CHARTING CHANGE

Workers' Voices *in an* Automated World

An IAM Canada Report

NOVEMBER 2021

TABLE OF CONTENTS

LETTER FROM

DAVE CHARTRAND
CANADIAN GENERAL VICE PRESIDENT

From the time that 19 machinists organized in a locomotive pit in Atlanta, Georgia, and every subsequent period, the IAM has been on the frontlines of defending, and fighting for our members. Throughout our long history, technological change is something we have often encountered, and worked to protect members from harsh consequences through strong collective agreements. We are now on the precipice of major changes brought on by never-before-seen advancements in technology.

The history of technological change has shown that the brunt of changes is borne by workers, who not only experience disruptions in their work lives, but communities, as well. As technological change disrupts social and economic orders, unions have also influenced the formation of public policy and legislation that protects the interests of all working people.

As technology moves at a galloping pace, the International Association of Machinists & Aerospace Workers is taking proactive steps and embarking on a study of automation in the Canadian Territory. The goal was to understand the extent and the nature of automation, and, most importantly, the impact. These findings will help us in our continuing fight for our members, their interests and justice. The task before us is immense, but not impossible; it is clear that collective agreements remain the best protection against the harsh impacts of technological change. But, our fight won't end there; stronger legislation, better public policy, and creative training solutions are all domains where the IAM will represent working people's interests.

With these findings, we aim to engage industry leaders, and government policy makers to jointly and proactively find solutions and mitigate major risks.

A new era is on the horizon, and the road ahead is uncharted, but it's a challenge that the IAM won't shy away from; we are ready to forge ahead.

Dave Chartrand
Canadian General Vice President

INTRODUCTION

In the last one hundred years, our societies have been witness to technological advancements not experienced before. As with every industrial revolution, societies will undergo profound changes, which comes with improvements, disruptions and costs. As technological change forges ahead into new frontiers, opening new possibilities, and tantalizes our collective imaginations, it also leaves us in a state of uncertainty over what the future holds. The ebb and flow of change has destroyed occupations while creating new ones, and we know the tide of change cannot be stopped; the best we can do is understand and prepare for it.

The labour movement has grappled with technological change for hundreds of years, and the track record of those changes is mixed. Throughout history, technological change has simultaneously obliterated craft work, trades and skills, routinized tasks making certain jobs dull, while in other cases it's made work easier. Luddites rebelled against technological change and the destruction of their craft, marking forever the uneasy relationship workers would have with technology.

A recent study showed that 42% of the Canadian workforce is at high risk of being affected by automation with existing technologies, while in some sectors, the likelihood is much higher. [1] 11.5 million Canadian workers over the age of 50 are at risk of losing their jobs due to automation. [2] In some cases, jobs will be entirely lost, others will be restructured. Recent technological advancements are raising serious concerns about what the future holds for workers, and our society. "Even jobs we once thought were completely outside of the realm of [automation], like truck driving are indeed at risk of being automated." [3]

Concerns over technological change are certainly warranted; artificial intelligence is revolutionizing the pace, and nature of what technological change looks like in the 21st century. While automation has been part of workplaces for decades, this era of automation, imbued with artificial intelligence, brings endless possibilities. There is an undeniable difference between technological changes of the last three industrial revolutions from technological change enabled by artificial intelligence.

Proponents of new technologies assure us that new, more interesting jobs will be created, while others, more critical of new technologies, fear it could eventually lead to massive job losses. In Canada alone, it is projected that 1.6 million jobs in industries not susceptible to automation, [4] will be lost. In highly susceptible industries, 2.5 million jobs will be impacted. [5] The World Bank projects that over the next twenty years 57% of jobs will be affected by automation, and that two-thirds of all jobs in developing countries are susceptible to automation. [6] Perhaps most alarming, is that some research indicates that unlike computers and other types of technology used up until now, which increased demand for labour, industrial robots may have a very different impact on employment and wages. [7] Some research indicates that over the last 30 years, " findings point to stronger displacement effects and weaker reinstatement effects", meaning that this era of technological change is eroding jobs at a quicker rate than new jobs are being created. [8]

Similarly, adjustment periods following an industrial revolution took substantial time. Consider that, "the aftermath of the Industrial Revolution involved two major Communist revolutions, and that the stabilizing influence of the modern social welfare

---

[1] *The Talented Mr.Robot. Brookfield Institute. June 2016. 1-50. pg.2*
[2] *Natalie Schwartz. " 3 Ways Colleges Can Prepare the workforce for automation" Pg.2*
[3] *Ibid. pg.4*
[4] *Automation Across the Nation. Brookfield Institute. June 2017. 1-32.*
[5] *Brookfield Institute.*
[6] *The Challenge of Industry 4.0 and the Demand for New Answers. IndustriALL. 2016. 1-34. Pg. 7*
[7] *Acemoglu, Daron, Restrpo, Pascual. "Robots and Jobs: Evidence From US Labor Markets." National Bureau of Economic Research. Cambridge, MA. March, 2017. 1-62. Pg. 32*
[8] *Acemoglu. Daron, Restrepo, Pascual. " Automation and New Tasks: How Technology Displaces and Reinstates Labor." Pg.6.*

state emerged only after World War II, nearly 200 years on from the 18th-century beginnings of the First Industrial Revolution." [9]The context in which technological change develops is important, history has shown that it is spurred by particular political and socio-economic conditions. Without proactive steps, systems tend to lag behind changes by decades, while the brunt of changes is borne by those with limited resources and opportunities.

Another concerning aspect of current technological developments lack of regulation. Presently, businesses are allowed to self-regulate and there is little to no understanding of the social impacts of this technology. After all, every technological change has been followed by a corresponding emergence of new social and political systems.

Unions have always played a part in shaping the new social order stemming from changes in the economy and technology. This era of change is no different, but in order to be proactive and involved in the shaping of new social and political orders, it is imperative to understand what kind of change is emerging.

This project is a small step in doing so. To understand change in the context of workplaces where IAMAW members work, the Canadian Territory has embarked on a study of automation. Our organization's response must be rooted in a reality our members face and be relevant to the work our members do. The report is a summary of research findings from across Canada in several industries.

The objective of the project was to assess the level of automation in workplaces our members work in, and develop appropriate responses, both at the bargaining table and through advocacy. Unions must work to address the social impacts, and shape appropriate responses that benefit the public interest; in this regard, unions have always played a role and been the best advocates. After all, "social consequences of automation are conditional on the strength of organized labor." [10]

During previous industrial revolutions, it took several decades for labour markets to adjust, and for training and educational systems to be built to match new realities. At this point in time, not only do we have historical precedents to learn from, but copious amounts of research findings about the impact of technological change. We urge governments to act now, and prepare for what is proving to be an unprecedented era.

---

[9] http://theconversation.com/what-the-industrial-revolution-really-tells-us-about-the-future-of-automation-and-work-82051

[10] *Parolin, Zachary. " Automation, Occupational Earnings Trends, and the Moderating Role of Organized Labor." Social Forces. Oxford University Press. 2020. 1-26. Pg. 8*

EXECUTIVE SUMMARY

For the purposes of the report, automation refers to the use of industrial robots, or other technology that is able to perform specific and repetitive tasks with precision and in high volume. Artificial intelligence, on the other hand is a form of automation, and includes technologies gathering large quantities of data for the purposes of complex decision-making.[11] This distinction is useful as it helps differentiate between new technologies, and its impacts in different workplaces. It's also a useful framework for understanding the impact on job tasks, employment levels and wages. Through qualitative research, it's evident that both types of technologies are present, majority of which consists of industrial robots, of which there are several types.

This report uses academic studies, government publications and studies conducted internally with rank and file members, and union representatives. Academic literature was especially useful in distinguishing the types of studies of automation, and in understanding regional vulnerabilities to automation and impact on communities. This type of research also clarified the focus of research, whether the effect of automation impacted jobs as a whole, or just certain parts of a job.

The research was conducted using both qualitative and quantitative research methods with rank and file members across Canada. Typically, studies of automation examine either the impact on occupations as a whole, or the impact on job tasks. From the onset it was clear that technological change had not yet resulted in job losses, rather on work re-organization and job tasks. There hasn't been a decline in wages due to strong collective agreements in workplaces.

A quantitative survey was conducted using a random sample of members, and focus group participants. The survey looked at attitudes towards automation, as well as, general awareness of the extent to which workplaces were automated. Quantitative information also revealed "hot spots", or areas where there was significant activity in automation, and instances where technological change is being negotiated into collective agreements.

> *Automation refers to both the use of industrial robots, or technology that is able to perform specific repetitive tasks with precision and in high volume, and artificial intelligence, which are technologies gathering large quantities of data for the purposes of complex decision making.* [1]

Subsequently, thirteen (13) focus groups were organized to further assess automation in key workplaces with a total of 130 participants. Given interest in the topic, focus groups were organized into core groups, and peripheral ones, which were workplaces with less automation activity. Qualitative results yielded consistent information across groups, with some variations depending on variables such as, age, skill level, industry, and training. Gender differences could not be determined given lack of sufficient number of women who participated in the study. Due to the composition of the IAMAW's membership in Canada, there are fewer members in "white collar" occupations, than those in "blue collar" jobs, however, our results confirm that education and skill level act as buffers against susceptibility to effects of automation.

There are some limitations to the study; namely, insufficient membership records limited those who could be recruited. Likewise, given the nature of the membership, the availability of white collar workers was limited. On the other hand, the data set for blue collar workers is very robust and provides good insight into changes occurring in those types of jobs. Lastly, and also relating to the nature of membership, fewer women were recruited for the study and so, differences relating to gender cannot be determined with certainty.

[11] How Robots Are Beginning to Affect Workers and Their Wages. The Century Foundation. Oct.17, 2019. Pg. 4.

EXECUTIVE SUMMARY

The research did not examine the effect of automation on wages. Results indicate that job tasks have changed, as well as workloads, while pay scales haven't. This is not to say that workers' wages did not increase over time, rather the increases may not have been proportional to changing workloads and job tasks.

The report also entailed gathering academic research on the impact of technology on jobs, job tasks and wages, while acknowledging that this is a rapidly changing field and new information may be forthcoming over the next few months.

