>104</sup> Djankov and Saliola, 2019, p.68.

<sup>105</sup> Djankov and Saliola, 2019, p.69.

protections, such as minimum wage, working time regulations, and regulations around occupational health and safety.<sup>106</sup>

Indeed, for some new forms of work, it is unclear what the status of workers is, who the employer is, and what rules should apply to them. Gig work, which involves intermediation through platforms that are remotely owned and operated, illustrates the ambiguity of current regulatory regimes. As de Ruyter, Brown, and Burgess (2019) explain,

“The process generates ambiguities around worker status, employee status, the workplace, and jurisdiction, such as when it may not be clear who the employer is. This has arisen in the case of food delivery, for example, in which it is unclear whether the employer is the consumer, the owner of the platform, the supplier of food, or in some cases the franchisee or the sub-contractor of labor. At the end of the process, a delivery agent/employee/contractor is delivering meals, but in the transaction, there may be multiple intermediaries receiving shares of the value-added. Who is responsible if there are delays in delivery, the order is incorrect, the agent is involved in an accident, or the customer is dissatisfied with the quality of the food?”<sup>107</sup>

A variety of measures can be taken to address the gaps in the existing legislation. *Clarifying the legal status of all types of workers* (gig worker, temporary worker, independent

contractor, dependent contractor, and the like) *and their relationship to their employer* would reduce ambiguity around who is protected by employment legislation, including health and safety, and minimum wages.<sup>108</sup> Consideration could be given to *extending rights to all workers rather than just employees*, including access to social benefits and training, collective bargaining and the like. Establishing *multinational workplace standards* or extending one’s country laws to workers in another country would protect offshore workers and others working within a global context.<sup>109</sup>

### Some Considerations

Social protection mechanisms will need to be carefully managed for adverse or unintended consequences. Income support schemes that provide income security and compensate for lost earnings will need to be designed so as not to inadvertently undermine incentives to work.<sup>110</sup> Thought will need to be given to the impact of schemes like the UBI on income redistribution and inequality, especially with respect to the most vulnerable. And where earnings are uncoupled from working, understanding the psychological impact of not having a job and how to spend one’s leisure time will be important.<sup>111</sup>

The digital revolution also brings with it the opportunity for societies “to formulate a vision [of the future of work] and plan so that the opportunities are seized.” The digital age opens the door to reconsidering the relationship between work, and health

<sup>106</sup> Alex De Ruyter, Martyn Brown, and John Burgess, 2019, “Gig Work and the Fourth Industrial Revolution: Conceptual and Regulatory Challenges,” *Journal of International Affairs*, 72, no. 1, p44, <https://www.jstor.org/stable/26588341>.

<sup>107</sup> De Ruyter, Brown and Burgess, 2019, p.46.

<sup>108</sup> OECD, “Future of Work and Skills,” 2017, p.18.

<sup>109</sup> OECD, 2017, “Future of Work and Skills,” p. 19.

<sup>110</sup> OECD, 2019a, “Preparing for the changing nature of work in the digital era.”

<sup>111</sup> Goolsbee, 2018.

and well-being: “[d]angerous, dirty and dull work can be drastically reduced while jobs that celebrate creativity, flexibility and purpose can be enhanced.”<sup>112</sup> Reflecting on harnessing technology, and all that comes with it, including flexible working arrangements, reduced working hours, and teleworking for will be key.

Consideration will also need to be given to revenue sources to finance benefits. Important questions include defining who pays the employer contribution for non-standard workers - the employer through social contributions as is the case for standard employees?<sup>113</sup> Some solutions in the area of taxation are beginning to emerge. For instance, in Estonia, Airbnb and the Estonian Tax and Customs Board (ETCB) developed a platform to make it easier for hosts on Airbnb to voluntarily report their earnings to the tax authorities, which will subsequently add the income to the host’s yearly tax returns. As non-standard forms of work become more common, the number of workers covered by collective agreements is likely to fall. Consideration should be given to the implications of this for work, workers, and societies more broadly.