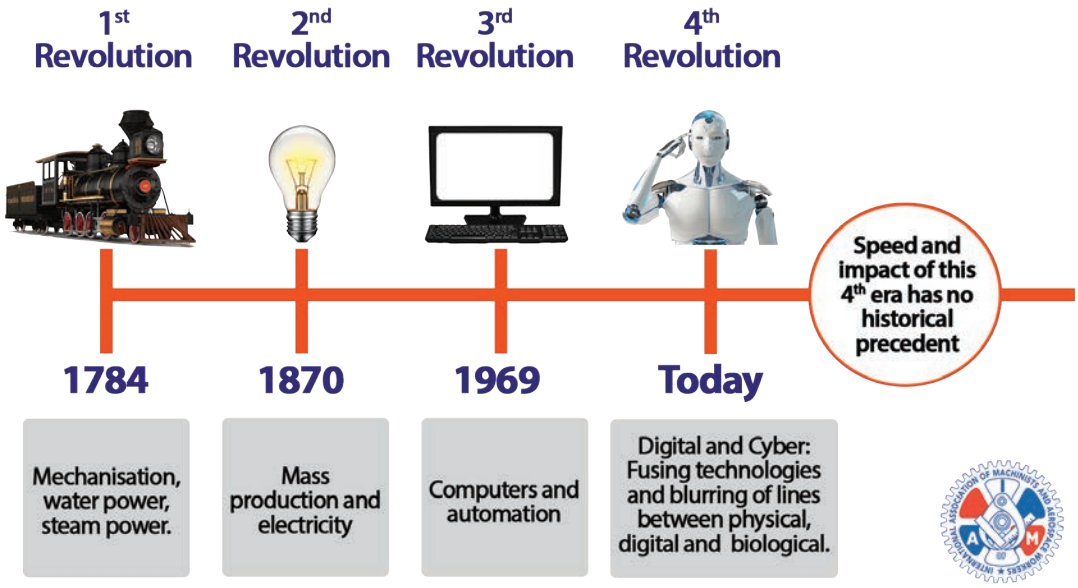
An important point to highlight is that despite debate about who will be impacted by technological change most adversely, it is clear that workers considered low-skilled, immigrants, racialized workers will bear the brunt of changes and be the first to be impacted. Their chances of upskilling and changing professions are limited, and the government should immediately and intensely focus on addressing issues these workers face. The impact will occur in waves, and certain workers will not only be insulated by their skills, but by their access to resources, and socio-economic backgrounds.

The report includes a brief historical overview of technological change, rooting it in a social, economic and political context. Following that section is a discussion of drivers of change, followed by a look at the effect of technological change on employment and wages. Subsequent to these sections is a sector specific look at trends in key industries, which is compared to information gathered through the IAM's qualitative research. The report also provides several recommendations applicable to collective bargaining, training and education, legislation, union organizing, and steps employers can undertake.

SUMMARY OF FINDINGS

- Increase in tracking and surveillance of workers
- Tracking of worker output.
- Jobs require increasing technical skill in some cases others show, evidence of de-skilling
- Micro-credentialing, and certification of tasks wthin a trade is leading to de-skilling and deconstruction of skilled trades
- Both blue and white collar workers have seen their jobs evolve to include additional tasks, increasing pace of work, while wages are not commensurate and practical.
- Automation at airports exacerbates precarity, and disproportionately affects women, and workers of colour
- In all cases, workers do not have control over the nature or pace of technological change. Many commented that they feel like "guinea pigs"
- Technology has been normalized to the extent that changes become invisible
- There is evidence of impact on job tasks, rather than elimination of jobs entirely
- Employers are engaging in ongoing time motion studies, without knowledge of or direction from the union
- White collar workers see an increase in routine tasks due to increasing computerization, and for members in payroll, new systems have the capacity to replace workers
- Outsourcing is as much a concern as automation; in some cases, work is outsourced to highly automated plants
- In some communities, employers have shaped labour markets spurring adoption of new technology.

HISTORICAL AND POLITICAL CONTEXT



Source: World Economic Forum

A Historical Perspective

From a strictly scientific perspective, technological change is inevitable, it's the progression of knowledge leading to improvements and convenience. From a societal perspective, the assessment of technological change gives mixed results. Looking at technological change from isolated perspectives obscures much of the history of technological change, and with it, worker's struggles. Technological change doesn't happen in a vacuum, it occurs in the context of socio-economic and political forces that necessitate development and implementation of technology.

To better understand the impetus for technological change, a brief overview of the history of technological change follows.

First Industrial Revolution

How the world became industrialized is as much a story of scientific advancements, as it is a lesson in history and politics. Pre-conditions, or specific circumstances were necessary, and for the purposes of this section, the 1600s and the *Enclosure Acts* in Britain are the starting point. This era is significant because key political developments were in place that helped put technological change in motion. Legislative pieces of the *Enclosure Acts* privatized common lands, allowing land owners to buy common farms and turn them into large, private farms. This disenfranchised farmers who worked on common lands, leaving them without sustenance. Two systems of production existed during this period, craft work and the emerging early factory system. At the same time, water and steam technologies changed the nature and speed of production, but there was no capacity to apply the technology broadly.

There was significant resistance to privatization; communities resisted and fought against the political attack through bloodshed. As new technologies emerged, craft workers rebelled leading to the Luddite uprisings. These workers opposed new technologies having seen the threat to artisanship, as well as, their autonomy and independence as craftspeople.

Despite resistance, the process of privatization was only just beginning. Having been pushed off their lands, and no other means to sustain themselves,

farmers became the early factory workforce. This marks the very first time in history that human labour and work would take place in an organized and centralized setting that measured output and efficiency. Disciplining workers was essential I a centralized system of production. Discipline of workers didn't only happen through a system of fines and penalties, it required the use of technology to extract as much productive labour in a working day as possible. With a large pool of workers, employers could afford to pay abysmally low wages and factory owners were in a continuous race to find cheap materials and labour. Around this time, slavery became widespread as an economic system, and a means to control supply of labour, and costs.

Technological change is as much about productivity, as it is about efficiency. Efficiency is about producing something quickly, and cheaply with as little waste as possible, in as little time as possible. Human labour is a hindrance to efficiency because it poses limits, namely, how much workers can endure without injury and illness. A function of efficiency is to overcome that limitation and reduce reliance on workers. Mechanization enhanced worker's output, but it wouldn't be until much later that repetitive tasks could be completely mechanized, removing a worker from a process entirely.

Water and steam technologies revolutionized production, from craft work to factory production, but also marked loss of artisanship. As workers moved into factories, they inevitably lost control and autonomy over their work processes, but were now parts of a much larger enterprise, one always in search of improved efficiency and increasing productivity.

Without a political push towards privatization of common lands, the rise of factories and new technologies would not have been possible. This historical period was marked by lack of regulation of businesses, lack of standards and social supports. Technology itself was innocuous, but why, how and by whom it was used defined an era and the history of human development.

Second Industrial Revolution

Advancements in technology made it possible to further develop production capacities of the First Industrial Revolution. Electrical power made possible mass production, which made the pace of work quicker and more efficient. During this period, factories organized work on the basis of assembly lines, but it was not electrical power that improved efficiency, new materials and substances contributed to substantial changes. It's during this era that the first modern car was developed in Germany by Karl Benz (1886) followed by Henry Ford's model the quadricycle in 1896. Factories sprung up, and this era brought on mass production; producing more, with fewer inputs.

This era also marks a change not just in work organization, but in the entire study of efficiency in production. Not only did technology continue developing, but a whole new field of study emerged, Scientific Taylorism. Engineers and managers understood that both machines and the human body became part of the mass production system. Technology was used to make human movements and output more efficient, resulting in breaking down tasks into physical and mental components. Movements to complete tasks were measured, and were called time motion studies, with the goal of increasing efficiency and output. Time motion studies are still used today, in some instances for ergonomic purposes, as well as, understanding where to make improvements in productivity. Time motion studies also indicate which tasks are repetitive and lend themselves to automation.

Industrialized economies operated in an unregulated environment, and social programs and safety nets were non-existent. Workers did not have many options to provide a living for themselves, education wasn't accessible and social mobility was limited. Living conditions were deplorable and working conditions weren't much better. These elements led to worker mobilization and organization in large numbers, forming industrial unions. Through collective power, workers fought bloody battles

TECHNOLOGICAL CHANGE

to establish and define what living and working conditions should look like. Workers also challenged the lack of regulations, and understood that the system of production was deeply exploitative and destructive. Labour didn't challenge the system of production, rather demanded an equal share of output and profit. While technological advancement couldn't be stopped, labour fought on the political front to make society more equitable, and the lives of working people better.

This was an era of labour unrest, political turmoil, and the rise of leftist parties challenging the status quo. Society was transformed by the First and Second Industrial Revolutions, but social systems lagged behind, playing catchup to the social fallout of technological advancement. While technology marched on, industrial unions drove societal change as a means of managing the fallout of technological change. During this period, unions launched the Eight-Hour Movement, fought for health and safety regulations, legal protections for workers, protection of injured and disabled workers, among other wins. While technological change transformed society, the collective power of workers, defined and shaped the social, political and economic conditions, mitigating the effects of an unfettered and exploitative system of production.

Computerization: 1969

It would be another 100 years, before the next technological breakthrough occurred, changing once again the world of work. Up until then, production relied on mechanization, a process that is in large part controlled by workers, although the pace and speed of work are determined by machines. Competition between domestic competitors, and later countries would drive continuous improvements in technology that helped businesses gain a competitive advantage over their competitors. Automation is one way of doing so, as it's a process that has throughout history allowed for substitution of human labour in a range of tasks and reduction of production costs. [12]

Production requires tasks that are either done by labour or capital, and new technologies aim to increase the productivity of both. New technology also impacts the allocation of tasks, in turn, affecting labour demand.

The socio-economic context of this era begins with greater applicability of technology in day to day lives, making life more convenient and suitable to fast living. In the 1980s and 1990s through the fall of alternative trading blocs, the concept of globalization and global trade gained traction. Globalization placed additional pressures on businesses of all sizes to compete globally.

While mechanization was very much present in most

[12] Acemoglu, Daron, Restrepo, Pascual. " Automation and New Tasks: How Technology Displaces and Reinstates Labor." Journal of Economic Perspectives-Volume 33, Number 2, Spring 2019. 3-30, pg. 1.

workplaces, automation began taking hold. Automation differs from mechanization in that it's premised on computerized technologies, purporting to be an aid in both physical and mental labour. It, too, aims to improve efficiency, but goes beyond making improvements in physical outputs; it's meant to be an aid in mental labour. Computerization also marks an important junction, not only would those with repetitive jobs be affected by technological change, but workers considered highly skilled would also see their jobs affected.

Mechanization helps with physical labour, automation and computerization help in both physical and cognitive tasks.

Politically, this period was marked by labour peace, growth and stability. The mid-1970s mark a period of decline, economic crisis, stagflation, oil crisis and decoupling of wages and productivity, which in particular, has continued to this day. The decoupling of wages and productivity is another junction that's critical to note. It means that despite improvements in output and efficiency, labour's share declined and became disproportionate to their contribution. In fact, automation, "always reduces labour's share in the economy, as it leads to slower wage growth than productivity growth." [13] Wages, to this day, as a share of GDP are at an all-time low, despite corporate profits being higher than ever.

But, what made this phenomenon possible? Two factors were at play:outsourcing and automation. With the help of Scientific Taylorism, which grew to be more sophisticated, the divide between physical and mental labour was deepened.

TQM SixSigma was a breakthrough managerial technique and process by which all tasks were identified on the basis of core and external tasks. As a result, some tasks were merged, including jobs, while other tasks and jobs were outsourced. The more physical and routine tasks were, the more likely they were to be automated. Job combining and outsourcing also reduced the number of workers needed, which also reduced costs of production.