### 4.3 Preparing Communities

The NS Working Paper on “Resilience and the New Synthesis of Public Administration” (2019) teaches us that communities are important loci for community engagement and collective problem-solving. Communities are unique spaces, with dynamic systems of convergence where multiple actors meet, interact, and exchange ideas. Building resilient communities depends on the strength of these interactions, a *diversity*

*of perspectives*, and a multidimensional approach to collective problem-solving. The story of Allentown’s adaptation in the face of deindustrialization is illustrative. Its success could be attributed to a “structure of civic relations that facilitated actions across socio-political and economic spheres: ‘serving on the boards of organizations like the Boy Scouts and local universities provided local economic actors who did not have intersecting economic interests a forum in which to develop, enact and reproduce community-oriented identities and values.’”<sup>114</sup>

Developing solutions to steer society through this unprecedented period of change depends on the collective coming together of its members - governments, workers, employers, workers associations, and education and training institutions. The state of North Carolina, U.S., brought together industry and higher education stakeholders to design the BioWorks certification program in response to the shortage of skilled workers in the biotechnology industry. Offered in community college, the BioWorks program seeks to “attract workers from the state’s shrinking manufacturing sector and retrain them for higher-paying work in the biotechnology industry. As of 2017, thousands of students have passed through the course and six community colleges in North Carolina offer the program.”<sup>115</sup>

#### Some Considerations

Allentown and North Carolina can serve as examples of the collective coming together of community members to transform intractable problems into workable

<sup>112</sup> OECD, 2019a, “Preparing for the changing nature of work in the digital era.”

<sup>113</sup> OECD, 2019a, “Preparing for the changing nature of work in the digital era”; Neufiend, et al., 2018.

<sup>114</sup> Chris Gunter, 2019, Unpublished Paper: “A PGI Working Paper: Resilience and the New Synthesis of Public Administration,” PGI: Ottawa.

<sup>115</sup> D2L, 2019, p.17.

solutions. Indeed, the various measures presented in the previous sections of the paper all depend on the engagement and interaction of community members, working together to find solutions and propel them forward in pursuit of a future can be enjoyed by all.

## 5. Concluding Remarks

This paper explores research around the impact of the digital revolution on the future of work. While there is uncertainty about the precise shape and scope of disruption, the research suggests that the changes promise to have a profound effect on the society that we know today. There are a variety of measures that governments can take to build the adaptive capacity and resilience of their societies, including developing a mixed skillset with durable skills at its core, reskilling and upskilling workers, establishing a system of lifelong learning, and ensuring social protections and regulations governing the labour market are fit for the digital age. There is no singular path for governments to follow; it is for governments to determine the appropriate mix of approaches and practices depending on their own legal, ethical and cultural contexts and circumstances. The key is to learn from others about how they invented solutions to build the *adaptive capacity* and *resilience* of societies in order for people to build and share a better future together.

## Bibliography:

- Arntz, Melanie, Terry Gregory and Ulrich Zierhan, 2016, "The Risk of Automation for Jobs in OECD Countries," OECD, <https://www.oecd-ilibrary.org/docserver/5j1z9h56dvq7-en.pdf?expires=1553457230&id=id&accname=guest&checksum=2AB7AB65603A6B5428731BE014A6A50A>, accessed March 6, 2019.
- Bourgon, Jocelyne, 2019, "NS Research Program 2019" (unpublished). Also see website: <https://www.pgionline.com/>.
- Bourgon, Jocelyne, 2011, *A New Synthesis of Public Administration: Serving in the 21st Century*, Kingston: Queen's Policy Studies.
- Brynjolfsson, Erik and Andrew McAfee, 2014, *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies*, W. W. Norton & Company.
- D2L, 2018, "The Future of Work and Learning in the Age of the 4th Industrial Revolution," <https://www.d2l.com/wp-content/uploads/2018/01/The-Future-of-Work-and-Learning-D2L.pdf>, accessed Nov. 8, 2018.
- D2L, 2019, "The Future of Skills in the Age of the 4th Industrial Revolution," <https://www.d2l.com/future-of-work/>, accessed June 11, 2019.
- Deloitte Insights, 2017, "Forces of change: The Future of Work," [https://www2.deloitte.com/content/dam/insights/us/articles/4322\\_Forces-of-change\\_FoW/DI\\_Forces-of-change\\_FoW.pdf](https://www2.deloitte.com/content/dam/insights/us/articles/4322_Forces-of-change_FoW/DI_Forces-of-change_FoW.pdf), accessed March 6, 2019.
- De Ruyter, Alex, Martyn Brown, and John Burgess, 2019, "Gig Work and the Fourth Industrial Revolution: Conceptual and Regulatory Challenges," *Journal of International Affairs*, 72, no. 1, pp. 37-50. <https://www.jstor.org/stable/26588341>.
- Djankov, Simeon, and Federica Saliola, 2019, "The Changing Nature of Work," *Journal of International Affairs* 72, no. 1 pp. 57-74, <https://www.jstor.org/stable/26588343>.
- European Commission, 2018, "Artificial Intelligence A European Perspective", (Dec) , <file:///C:/Users/NSW1/Desktop/Governing%20in%20a%20Digital%20Age/Future%20of%20Work/ai-flagship-report-online.pdf>, accessed March 6, 2019.
- Frey, Carl and Michael Osborne, 2016, "Technology at Work v2.0: The future is not what it used to be, Citibank," Citi GPS: Global Perspectives & Solutions, [https://www.oxfordmartin.ox.ac.uk/downloads/reports/Citi\\_GPS\\_Technology\\_Work\\_2.pdf](https://www.oxfordmartin.ox.ac.uk/downloads/reports/Citi_GPS_Technology_Work_2.pdf), accessed March 21, 2019.
- Frey, Carl and Michael Osborne, 2016, "The future of employment: How susceptible are jobs to computerisation?," *Technological Forecasting and Social Change*, Elsevier, vol. 114(C), pages 254-280, accessed Mar 6, 2019.

- Furman, Jason, 2017, "Should we be Reassured if Automation in the Future looks like Automation in the Past?", National Bureau of Economic Research, <https://www.nber.org/chapters/c14031>, accessed March 6, 2019.
- Global Commission on the Future of Work, 2019, "Work for a brighter future," International Labour Organization: Geneva, [https://www.ilo.org/wcmsp5/groups/public/--dgreports/---cabinet/documents/publication/wcms\\_662410.pdf](https://www.ilo.org/wcmsp5/groups/public/--dgreports/---cabinet/documents/publication/wcms_662410.pdf), accessed September 9, 2019.
- Goalsbee, Austan, 2018, "Public Policy in an AI Economy" (No.w24653) National Bureau of Economic Research, <https://www.nber.org/papers/w24653>.
- Gunter, Chris, 2019, "A PGI Working Paper: Resilience and the New Synthesis of Public Administration," (Unpublished).
- Hirsch, Jeffrey, 2019, "Future Work," *University of Illinois Law Review*, 2020 Forthcoming; UNC Legal Studies Research Paper, <https://ssrn.com/abstract=3334667>, accessed June 11, 2019.
- Korinek, Anton and Joseph Stiglitz, 2017, "Artificial Intelligence and Its implications for Income Distribution and Unemployment," NBER Conference, The Economics of Artificial Intelligence, (Dec), <https://www.nber.org/chapters/c14018.pdf>, accessed March 6, 2019.
- Manyika, James, Michael Chui, Mehdi Miremadi, Jacques Bughin, Katy George, Paul Willmott, and Martin Dewhurst, 2017, "Harnessing automation for a future that works," (January), McKinsey Global Institute, <https://www.mckinsey.com/featured-insights/digital-disruption/harnessing-automation-for-a-future-that-works>, accessed March 21, 2019.
- Manykia, James, Susan Lund, Michael Chui, Jacques Bughin, Jonathan Woetzel, Parul Batra, Ryan Ko, and Saurabh Sanghvi, 2017e, "Jobs Lost, Jobs Gained: Workforce Transitions in a Time of Automation," <https://www.mckinsey.com/-/media/mckinsey/featured%20insights/Future%20of%20Organizations/What%20the%20future%20of%20work%20will%20mean%20for%20jobs%20skills%20and%20wages/MGI-Jobs-Lost-Jobs-Gained-Report-December-6-2017.ashx>, accessed March 6, 2019.
- Manykia, James, Susan Lund, Michael Chui, Jacques Bughin, Jonathan Woetzel, Parul Batra, Ryan Ko, and Saurabh Sanghvi, 2017, "What the Future of Work Will Mean for Jobs, Skills, and Wages," McKinsey Global Institute, <https://www.mckinsey.com/featured-insights/future-of-work/jobs-lost-jobs-gained-what-the-future-of-work-will-mean-for-jobs-skills-and-wages?reload>, accessed March 20, 2019.
- Martens, Bertin and Songul Tolan, 2018, "JRC Digital Economy Working Paper 2018-08, Will this time be different? A review of the literature on the impact of Artificial Intelligence on Employment, Incomes and Growth," JRC Technical Reports, [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=3290708](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3290708) &nbsp;, accessed March 6, 2019.