A simultaneous process emerged; not only was worker's productivity enhanced, but reliance on workers was reduced through elimination of routine tasks. Routine tasks were either automated, or outsourced. In the 70s and 80s and since then, worker's productivity continued increasing. In fact, labour productivity in North America is 70% higher than it was in 1981, yet wages have only risen by 22% since then.[14] Declining unionization is certainly a factor, but, technological change is part of the reason this phenomenon has persisted. [15]

Jobs that couldn't easily be automated were looked at in terms of direct and indirect labour costs. Jobs determined to be indirect were outsourced, leaving employers to focus on core business, paying for direct labour costs. In the 1980s, numerous firms outsourced certain tasks, which was only possible when tasks have been delineated, and classified as core tasks(ie. what is at the core of firm's business?). All that is not core business, can be outsourced.

[13] Kinsella, Stephen, and John Howe. "Global Perspectives on Wage Stagnation." The Wages Crisis in Australia. University of
[14] Adelaide Press. 2018. Pg.42.
[15] Kinsella. Pg. 43.

TECHNOLOGICAL CHANGE

The effect, simply stated: the type of automation in this period resulted in reducing workers and costs of production, while increasing productivity.

Stagnating wages can also be, "understood as a result of global progress toward a technological frontier, affecting many countries simultaneously." [1]Additionally, digital labour substitutes for human labor, which happens first in routine tasks. [17] As digital labour becomes less costly than human labour, and as technology evolves, the distinction between routine and "intellectual" tasks will be drawn more sharply, but only one of those jobs will be well paid.

Speeding Towards the Fourth Industrial Revolution

If we follow the thread of the need to overcome limitations of the human body, first the physical limitations, and now the mental, it helps us to understand emerging technologies like artificial intelligence. Artificial Intelligence (AI) emerged as an area of study in the 1980s as a subfield of mathematical sciences and programming. The goal was to replicate human learning processes and decision-making in machines. Speech recognition, visual recognition, and neural networks, are all based on complex algorithms that allow machines to replicate human behaviours.

A differentiating feature of the next generation of technological change is that while previous forms aided and replaced physical labour, new technologies are able to assist with "intellectual" work, and in some cases, even replace that human capacity.

AI allows us to offload our mental labour, our thinking and judgement. In the financial industry, AI is used widely, stock markets are now predicated on AI technologies. Decisions are decreasingly being made by humans, and increasingly by AI. Several projects in Canada have been launched to test AI fueled technology. For instance, Ontario launched a pilot project for autonomous driving and in 2019, regulations that allow for testing and sale of autonomous vehicles were developed. Two participating cities, Edmonton and Beaumont approved a pilot project that facilitates cold weather testing of autonomous vehicles through the University of Alberta. The vehicle is supervised by an operator and carries a maximum of 12 passengers. Projects like these shouldn't go unnoticed not only because of the implications, but also because government pilot projects actually subsidize private companies and allow for transfer of knowledge. [18]

In a relatively short amount of time, some 50 years, technological advancements have moved at a galloping pace. Computerization has taken hold of almost every aspect of our lives, and advances in nanotechnology, artificial intelligence, biotechnology have altered the materials and substances used in production.

A recent study of the impact of automation on work shows that in a thirty year time frame, 1987 to 2018, there was a notable increase in the, "share of workers employed in occupations associated with non-routine tasks, and a decline in routine-task-related occupations.[19]The most pronounced shift in employment was away from production, craft, repair and operative occupations toward managerial, professional and technical occupations." As a result, the trend of technological change is consistent in the way it affects production, and craft, repair and operative occupations. As automation transforms jobs, labour markets also change resulting in how an economy is structured. For example, society moved away from an agrarian to an industrial society with the growth of factories, mass production and workers who had moved from working in agriculture to factories.

[16] Kinsella, pg.44
[17] Brybjolfsson, Erik and Andrew McAfee. " Jobs, Productivity and the Great Decoupling." The New York Times. Dec.11, 2012. 1-3.
[18] The Challenge of Industry 4.0 and the Demand for New Answers. IndustriaALL.2017. 1-34. pg.6
[19] https://irpp.org/research-studies/are-new-technologies-changing-the-nature-of-work-the-evidence-so-far/

TECHNOLOGICAL CHANGE

The political landscape and imperatives for technological change have moved away from simply extracting labour power more efficiently, although that is a strong driver of technological change. Economic growth of countries is tapering off, as is worker's share of growth, despite some growth in productivity. Economies have reached their limitations, which has led to rapid advancements in technology to find solutions. Limits to resource extraction and climate change are just as much as drivers of technological change, as the continuous drive to reduce costs and time of production.

The Fourth Industrial Revolution, propelled by advancements in artificial intelligence stands to alter not just the world of work, but our society in fundamental ways, as well. In the same way that the first two industrial revolutions disrupted and changed society as a whole, artificial intelligence places us on the precipice of monumental change.

Global competition has intensified over the last several decades, just as investments in AI technologies have grown. Not just businesses, but governments are now competing in the area of high technology. Much like earlier periods, this area of businesses are unregulated, and that which exists is being defined by the financial industry.

ADOPTION OF TECHNOLOGICAL CHANGE

Drivers of Adoption of Artificial Intelligence

While some researchers claim that drivers of technology adoption are different than previous eras of technological change, the position of the IAM is that the drivers of adoption have always been the same; but it's the social, economic and political context that differs. In fact, based on current examples, we see that the supply of labour and costs of labour are playing a major role in adoption of AI technology. Below is an overview of factors that typically drive technological adoption.

Technological Availability

The level of adoption of technology in an industry is a strong indicator of the speed at which technology is adopted. New technologies give employers a competitive advantage, diversify their operations and differentiate them from their competitors. Particularly, competitor's behaviours are a significant factor, and these behaviours vary by sector. Firm size, financial resources, and the business strategy are also things that play into the likelihood of technology adoption. One study showed that industries that adopted more robots in Europe, were the same industries that adopted more robots in the United States.[20] This is not just an indicator of competition within an industry, but global competition.

Development Costs

Costs associated with adoption of new technology tends to be high and favours large and well developed businesses. However, as adoption becomes more common and the price of production allows for mass adoption of new technologies, more businesses are able to switch to new modes of operations.

Currently, costs of new technologies vary; in some cases the costs are very high in some cases making technology unattainable for medium and smaller businesses. As we are still in the early days of development of technologies and artificial intelligence, the cost of adopting AI for most businesses in Canada remains prohibitive.

Supply of Labour

This aspect is not just an element of technology adoption in Canada, but in the world, as well. Numerous industries in Canada and other parts of the world are strapped for labour resources. In many cases, the demand for labour, is much greater than supply, especially in countries where the reproductivity rates are falling. This, coupled with lack of training programs for jobs in industries where labour shortages have been on the horizon and have now come to fruition, have led to serious shortages.

Japan serves as a case in point, and shows the trajectory that Germany, South Korea, United States and Canada will face in the future. Japan has been facing labour shortages for years due to a shrinking population where more than a quarter of the population is 65 and older. This age group is expected to make up for nearly 40% of the workforce by 2050.[21] The situation in healthcare is especially acute, where the elderly are looking after the elderly, and Japan isn't able to replace workers quickly enough to fill more remedial jobs,[22] which tend to pay low wages. Japan's usage of robots is the fourth highest in the world (308 robots per 100,000 workers), the majority of which is spurred by labour shortages in various sectors, but especially in healthcare. By 2025, Japan will face a shortage of 380,000 workers.

Common trends in long-term care, nursing and retirement homes is high turnover, physically demanding work and high rates of burnout. Despite the pandemic highlighting the importance of care work, governments around the world have done little to address systemic issues in this field, if for no other reason than to prepare for future challenges in the sector.

To mitigate the physical demands of care work, Japan's nursing homes are increasingly using robotic devices to assist in lifting and moving patients. Lumbar devices and cyborg suits help residents build strength and restore mobility, without the help of a

[20] Acemoglu, pg.17.
[21] Don Lee. " Desperate for workers, aging Japan turns to robots for healthcare." The San Diego Union Tribune. 26.7.2019. 1-10. Pg. 3.
[22] Lee. Pg. 3.

human physiotherapist or assistant. In fact, some of the exoskeletons are used in assisting patients who suffered from strokes to regain their mobility and recover from paralysis. Panasonic has built a bed that transforms into a wheelchair, eliminating the need for patient transfer assistance. Sony's robot puppy and "care-robo" animals are used for therapy for loneliness and dementia,[23] making up for social interaction with other humans.

Recreational time at Shintomi nursing home in Tokyo is led by a robot, which includes sing alongs and games.[24] In recent years, the EU and the Ministry of Internal Affairs and Communications of Japan began a partnership piloting robots that can interact with elderly people and be customized to the cultural context in which they're used. CARESS, which stands for Culture-Aware Robots and Environmental Sensor Systems for Elderly Support, is a fleet of robots that assist and interact with elderly people, either as part of home care, or in an institution. The robots are able to performing tasks like, reminding a resident to take medication, encouraging them to keep active and eat a healthy diet, helping them keep in touch with loved ones, and reminding them about important cultural and religious festivals.[25] The robot is meant to be a companion.

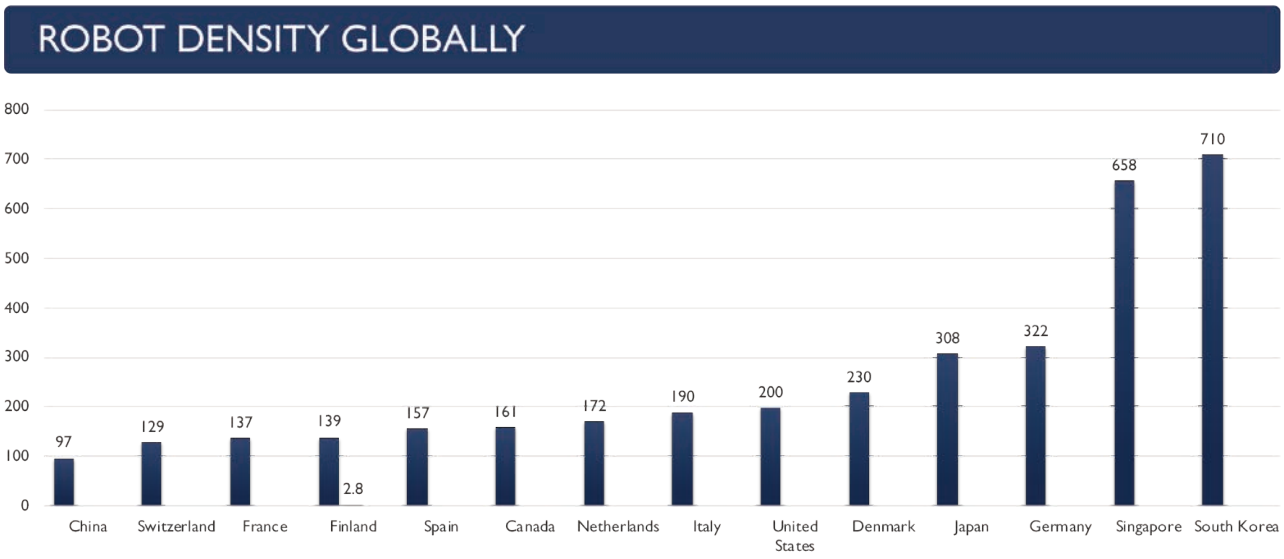
Technology is bridging the gap where labour isn't able to; this is in part due to demographic changes, but it's also a result of how the labour market in the long term sector is shaped. Work in the sector is undervalued, and underpaid, which discourages new entrants into the profession.