- McKinsey, 2017, *A Future that Works: Automation, Employment and Productivity*, McKinsey Global Institute, [https://www.mckinsey.com/-/media/McKinsey/Featured%20Insights/Digital%20Disruption/Harnessing%20automation%20for%20a%20future%20that%20works/MGI-A-future-that-works\\_Full-report.ashx](https://www.mckinsey.com/-/media/McKinsey/Featured%20Insights/Digital%20Disruption/Harnessing%20automation%20for%20a%20future%20that%20works/MGI-A-future-that-works_Full-report.ashx), accessed March 20, 2019.
- McKinsey, 2017a, “A Future that Works Executive Summary,” McKinsey Global Institute, <https://www.mckinsey.com/-/media/mckinsey/featured%20insights/Digital%20Disruption/Harnessing%20automation%20for%20a%20future%20that%20works/MGI-A-future-that-works-Executive-summary.ashx>, accessed March 23, 2019.
- Mialhe, Nicolas and Cyrus Hodes, 2017, “Making the AI Revolution Work for Everyone: A Report to the OECD” (March), The Future Society, AI Initiative, <https://www.tufts-globalleadership.org/sites/default/files/images/resources/Mialhe%20Reading.pdf>, accessed Dec.7, 2018.
- Mokhtar, Faris, 2018, “Over 285,000 Singaporeans benefitted from SkillsFuture Credit since its launch,” <https://www.todayonline.com/singapore/over-285000-singaporeans-benefitted-skillsfuture-its-launch>, accessed Sept. 13, 2019.
- Nedelkoska, L. and G. Quintini, 2018, “Automation, skills use and training”, *OECD Social, Employment and Migration Working Papers*, No. 202, OECD Publishing, Paris, <https://doi.org/10.1787/2e2f4eea-en>, accessed June 11 2019.
- Neufeind, Max, Florian Ranft and Jacqueline O’Reilly, 2018, “Conclusion: Political realities and a reform agenda for the digital age,” in *Work in the Digital Age: Challenges of the Fourth Industrial Revolution*, Edited by Max Neufeind, Jacqueline O’Reilly and Florian Ranft, Rowman and Littlefield: NY.
- Nguyen, Anna, 2019, “Book Review of *Technology and the future of work: the impact on labour markets and welfare states*, by Brent Greve, Cheltenham, UK, and Northampton, MA, Edward Elgar Publishing, 2017, ISBN 978-1-78643-428-9,” *Information, Communication & Society*, Vol.22, no.1, p.152, DOI: 10.1080/1369118X.2018.1499795, accessed March 23, 2019.
- OECD, 2017, “Future of Work and Skills,” Paper presented at the 2nd Meeting of the G20 Employment Working Group, 15-17 February 2017, [https://www.oecd.org/els/emp/wcms\\_556984.pdf](https://www.oecd.org/els/emp/wcms_556984.pdf), accessed March 8, 2019.
- OECD, 2018, “Policy Brief on the Future of Work: Putting faces to the jobs at risk of automation,” (March), [www.oecd.org/employment/future-of-work.htm](http://www.oecd.org/employment/future-of-work.htm), accessed Dec. 4, 2019.
- OECD, 2019, *Artificial Intelligence in Society*, OECD Publishing, Paris, p.109, <https://doi.org/10.1787/eedfee77-en>, accessed June 11, 2019.
- OECD, 2019e, *Going Digital: Shaping Policies, Improving Lives*, OECD Publishing, Paris, <https://doi.org/10.1787/9789264312012-en>, accessed June 11, 2019.