Leading Countries in Robot Use:

South Korea is the international leader in the use of robotics (710 robots for every 100,000 workers), with a high concentration of automation in electronics and automotive conglomerates. Due to the high usage of robotics, the government has adopted a robot tax to limit corporate incentives for investments in automation.

Singapore has also began relying on automation due to labour shortages, mostly in the hospitality sector, like hotels and restaurants. The ratio of robots to workers in this sector is 658 per 100,000 workers.

Germany both uses and is an exporter of robots, where the ratio is 322 robots for every 100,000



[23] Lee. Pg. 2.
[24] Lee. Pg.3.
[25] http://caressesrobot.org/en/project/ Accessed May 2019.

ADOPTION OF TECHNOLOGICAL CHANGE

workers. The country has turned to automation due to increasing labour costs and shortages.

In North America, the United States of America leads the way, where in recent years there's been a sharp increase in use of robotics. For every 100,000 workers, American employers, on average, use 200 robots. Initial uses were common in auto manufacturing, but usage has expanded as employers look to cut labour costs.

The Netherlands are making use of robots in agriculture, and self-driving boats are used to travel Amsterdam's extensive network of canals. Spain's use of robots has intensified in car and aeronautical manufacturing, and investments are concentrated in sectors where automation is already common.

Finland, much like other countries on the list, is managing an aging population and labour shortages, relying on technology to replace humans in jobs that are not well-compensated. France is in a similar position, as the skilled labour shortage is especially severe.

China has a relatively low usage of robots, despite the fact that it supplies 40% of the world's robots. Its own use is limited to industrial settings, and usage is largely driven by high labour costs.

Some figures are indicating that as soon as 2030, 375 million people across the world will be out of work due to automation. While automation will disrupt, and alter labour markets beyond recognition in some cases, it's important to highlight that automation will also heighten global competition. Virtual reality and augmented reality platforms, and remote work arrangements will make it easier for employers to scout for workers across the globe, meaning that as soon as 2030, there could be heightened competition between workers.[26] Furthermore, new platforms of work will erode the full-time employment model, leading to, "precarious, individualized terms and conditions of work that ultimately open up unprecedented possibilities for control of workers." [27] Labour will have to adapt and change with times to build solidarity that extends beyond national borders.

[26] Turn and Face the Strange. Brookfield Institute 2021. 1-114. Pg. 15.
[27] IndustriaALL. pg. 6

Labour Costs

The supply of labour is clearly a strong indicator of automation, given the previous example. Coupled with labour costs, these two factors are the best predictors of a firm's intent to automate. A focus group with employers revealed the following;

"The biggest thing the government has done for automation is raising the minimum wage. We've been subsidizing business owners with below market labour and it's been dis-incentivizing automation. Now that they'll have to pay closer to market rates for labour there will be more incentive to automate." [28]

> *In occupations where wages have been so low to make recruitment difficult, automation is just as likely to occur, as in industries with labour shortages.*

Essentially, when the relative cost of labour exceeds technology, it will generally shift to technology.[29] Labour costs are the greatest expenditure businesses have, and the struggle, especially in unionized workplaces, is to ensure workers are adequately compensated for their time. Employers that are able to afford technologies that replace labour, or reduce labour costs, have certainly done so. In 2017, Metro announced it would turn to automation as a means of offsetting the impact of the rise in the minimum wage in Ontario.[29] Smart shopping carts have been piloted in the United States since 2019, and have recently been adopted for use in Sobey's locations in Canada. The technology eliminates the need for cashiers, as the cart calculates the total cost based on items placed inside it. It's important to note that in occupations where wages have been so low to make recruitment difficult, automation is just as likely to occur.

The Los Angeles Port is the world's first fully automated port, with hundreds of workers having been displaced. As a result of automation, 100 of the driverless straddle carriers, replaced 200 cranes and trucks operated by 500 union dockworkers across the facility's 26 miles of roads. The robots, guided by remote computers using WiFi, deliver cargo to trucks parked outside the container storage yard.[30] The turnaround time was expected to go down from 96 minutes to 35 minutes for 4,000 trucks that enter the terminal daily. Ultimately, automation has made the dock more competitive and ecologically friendly. Inevitably this has led to job losses, and while some re-skilling was negotiated, it's debatable about how effective and all-encompassing efforts have been.

Jobs in oilsands are also quickly succumbing to automation. In 2018, Suncor Energy shed 400 jobs to prepare for the implementation of driverless ore-hauling trucks, which supporters tout as being safe, reducing transportation costs and showing environmental benefits. Not only have drivers and operators been affected by this move, but mechanics that repaired and maintained the vehicles will also be impacted. Labour shortages in the trucking industry have been flagged for several years now, and it is not at all surprising that employers are looking to adopt technologies that can bridge that gap. Note that workers in this sector are well compensated, and it's likely that employers adopted technology to reduce labour costs.

Sectors are ecosystems with complex supply chains and related industries, and the rise of automated vehicles has the potential to disrupt employment for transit workers, bus drivers, gas station attendants, people who work for car dealerships, people in the insurance industry, to name a few.

AI has made it possible to automate jobs previously thought to be immune to automation. Physiotherapy, highly skilled work that requires not just skill, but certain human aptitudes have insulated the job from automation. However, AI makes this job, too, easily

[28] Better, Faster, Stronger: Maximizing The Benefits of Ontario's firms and people. Brookfield Intitute. 2019. 1-114. Pg. 26.
[29] ibid, pg.26
[30] https://www.inquirer.com/business/apple-walmart-trucks-port-los-angeles-automation-longshoremen-20191108.html April, 2020.

automatable. Studies are showing that robot markets are expected to achieve significant growth as robots replace much of the human work in physical therapy.[31] Rehabilitation robots seem to be steadier, make fewer mistakes, support treatment for longer durations and above all, decrease costs of rehabilitation for many conditions.[32] Devices assist rehabilitation by supporting repetitive motions that build neurological pathways to support use of muscles. In studies where people used rehabilitation robots, patients made continued progress in regaining functionality even after suffering a stroke.

In terms of costs, insurance providers pay some portion for rehabilitation, however, robots have shown to be less costly, as robots can be used in a home setting. These robots can also be used for physiotherapy, as homecare equipment, and in nursing home settings allowing for longer and more consistent rehabilitation. But, focusing only on improvements, efficiencies, and lower costs, the effect on jobs, and those who will soon be affected is obscured.

Social robots are also increasingly being used in work with autistic children. The robots are programmed for specific interaction with autistic children, allowing the robot to adapt to the child's way of learning, and provide tailored therapy.[33] Children that worked with robots showed improvements in their social skills, like eye contact and initiating communication. Not only did children continue progressing even when they no longer worked with the robots, the therapy was effective because they felt safer interacting with robots as social interaction with them "doesn't trigger a lot of the other baggage they've come to associate with social interaction."[34]

Productivity Gains

In an effort to remain competitive, and reduce costs, firms continuously look to improve productivity. Automation has historically been the key element of productivity gains, and has generally occurred by substituting certain job tasks for technology that can perform the tasks quicker. This means that firms are able to produce more at a lower cost, and more efficiently, which increases margins and revenues. Employers continuously assess their business models to ascertain which parts of the production process are key and core to the business, and which can either be outsourced or automated, or both.

Historically, tasks have been defined as either cognitive or non-cognitive tasks, where "non-cognitive" or physical tasks are more susceptible to automation. AI is now capable of performing some cognitive tasks, given increasing adoption in the financial industry, warehousing and shipping/receiving.

A Russian firm, Magnitogorsk Iron and Steel Works (MMK) recently deployed 16 robots, with plans to automate 32 manufacturing processes, eliminating dependence on workers. The 16 robots are capable of interacting with scrap metal suppliers, and are able to email, and independently perform searches through the Russian Railways database and issue reports. Focus groups with IAM members in parts ordering, shipping and receiving confirm this trend, indicating that robots with these capabilities are starting to be widely used. The Russian firm is planning on potentially automating another 69 processes in an effort to increase efficiency. MMK is also looking to improve efficiencies in planning, product quality, and aims to reduce transaction costs. The company has partnered with Deloitte to develop a digitization strategy, which will spur automation and displacement.

Materials that are used are also an important aspect of automation, such as 3D printing. Automation and algorithms are revolutionizing manufacturing, by taking out the risk of 3D printing manufacturing. On-demand manufacturing allows engineers to upload their designs, and feedback algorithms detect

[31] Rehabilitation Robots Market Report 2019…Industry Growth BY 2025. 1-7. July, 29, 2019.
[32] Ibid. pg.2
[33] Weir. William. " Robots help children with autism improve social skills." Yale News. 22.08.2018.
[34] Weir.

flaws within seconds, offering solutions for a better print. This applies to 3D printing and CNC machining services. Once the optimal design has been chosen, the system also gives an instant price quote and a production time deadline. These processes has shortened the production time, but it has also cut out intermediaries like salespeople, and local shops.[35]

3D printing stands to revolutionize how goods are produced and consumed. First uses of 3D printing are evident in manufacturing as it becomes less reliant on human labour. Large manufacturing crews are replaced by single machines and the time to complete jobs is shortened. Factory footprints could be reduced because products are printed in one piece on one machine. The same technology will impact the retail side of the business, and be replaced by "filaments" and machines where individuals can print their own products. This could impact many sectors including healthcare, and construction.[36] 3D printing also allows companies to gain a competitive advantage over competitors, as indicated by 93% of companies recently surveyed for a study of 3D uses.[37]

3D printing is becoming increasingly common in different industries. The Royal Netherlands Air Force uses the technology to produce specialized parts needed for repair and maintenance of various aircraft, cargo jets and helicopters. "People who work with 3D printing often have no technical background, but only need about three hours of training. After that, they start looking for solutions for issues they have in their work."[38] Instead of outsourcing the work and relying on external resources, the Air Force produces its own parts, reducing the costs of production and time. 3D printing technology is also able to produce metal parts that would otherwise require CNC machining.

3D printing directly impacts production, but new production methods will also, " shift the point of greatest value-added along the chain; the design, engineering and maintenance stages of a product must be considered, not merely the production of it." [39] The availability of this type of technology poses serious threats to IAMAW skilled workers in maintenance and repair, but also those who work in aircraft assembly and production. If companies choose to rely more on in-house 3D printing, tasks of skilled workers will inevitably be affected.

Regulatory Framework

On this topic, workers and employers couldn't take more divergent positions. In a recent research project by the Conference Board of Canada, the group of participating employers indicated that regulations in Canada lag behind other countries, making adoption of new technology challenging. For the most part, the AI market is largely left to self-regulation, without any clear or firm government positions. Policies serve as levers that can either obstruct or make adoption of technology easier, but lessons from the past have shown that some level of government regulation is necessary. More on regulations is reviewed in the recommendations section, specific to legislation.