- OECD, 2019c, *Measuring the Digital Transformation: A Roadmap for the Future*, OECD Publishing, Paris, p. 190, <https://doi.org/10.1787/9789264311992-en>, accessed June 11, 2019.
- OECD, 2019d, “OECD Skills Outlook 2019: Thriving in a Digital World,” OECD Publishing, doi: 10.1787/df80bc12-en, <https://www.oecd-ilibrary.org/docserver/d2a805cf-es.pdf?expires=1568478314&id=id&accname=guest&checksum=AFEC85DF0AD1888EB8179B7E39FCAACO>, accessed June 11, 2019.
- OECD, 2019a, “Preparing for the changing nature of work in the digital era”, *OECD Going Digital Policy Note*, OECD, Paris, [www.oecd.org/going-digital/changing-nature-of-work-in-the-digital-era.pdf](http://www.oecd.org/going-digital/changing-nature-of-work-in-the-digital-era.pdf), accessed June 11, 2019.
- OECD, 2019b, “Well-being in the digital age,” OECD Going Digital Policy Note, OECD, Paris, Paris, [www.oecd.org/going-digital/well-being-in-the-digital-age.pdf](http://www.oecd.org/going-digital/well-being-in-the-digital-age.pdf), accessed June 11, 2019.
- Scarpetta, Stefano, and Journal of International Affairs, 2019, “The Future of Work: Advancing Labor Market Resilience,” *Journal of International Affairs* 72, no. 1, pp. 51-56. <https://www.jstor.org/stable/26588342>, accessed June 11, 2019.
- Schwab, Klaus, 2016, *The Fourth Industrial Revolution*, Switzerland: World Economic Forum.
- Scott, Mark, 2019, “Sweden tries to make digital lightning strike twice: The Nordic country bis revamping its education system to create a second generation of tech savants,” April 19, <https://www.politico.eu/article/sweden-education-system-digital-revamp-coding-stockholm-school/>, accessed Sept. 16, 2019.
- Stevenson, Betsy, 2017, “AI, Income, Employment, and Meaning”, in A Agrawal, J Gans, and A Goldfarb (eds), *The Economics of Artificial Intelligence: An Agenda*, <https://www.nber.org/chapters/c14026.pdf>, accessed March 6, 2019.
- Susskind, Daniel and Richard Susskind, 2018, “The Future of the Professions,” *Proceedings from the American Philosophical Society*, Vol.162, No.2, June, <https://www.amphilsoc.org/sites/default/files/2018-11/attachments/Susskind%20and%20Susskind.pdf>, accessed Mar 8, 2019.
- World Economic Forum, 2016, *The Future of Jobs: Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution*, World Economic Forum, [http://www3.weforum.org/docs/WEF\\_Future\\_of\\_Jobs.pdf](http://www3.weforum.org/docs/WEF_Future_of_Jobs.pdf), accessed Feb. 2, 2019.
- World Economic Forum, 2018, *The Future of Jobs*, [http://www3.weforum.org/docs/WEF\\_Future\\_of\\_Jobs\\_2018.pdf](http://www3.weforum.org/docs/WEF_Future_of_Jobs_2018.pdf), accessed Feb. 2, 2019.





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