[35] "How Automation and Algorithms Can Take Out The Risk of 3D Printing Manufacturing". 7.29.2019 Online resource
[36] *Turn and Face the Strange* pg. 24
[37] *Turn and Face the Strange* pg. 24
[38] https://ultimaker.com/learn/royal-netherlands-air-force-speeding-up-maintenance-with-3d-printed-tools?utm_campaign=coschedule&utm_content=Royal%20Netherlands%20Air%20Force%3A%20Speeding%20up%20maintenance%20with%203D%20printed%20tools%20%7C%20Ultimaker&utm_medium=Ultimaker&utm_source=linkedin_company 2019.
[39] IndustriALL, Pg.11 This will also impact intellectual property rights, patents and copyrights, which are concentrated by a few large corporations. This is an important consideration since control over information will be monopolized, and will lead to a further divide between developing and developed countries.

SECTOR SPECIFIC TRENDS

Air Transportation

With a significant portion of our membership in the air transportation industry, and with a heavy concentration at airports, it was important to fully assess the level of technological change and compare it to international standards. This section looks at international trends in aviation, leading edge airports and research results to informing about the current state of affairs, and the future direction.

The aviation industry functions in cycles of ups and downs, with the pre-pandemic period marking a consistent cycle of growth. Passenger levels have grown exponentially, and were slated to continue growing prior to the pandemic. Facing pressures to adapt and secure a safe travel experience, the pandemic may actually spur the adoption of technology, rather than slow it down. The business environment of airports is fast paced, requiring efficiency and convenience. Airports are also part of national infrastructures, and technological implementation takes time. Collection of data about passengers and cargo is critical in planning for future technological change, but also in addressing efficiency gaps inside airport operations. Digitization is the norm, and with that there's greater self-reliance for passengers, such as self-service kiosks and automated baggage drop off. Self-service and contactless technologies are not just a matter of convenience in the post-pandemic environment, they are a necessity.

As passenger levels are expected to grow, and given pressures of safe travel, airports are turning to technology to streamline operations and improve the traveling experience for the public by creating a seamless process. The head of technology of a company that provides services to major international airports reflected on this trend and emphasized that, "Technology is going to play a much bigger role at airports than it ever has in the past and will be the key driver in creating every facet of a seamless travel journey."[40] Currently, airports and airlines are placing an emphasis on technology to establish safe travel and manage the possibility of transmission of COVID, and other communicable diseases, as well. While technologies exist that could eliminate much of the human contact through the check-in experience, lease agreements that airports have with airlines in terms of equipment, and government regulations are slowing the adoption of technology.

Biometrics are expected to become an essential feature of future travel. These types of technologies use body measurements such as facial symmetry and proportions, or iris scans to verify a passenger's identity. The rationale is that it speeds up passenger processing, and processes travelers with greater accuracy. This technology is typically developed by a third party, which sells the technology to an airport authority or airline, which raises some concerns, such as protection of privacy and data collection. Biometrics has also been shown to be a flawed process, with built-in biases that disadvantage groups that are disproportionately targeted.

Despite hesitations about the technology, biometrics are increasingly being used to help create a "seamless travel experience", through the use of fingerprinting, iris scans and facial recognition. At the Singapore Changi Airport, biometrics are used to clear immigration using an automated lane where passengers are identified through an iris scan or a face capture.

British Airways recently began using biometric boarding for all domestic flights out of Terminal 5, and Heathrow airport is now using automated ramps. British Airways is full speed ahead with plans to introduce autonomous robots in May 2020. The autonomous robots can walk passengers to different areas, answer questions in multiple languages with the goal of freeing up airline employees to deal with more complex issues passengers encounter. Similarly, Delta is preparing to launch a digital concierge.

American Airlines, including the Port Authority of New York and New Jersey are also planning to make

[40] https://www.cnn.com/travel/article/airports-future-technology/index.html

use of biometrics. A spokesperson for American Airlines stated that biometrics are already being tested for international airports. The goal is to expand biometrics to include the check-in process, security check-points and domestic boarding. [41]

Automation will help the company manage higher volumes with no additional manpower.

The Vancouver International Airport is also testing out biometrics for NEXUS passengers. NEXUS is a joint Canadian Border Services Agency and U.S. Customs and Border Protection (CBP) operated trusted traveler program, designed to speed up border crossings for low-risk, pre-approved travelers into Canada and the US. Up until now, Nexus passengers were identified through an iris scan, whereas now, the biometric screening will involve facial recognition. Vancouver has 11 such kiosks, with Montreal Pierre Elliot Trudeau International Airport and Halifax Stanfield International Airport slated to implement the technology later in the year.

Artificial intelligence has also enabled luggage screening equipment for both check-in and carry-on bags to identify problematic bags that would be sent for additional screening. This technology is also revolutionizing other aspects of airport operations. Heathrow Airport has implemented automated ramps; in fact, there is a strong push to automate ground service equipment, jet bridges, cargo and baggage loading trucks.

The Changi Airport is on the precipice of major change, as the airport is testing out remote-controlled vehicles that can collect luggage from a plane and move it to the baggage handling area in as little as 10 minutes. In this case, automation will "help the company manage higher volumes with no additional manpower." The airport authority is partnering with SATS Ltd., a company that specializes in ground handling and in-flight catering. SATS's automated cutlery packing system has boosted productivity 36%, and its tray assembly line now has nine employees instead of 45. It's anticipated that staff productivity in terms of value added per employment cost has risen 11% in the past four years. In 2020, staff costs fell for the first time since 2008. While Winnipeg may not be a hotbed of technological change, Winnipeg International Airport implemented the first autonomous snow plow in North America.

The Montevideo Carrasco International Airport is the world's first digital airport. The airport has fully integrated biometric scanning eliminating the need for passports and boarding passes. The Changi Airport in Singapore has dedicated an entire terminal to testing out fully automated technologies for passenger travel. That travel experience looks something like this;

"As a plane joins the long line to land, it's detected, identified and monitored by an array of cameras and technology that bypass the traditional control tower. Once at the gate, a laser-guided aerobridge positions itself to let passengers disembark, while automated vehicles below unload baggage, dodging others that are delivering robot-packed meals or processing cargo. The passengers head to automated immigration turnstiles that face-scan and thumb-print them, then head to collect their luggage, which baggage bots have already delivered to the carousel. Under the gaze of an actual human — the steely-eyed customs official — they head out to queue for a driverless taxi."

One of the largest employers in air transportation, where the IAMAW represents a large number of members, has given itself the mandate of becoming a leader in development and implementation of artificial intelligence. The primary focus of their efforts is cargo and baggage. Discussions with members indicate that Big Data and Amazon's business model in cargo has already been implemented, and is impacting the organization of work, as well as, the pace and volume of tasks, which have both increased. Deregulation and privatization certainly make it easier

[41] https://www.cnn.com/travel/article/airports-future-technology/index.html

to make changes in infrastructure, so an airport of the future will be delayed in Canada. However, this hasn't stopped airlines from adopting technologies that streamline passenger travel and cargo.

Manufacturing

The shift towards smart factories is certain but gradual, given that technological change in manufacturing tends to happen gradually, rather than during a complete overhaul. Specific to the automotive industry, the pending shift to electronic vehicles and away from internal combustion engines will impact every job in the industry. It's estimated that that, "the number of workers required to build an electric powertrain will require 1/6 of the workforce needed for producing an internal combustion powertrain."[45] Reduction in employment will likely take place in the automotive industry, later taking root in other sub-sectors.

There are some overarching trends that apply to the whole of the manufacturing sector. Studies in the United States have shown that the use of robots in manufacturing industries was far greater than the national average, indicating that since 2009, "the number of robots more than doubled-from 0.813% per thousand workers to 1.974% per thousand workers."[46] In China, a mobile phone manufacturer, announced plans to adopt industrial robots, whereas one robot could replace eight workers and reduce the defect rate by 20%. The employer was awarded a government subsidy for the project, despite the company owner's derogatory public statements about workers being animals, and that managing one million workers gave him a headache. [47]

However, indicators in states with high unionization, show that the usage of robots is much lower than regions where unionization is low.[48] While unionization alone can't stop implementation of technology, unionized workplaces are better equipped to manage the pace at which technology is introduced.

In manufacturing, the effect of automation predominantly affected men, while women were affected in non-manufacturing industries, like retail where risk of automation was very high.

[45] IndustriALL. pg. 21
[46] The Century Foundation. How Robots Are Beginning to Affect Workers and Their Wages. Oct.17, 2019. Pg. 2
[47] "From Workerless Factory to Robots Create Jobs!".
[48] Ibid.

Ninety-two percent of retail sales persons are at risk of automation, as are 96% of administrative assistants, 91.5% of kitchen helpers and food counter attendants, and 97% of cashiers.[49] This finding isn't surprising given gendered composition of the workforce in certain sectors. In manufacturing, occupations like machinists, assemblers, material handlers, and welders were found to be at highest risk of automation.[50] This finding is especially important to note for the IAM, as the union's membership continues to be in manufacturing, and is male-dominated.

In manufacturing, workers of colour will bear disproportionate impacts of automation. 26% of Hispanic and 23% of African American workers will be displaced, and young workers aren't spared; workers under the age of 34 and over the age of 50 have equally high displacement rates due to automation.[51]

Statistically, for every robot, per 1,000 workers, the employment to population ratio of young, less educated workers fell by 3.5%.

The same study looked at different areas based on census divisions, and found that certain regions, namely, the East North Central census division (Illinois, Indiana, Wisconsin, Michigan and Ohio) showed evidence of job displacement as a result of increasing use of industrial robots. The displacement mostly affected young, less educated workers. Statistically, for every robot per 1,000 workers, the employment to population ratio of young, less educated workers fell by 3.5%. Using the same ratio of industrial robots to workers, showed a 4-5% reduction in wages for young and less educated workers. Women and black men bore the brunt of the impact of automation.

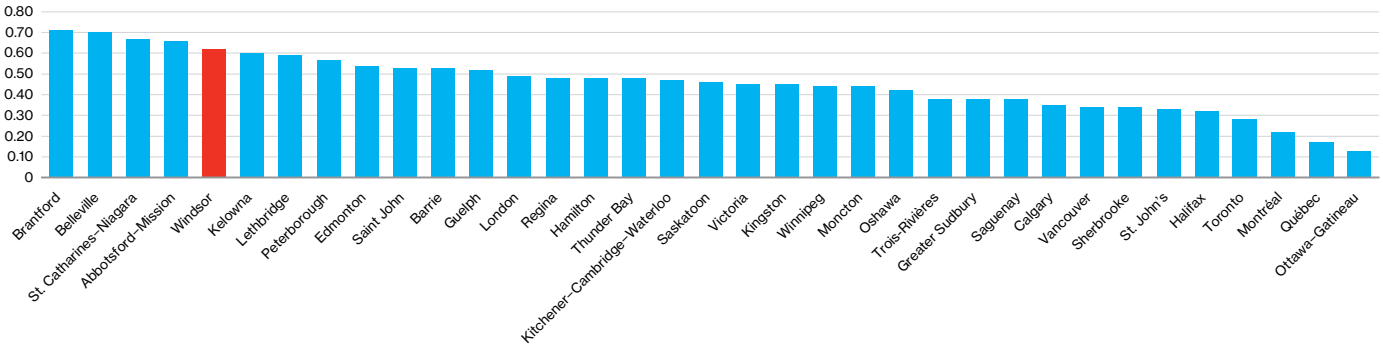
Canadian Manufacturing:

The manufacturing industry in Canada, "ranks relatively low when it comes to robot density, compared to international peers, meaning there is room to expand when it comes to adopting productivity enhancing technology."[52] One explanation for relatively low adoption rates of robotics is that Canadian manufacturing firms are mostly small to medium businesses, who will benefit from declining prices of industrial robotics.

A recent study conducted by the Conference Board of Canada ranked vulnerable regions throughout Canada using the Automation Vulnerability Index. The index contains five indicators; the share of a region's workforce in high risk and low mobility occupations, the economic cost of occupational transition, jobs with limited growth potential, the share of workers over the age of 55, and the share of workers with a high school diploma or less. Below are all of the

[49] The Talented Mr.Robot, pg.12
[50] Ibid
[51] Schwartz.
[52] Brookfield Institute. Pg .9

Automation Vulnerability Scores for Canadian CMAs
(Automation Vulnerability Score [AVI], red indicates Windsor)



Source: The Conference Board of Canada.

53

regions that were assessed in order of vulnerability to automation from most vulnerable to least.

Regions that are most vulnerable had in common the following;

- Large portions of the workforce concentrated in a single sector
- Lower educational attainment such a high school diploma or less
- A large share of workers (higher than provincial and national numbers) in high risk, low mobility occupations
- Large portions of workers in slow growing occupations
- An aging workforce
- Higher costs of transitioning workers from highly vulnerable occupations

A study conducted by the Brookfield Institute pointed to similar findings, determining that smaller towns and communities that specialize in manufacturing, mining, quarrying, oil and gas extraction are at highest risk of job loss due to automation. The majority of these communities are found in Alberta, Saskatchewan, Southern Ontario and parts of Quebec. [54]

The findings are not just consistent in North American studies, comparable findings were found in international studies. But, we shouldn't ignore that these findings are also consistent with historical data, in that technological change has primarily impacted low-skilled workers, with lower education levels whose chances of upgrading to a more technical occupation were limited. Likewise, workers whose jobs offer limited promotion prospects, whose jobs have remained fairly stagnant, and who have had limited on-the-job training or upskilling, are also at high risk of automation.

[53] Assessing Windsor's Vulnerability to Automation. Conference Board of Canada. 2021. Pg. 5
[54] Brookfield Institute. Pg.7

Regardless of the methodology used, research shows that the highest risk for automation tends to be, "in the private sector and in larger, single site, workplaces. [The risk is even] higher for workers on fixed-term or temporary agency contracts."[55] Moreover, "employees in (highly) automatable jobs, for instance, receive about 3.5% lower hourly earnings relative to comparable workers facing lower degrees of automation risk." [56]

Canadian jobs' susceptibility to automation ranges from 30% to 69%, with the average risk of automation for all jobs is 46%.

According to one study, Canadian jobs' susceptibility to automation ranges from 30% to 69%, with the average risk of automation for all jobs sitting at 46%.[57] Canadian industries such as, accommodation and food services, transportation and warehousing, manufacturing, mining, quarrying and oil and gas extraction, and agriculture were at highest risk of automation, with a total of 2.5 million job loss.[58] However, even in industries with a low risk, the study showed there could be 1.6 million jobs impacted by automation.[59]

Specific jobs were found to be at high risk of automation, some of which would directly impact IAMAW's membership; aircraft assemblers, and aircraft assembly inspectors (93%), close behind are workers in the plastics industry, woodworking machine operators, paper converting machine operators and motor vehicles assemblers and testers.[60]

Aerospace:

As a sector aerospace is already high-tech, and is subject to both technological change, but also political decisions, like military contracts, export

support, trade deals, to name a few.[61] It's not surprising that many aerospace companies are further along in terms of technology adoption than other industries and sectors.

Countries with national aerospace industries, most notably, France, are pledging their commitment to transforming industries into becoming more sustainable and "green". Reducing carbon footprints, using new energy sources, and ultimately

[55] Pouliakas, Konstantinos. " Determinants of Automation Risk in the EU Labour Market: A Skills-Needs Approach." Institute of Labor Economics. 2018. Pg.14.
[56] Pouliakas. Pg.18.
[57] Brookfield Institute. Pg. 2.
[58] Brookfield Institute. Pg.5
[59] Ibid.pg.5.
[60] Better, Faster, Stronger. Pg.63.
[61] IndustriALL.

development of new aircraft will revolutionize work in the sector. Combined with smart technologies, and AI, within the next 30-50 years, production, assembly and maintenance will inevitably be transformed.

Airbus developed a smart factory to be established by 2025, set to produce a new line of concept aircraft using cutting edge technology. For instance, the smart factory will utilize self-driving vehicles used in logistics and material handling, smart tools that assist with assembly, laser technology for parts assembly that gives better precision in less time and effort. 3D printing is already being used, namely by Airbus suppliers, in production of titanium brackets.[62]

Recently, Boeing and Safran announced a joint investment in Electric Power Systems, a company that produces an automated industrial base capable of producing aviation-grade energy storage, including technologies that reduce costs of battery systems for electric airplanes.[63] Advancements in this area will not just transform aerospace, but transportation, in general.

NASA is continuously working on its all electric aircraft (X-57 Maxwell) in efforts to develop a safe aircraft and pass on the technologies to private industry.[64] Electric aircraft will likely encompass smart technology, too. There is already thought being given to aircraft that can detect and diagnose issues on its own, schedule its own maintenance, order its own parts, and choose where maintenance will be done.[65] It's not a farfetched idea, considering that Tesla vehicles detect necessary system upgrades, and can order new parts through dealerships.

Advancements in maintenance and repair have already been accomplished. For instance, Rolls Royce is developing a suite of mini robots for use in engine inspections, diagnostics and repair. One group of robots called INSPECT is placed inside engines to continuously identify and report anomalies. SWARM robots that measure 10mm in diameter are meant to be deposited within the centre of an engine and access hard-to-reach areas to perform a visual inspection. The camera-equipped bots would send live video to the operator, who could quickly check the engine for problems.[66] Another diagnostic tool is FLARE, which is another type of bot that can travel throughout the engine and conduct patch repairs. These advancements reduce the amount of time needed for diagnostics and repairs, which translates into reduced costs and shifting maintenance and repair into an on-demand business.

Drones are also being used for maintenance to quickly inspect the full length of aircraft, which saves time, approximately 1-2 hours.[67] Drones could also be used to transport spares, stocks and materials.

New materials are also transforming the nature of the business. Fuselage, wings, and empennage are assembled using carbon fibre reinforced plastic (CFRP) as it's lightweight, stiff and durable. Diagnosing damage to CFRP is difficult to detect, and left undetected can cause major problems. Airbus's non-destructive testing line tool using ultrasound makes inspection possible by those who are not experts in CFRP, such as line mechanics who aren't NDT certified. Repairs have also been simplified; during production of CFRP, microcapsules are inserted into the composite material. In an aircraft wing with this modified material, the microcapsules rupture upon impact releasing the liquid that repairs cracks, which hardens. Research studies show that this process can recover 100% of the CFRPs mechanical strength.[68]

Pratt and Whitney Component Solutions in Singapore embarked on a three year program to digitize and boost MRO capabilities with artificial intelligence.

---

[62] IndustriALL
[63] Automotive Electronics."Boeing and Safran Invest in Electric Power Systems." 19.09.2019. 1-3. Pg.1.
[64] Pg.2.
[65] "Smart airplanes anticipate repair needs."
[66] https://robbreport.com/motors/aviation/robots-repair-jets-engine-2810599/ April 2021.
[67] "Smart airplanes anticipate repair needs." Pg. 4.
[68] "Smart airplanes anticipate repair needs." Pg. 5.

The plant repairs combustion chambers, fuel nozzle injectors and guides, tubes, ducts and manifolds. The goal is to increase productivity and precision of engine maintenance. The system is anticipated to increase productivity by 80% and higher inspection quality. Part of these efforts also eliminates manual input of service orders and other administrative tasks, while also yielding large sets of data that are analyzed to determine how processes can be continuously improved.[69]

The plant will also feature an AI robotic visual aided system for its automated chamber assembly and disassembly system.[70] The new system is able to detect cracks and dimensions, can perform auto routing and blending, reducing the need for welders.[71] Given a clear impact on workers, Pratt and Whitney commented that advanced technology will, "enable opportunities for people to move into value-added tasks."[72] At best, it's a bland statement that gives no guarantees about job protections, upskilling and retraining.

Information gathered from IAM union representatives who are responsible for labour relations and negotiations of collective agreements noted that employers have started discussions about advanced technologies. Most common types of technologies that are either in use or will be, are CNC machining centres, robots that polish landing gear, and CNC machines that don't require human operators at all. As a result, CNC operators are left to supervise several machines at once.

Representatives also noted that in recent negotiations NDT testing, 3D printing and other technologies related to aircraft manufacturing were part of the negotiation process. In those cases, the union secured language that specifically dealt with these technologies. Also common in the aerospace sub-sector are integrated conveyor systems, x-ray systems, metal detection systems and integrated LNC welding systems.

While employers haven't reached the full potential of advanced technology, technological change is certainly underway.

Healthcare/Long-Term Care

Quickly aging populations, and changes in the demographic make-up of care homes will shape the future of this sector and the pace of technological adoption. Additionally, these factors are underpinned by a trend experienced globally: major labour shortages, which will increase the reliance on and use of technology in the sub-sector. In some countries, training and recruitment initiatives simply can't keep up with demand for workers, which is ushering in new technologies, most of which are in their pilot stages.

Globally, this sector is also characterized by low-wage work, demanding physical labour, high rates of burnout and difficulty in retention, factors which

[69] Chuanen, Chen. " Pratt and Whitney's Singapore Operations Get AI and Robotic Technology." MRO Network. 1-3. Pg.1
[70] Chuanen. Pg. 2
[71] Chuanen. Pg.2
[72] Chuanen, pg.3

compound labour shortages. Different countries are at different points in terms of technology adoption, however, in some countries, like Japan, technology is in full use, particularly in resident care in nursing homes and, in home care settings. In Japan; long-term care sector robot usage is being normalized in resident care. For instance, culturally sensitive robots, exo-skeletons and interactive robots are all becoming the norm as the country anticipates severe labour shortages coupled with growth of the long-term sector. Simply put, demand for labour will outgrow available supply.

The situation in other countries is fairly similar; for example, the U.S. Bureau of Statistics released a study indicating that personal care and home health aide positions are projected to be one of the fastest growing occupations over the next 10 years. The study also revealed that 90% of people 65 and older prefer to stay at home for as long as possible.[73] Much like in Japan, chronic staffing shortages have been an issue over the last several decades in North America, as well. Despite efforts to train healthcare workers, cuts to healthcare, and education and training have eroded the labour market to the extent that recruitment will only get more difficult.

TABLE 1
Selected Research Programs in U.S. - Based University Research Programs

RESEARCH CENTER	WEBSITE	RESEARCH AREAS
Center for Research and Education on Aging and Technology Enhancement (CREATE) at the University of Miami	http://www.create-center.org/	Research on human interaction with technology
Georgia Institute of Technology. The Aware Home Research Initiative	http://www-static.cc.gatech.edu/fce/ahri/projects/index.html	Social communication, memory aids, and everyday home assistants
Massachusetts Institute of Technology (MIT) AgeLab	http://web.mit.edu/agelab/	Electronic toy pets for medication taking, biosensors to monitor health, safe return for wandering in Alzheimer's disease
Oregon Center for Aging and Technology (ORCATECH)	http://www.orcatech.org/	Intelligent pill box, home sensors and tracking devices, intelligent walkers and canes
University of Colorado Coleman Institute for Cognitive Disabilities	http://www.colemaninstitute.org/about.php	Assistive technology for people with cognitive disabilities
University of Florida Mobile & Pervasive Computing Laboratory	http://www.icta.ufl.edu/gatortech/index2.html	Gator-Tech Smart House pr9gram with smart technologies
University of Pittsburgh/Carnegie Mellon University Nursebot Project	http://www-2.cs.cmu.edu/~nursebot	Memory aids, activity assistant, cognitive orthotics and robots
University of Rocheter Center for Future Health	http://www.futurehealth.rochester.edu	Medication assistance and automated health assessments systems
University of Virginia Medical Automation Research Centeer	http://marc.med.virginia.edu/projects.html	Automation and robotic solutions for in-home monitoring and sleep monitoring systems, intelligent automated assistive walking device
University of Washington Laboratory for Assisted Cognition Environments	http://www.cs.washington.edu/assistcog/	Assisted cognition and system for human

74

[73] https://www.paycor.com/resource-center/articles/5-trends-in-long-term-care-for-2021/ May 2021.
[74] Tak, Sunghee & Benefield, Lazelle & Mahoney, Diane. (2010). Technology for Long-Term Care. Research in gerontological nursing. 3. 61-72. 10.3928/19404921-20091103-01. 1-73. Pg.62

In the United States alone, several universities are developing smart walking canes, resident monitoring and tracking systems, automation and robotic solutions for in-home monitoring and sleep monitoring systems, intelligent automated assistive walking devices, electronic pets to help with medication taking, and electronic pets with biosensors that monitor health. Since the technologies are in early stages of implementation, most haven't been studied enough to determine their efficacy in improving care of residents in LTC settings, and home care settings.

These technologies aim to address several areas, like, "safety (e.g., falls, wandering), self-care activities (e.g., bathing, taking medication, eating, mobility, sleeping), communication (e.g., social interaction and connection), and entertainment."[75] Note that personal support workers, healthcare aides, and other ancillary staff assist with many of these activities, opening the possibility of, at the very least, a reduction in the number of personal support workers needed, or eventual elimination of these types of jobs.

The technology goes beyond assistive devices, prototypes of a nursing care robot are deployed right now in participating nursing homes in the United States. The robot, named RoBear is:

"a miniaturized personal robot aide, always ready, never tired or off duty with affective computing ability. It can respond to emotional expressions and convey features on its face and in its intonations that range from happiness to sympathy. RoBear's eyes also transmit video, its belly is a screen that displays two-way communication, and its hands sense and transmit physiological reports. Residents can now decrease their social isolation by having virtual visits with their friends and family any time, any day in between onsite visits via RoBear or their two-way communication screen in their room." [76] The robot is also capable of patient lifting and transfer, responding to voice commands and taking x-rays, and digital pictures that are transmitted to specialists, avoiding use of ambulatory services.[77]

In some cases, interaction with humans would be limited, as these technologies are truly meant to reduce reliance on staff. The availability of these types of technologies is said to also reduce costs related to long-term care, and possibly enable a greater number of people to " age-in-place." Generally speaking, "because technologies rapidly drop in price every 18 months, over a short period of time, they become affordable and thereby increase access." [78]

As another cost cutting measure, facilities are also removing nursing stations as they require 24/7 staffing. Instead, nurses are using mobile kiosks and iPads to conduct their work. Electronic health record systems centralize data, allowing for quicker research on patient records, which makes mobile kiosks possible. "Efficiencies gained in better organizational activities and deployment of skilled workers will translate into cost savings,"[79] which is aided by new and emerging technological advancements.

Barriers to implementation, such as regulations, will slow the adoption of technologies, but in a sub-sector like LTC, lack of unified regulation, and exclusion from the Canada Health Act could lead to implementation of cost-cutting technologies that may not improve patient outcomes. Privatized homes have a track record of being costly, with reduced level of care. Technology adoption could exacerbate this situation. Consider that one of the goals of technology is to make it so that, "nursing home surveyors will no longer have to visit every home to ensure quality but will receive sentinel alert reports from systems that automatically identify facility criteria lapses or unrectified deficiencies."[80] The potential for missed

[75] Tak. Pg. 64.
[76] Tak. Pg. 69.
[77] Ibid. pg. 70
[78] Ibid. Pg. 67.
[79] Ibid. pg.67

alerts, and alert failures exists, and unfortunately, the brunt of system anomalies would be very real and borne by residents.

Lastly, smart residencies will usher in an era of real-time monitoring. Embedded technologies in the everyday environment would serve as the recorder of many of the day's tasks. It's anticipated that technology will add a critical missing quality oversight piece—"real time" monitoring with proactive sentinel alerts to negative patterns within and across facilities—which is unfeasible today.[81] This would open new possibilities of worker surveillance over a group of workers that is bound by numerous policies and regulations on not just ethical behaviour, but in carrying out of tasks, interacting with patients, residents, families and other health team members.

It's clear that technology in the healthcare sector will impact work organization. Technological changes could lead to de-skilling, and continuing routinization and automation of tasks, against a backdrop of severe labour shortages and an aging population. In other words, the context that gives rise to technological adoption is ripe with opportunities.

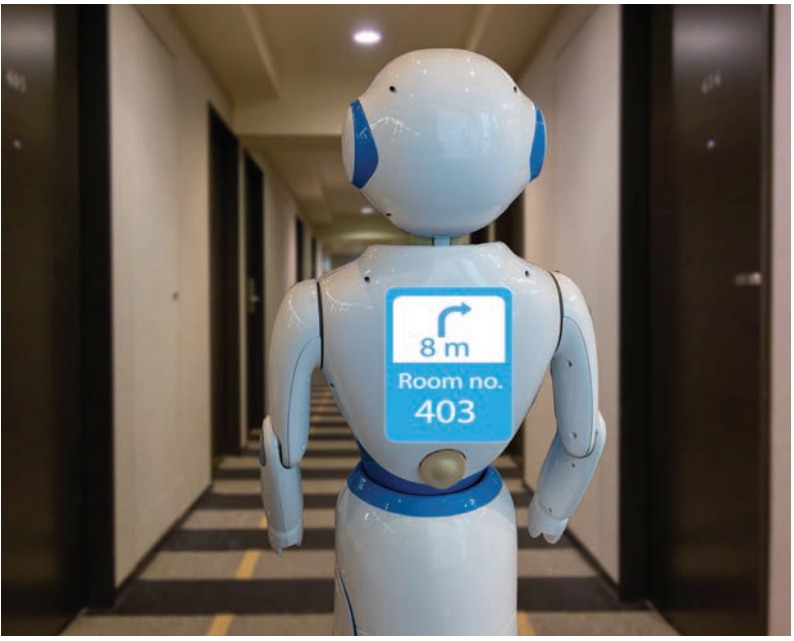
While demand pressures in this sector are looming, and while technology is a convenient solution, there should be further assessment of the effects of existing pilot projects from a variety of points of view, which must include workers who will be impacted.

Hospitality

The pandemic has ravaged the tourism and hospitality industries, and placed pressures on businesses to adapt to the new environment which is so critical to recovery. The trend in the service sector focuses on personalized services, and in the post-pandemic environment, contact-less technologies. Some of these technologies have been in use for some time, but, with external pressures, businesses are looking to technology to aid in their post-pandemic recovery.

Digital wallets, and wearables have been in use for some time allowing clients to pay for transactions without their card. With an added emphasis on reducing contact and transmission through common surfaces, hotels are expanding this feature, which has reduced the need for staff to perform this service throughout hotels. For some time, travelers have had the option of using mobile check-ins, the use of which

[80] Ibid. Pg.68
[81] Ibid. Pg 69.

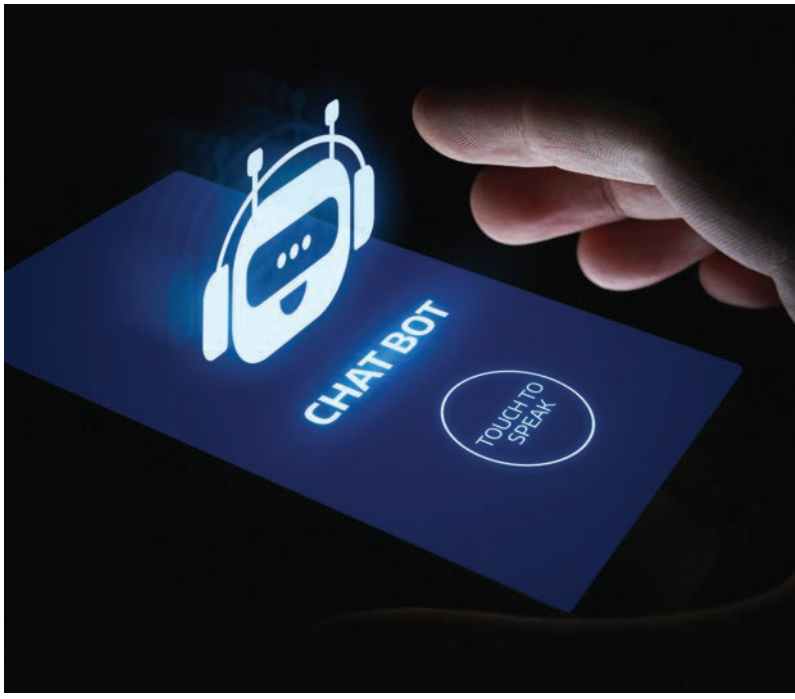


is already expanding, but in some cases, self-check in kiosks involve facial recognition for self-check in.

The use of robots has also expanded beyond greeting guests and concierge services, to cleaning, disinfecting, luggage transportation, security, room service and restaurant waiting. Similarly chatbots, which are common in customer service, are being used in hotels to assist with quick answers. The chatbots are programmable in several languages catering to international travelers. Although in its early stages, robots are being piloted in kitchens to either help with food preparation, or in some cases, cook simple dishes.

Virtual reality(VR) and augmented reality(AR) are also emerging trends. Virtual reality tools allow travelers to visit the hotel virtually before booking, either for personal or business needs. Hotels have benefitted from this technology as it's boosted additional sales. AR will also make it possible for clients to personalize their hotel stay through smart technologies, like windows that can simulate a preferred view and location, along with sounds, temperature and smell.

Like many businesses, hotels directly cater to client preferences as it's critical to remaining relevant and competitive. Technological changes in this industry are happening the fastest, and have enabled self-service and personalization for clients. Self-service kiosks, online registration, targeted feedback questionnaires, and options to pre-set the amenities within a room are becoming increasingly common, and are just the beginning of what hotels will look like in the future. While focus groups with workers in hospitality weren't conducted, given the nature of the technologies, it can be assumed that, at the very least, work and tasks have been re-organized, and some jobs have been lost.



EFFECT OF AUTOMATION ON WAGES

As automation becomes more prevalent, the effect on wages is easier to study. Recent studies indicate that there is, " little systematic evidence of the equilibrium impact of new technologies, especially of robots on wages."[82] Evidence from a study of 50 countries in a 21 year period (1993-2014) points to the fact that automation of low-skill and medium skill occupations has, "contributed to wage inequality and employment polarization."[83] Another study also indicates that the effect of automation on wages has been especially severe for middle-skilled workers, since, "tech change is biased towards replacing labour in routine tasks."[84] With a targeted effect of technology on wages, it is not at all surprising that there is, "job polarization between high skilled and low-skilled occupations."[85]

Without a doubt, both employment and wages have decreased in areas, "with greater exposure to robots compared to low exposure areas."[86] While AI has made numerous technological applications possible, industrial robots, those capable of performing various tasks, and even several at once, that are capable of replacing human labour have grown in popularity. The use of industrial robots is common in manufacturing, but increasing use is noted in agriculture, forestry and fishing, mining, utilities, construction, education, research and development, and services and entertainment.[87]

Between 1993 and 2007, the use of industrial robots in North America and Western Europe has increased fourfold, bringing the ratio of robots to workers to 1:1,000.

[82] Acemoglu, Daron, Restrepo, Pascual. " Robots and Jobs: Evidence From US Labor Markets". National Bureau of Economic Research. Cambridge, MA. March, 2017. 1-62. Pg. 1.
[83] Acemoglu. Pg. 1
[84] Kinsella, pg. 44.
[85] Kinsella, pg.44.
[86] Acemoglu. pg.19
[87] Ibid. Pg.14

EFFECT OF AUTOMATION ON WAGES

Between 1993 and 2007, the use of industrial robots[88] in North America and Western Europe has increased fourfold, bringing the ratio of robots to workers to 1:1,000.[89] In the United States, in 2000 that ratio has increased to 2.6 robots for every one thousands workers.[90] The Industrial Federation of Robotics estimates that currently there are between 1.5-1.75 million industrial robots in operation, which could reach 4-6 million robots by 2025.[91] Statistics show that the automotive industry leads usage by employing 39% of its workforce as robots, followed by the electronics industry (19%), metal products (9%), and the plastics and chemical industry (9%).[92] Ultimately, the use of industrial robots negatively affects workers' wages, and employment, by directly displacing workers from their jobs through productivity gains.[93]

What is most concerning is that between 1990 and 2007, employment and wages have declined substantially. For every one robot that is used per thousand workers, aggregate employment is reduced by 0.37%, and average wages by 0.73%, when compared to an industry in which there is no robot use.[94] This means that the use of one robot reduces

employment by 5.6 workers.[95] These findings are most evident in manufacturing, especially in occupations considered routine, blue collar, assembly related, where workers without higher education tend to work.[96] But, workers like operators, machinists and transport workers have also shown to be susceptible to automation. Workers in low-skilled jobs that are either routinized or precarious, tend to be racialized workers, immigrant workers, youth, and those from low socio-economic backgrounds. The first wave of impacts of technological change will irrefutably affect those most vulnerable, and most likely to have a tougher time upskilling and changing professions.

Studies that looked at the effect of automation on wages took place in the manufacturing sector, namely automotive plants, however, emerging information shows that automation is growing in jobs in accommodations and food prep, transportation and warehousing, mining, quarrying, oil and gas extraction, agriculture, and forestry and fishing. Few studies have been done on the retail sector, although it's a sector highly susceptible to automation, and could lead to both job losses and even lower wages.

[88] Automatically controlled, reprogrammable, multipurpose machines capable of replacing human labour.
[89] Ibid. pg. 2
[90] Ibid. pg.16
[91] Ibid. Pg.2
[92] Ibid. pg.2
[93] Ibid. Pg.
[94] Ibid. pg.4
[95] Ibid. Pg. 4
[96] Ibid. pg.5.

IAMAW FOCUS GROUPS

Information in this section was gathered through surveys with union representatives who service locals and negotiate collective agreements, as well as, rank and file members from different sectors. Surveys with union reps were conducted using quantitative questionnaires, with full participation from all reps.

Fifty-one percent of representatives indicated that employers discussed plans to upgrade technologies in the workplace, and another 45% indicated that these discussions haven't been taking place. In most cases, (61%) technological change was not an item on the bargaining table, as bargaining priorities are driven by member priorities. Lack of knowledge about automation among an average union member is a challenge in prioritizing technological change. Moreover, most members welcome equipment and technology that reduces physical exertion, but may not realize that in some cases the same equipment makes job tasks repetitive, and susceptible to automation.

Employers in aerospace, air transportation, manufacturing and automotive shops were most likely to discuss and implement new technology, which is supported by information from focus groups with members. Hot spots where automation and technological change is occurring also aligns with academic research on automation. Not only is it consistent in terms of affected sectors, but also in terms of some of the effects of automation, when on job task technological change is discussed, employers are most likely to negotiate retraining of workers.

The second portion of research findings come from surveys conducted with members, and focus groups with the same individuals. Possible recommendations were discussed with members, and those suggestions have been incorporated. Below is a summary of findings from focus groups with rank-and-file members.

Air Transportation: Introduction

Members in air transportation work for airlines and service providers at airports across Canada. The sector is integrated into the global economy, meaning that pressures of on demand and on time delivery plays a role in technological change. Likewise, increased global travel placed pressures on airport operations. Some of the employers are industry leaders, and to maintain their competitive streak, and gain a greater share of markets, they are very likely to continue adopting cost cutting and productivity raising technologies. For example, Amazon's business model is being adopted and is driving changes in non-passengers business activities of air transportation.

Use of Big Data to access information about passengers and cargo, which also drives changes in the workplace, exerts additional pressures and increases the volume and pace of work.

> *"No realization [among members] how automated everything is. On a surface level people welcome it, but there is no deeper understanding."*

Six focus groups were conducted in this sector; spanning three provinces, B.C., Ontario and Quebec. These were diverse groups in terms of positions, ages and educational backgrounds. The group was divided between those who perform screening services at airports, maintenance technicians, ramp agents, cargo services, cabin cleaners, and fuelers.

The non-screening officers group consisted of 15 participants, some of whom work in Montreal, and others who work in Toronto. The majority of this group was male, with a total of 12 male participants and 3 females. There was an even age spread of ages, with a slight majority of those in the 41-50 age range. Most of the participants had spent 15-25 years in their position, and the majority had college training (9), two with university degrees (2), and five (5) participants with high school degrees. For some a career in air transportation is a second career, with one individual indicating the second career arose due to technological change in his first career.

Analysis of qualitative information point to several themes. Technological change has been a feature of work environments for years, and has impacted job tasks, the organization of work. Workers with more than 15 years' experience have noted that the pace of work and productivity has substantially increased. These participants were also able to give more context to technology adoption over time, coining the phrase " death by a thousand cuts." This means that technological change has been gradual, slowly eliminating and restructuring the workplace, which in some cases has led to job losses.

Another phenomenon emerged in discussions, that of "invisible tasks". As jobs evolve due to automation, tasks that can't be automated are absorbed into existing jobs. Individual experiences show that in some cases, two people would have done a particular job, but with automation, one job was shed, leaving one person to work quicker with the assistance of technology. Additions in job tasks sometimes come with a change in titles, but proportional compensation doesn't always follow. This scenario indicates that the phenomenon of increasing productivity and wage stagnation is present.

Some union representatives who service workplaces in the air transportation sector indicated that employers have at the very least, engaged the union in discussions about new technologies. Autonomous vehicles, biometrics, and GPS based equipment monitors have been tabled, indicating that plans for implementing advanced technology are under development, but through member surveys, it's clear full implementation hasn't happened, yet.

Details

The majority of participants indicated their jobs can't be easily automated (67%), although 40% indicated that over the course of their career, they had seen a significant increase in automation. For participants, technology is synonymous with high-tech, sci-fi capabilities, rather than those that surround them on a daily basis. Awareness of the extent of technological adoption was higher among workers with 15 or more years' experience. 60% indicated they had experienced technological change in their positions, and 90% required upskilling and retraining, which in most cases happened on the job. 53% of participants indicated their employers do not discuss technological change, but that their collective agreements contain provisions. Most participants weren't familiar with specifics of those provision, but those that were aware, stated that current provisions on technological change covers jobs that have changed.

Sixty percent indicated automation could be helpful in their jobs, and 47% stated continued automation would make their jobs more technical, easier to outsource, and would increase the pace of work and output. Although the majority was confident their

jobs couldn't be automated and eliminated; over half of the participants believe automation can replace coworkers in their workplace. Most people believe their jobs are immune to automation, but are much more likely to believe their co-workers' jobs are susceptible.

Participants working as maintenance technicians indicated that technological change is part and parcel of their jobs, mostly driven by new aircraft. The

nature of the work has become much more digital and on demand. A notable change in this line of work is that engines used to be based on pistons, and are now turbo fan engines, requiring new tools and ways of working. Diagnostics of issues happened on the basis of learned knowledge and expertise, and books. Equally important were technician's intuitive knowledge built on experience, sight, feel, smell and sounds.[97] Much of this knowledge and diagnostics are digitized, with maintenance personnel using iPads for access to information. Before the plane lands, technicians are already aware of issues, and are ready with parts and tools. The craft based knowledge is certainly being eroded as diagnostics become digitized.

Participants believe that some deskilling will occur in the future, and that the occupation will delineate between practical and certified mechanics. History may repeat itself, as in 1958 in the Buffalo Stamping Plant when automation was introduced, "management insisted that the complexity of the equipment made it mandatory… to break down the lines of demarcation between the skilled trades."[98] Although this happened in 1958, it seems that the trajectory of changes will follow a similar path. Job descriptions will have to change, and be matched to the work and time that is required, including the compensation scale.

Parts retrieval has become entirely automated, completely eliminating the need for labour power in those positions. Automated parts retrieval keeps stock of parts and tools used, and it tracks who is using the equipment. Similarly, the system for pulling batteries out of forklifts has been entirely automated. The system is magnetized to remove batteries faster and with less skills. This indicates de-skilling and blurring of lines between those who would have been designated for this work.
Visual docking guidance system (VDGS) has been a feature of daily activities for workers on the ramp for some time. Increasingly its use and the information it provides has become more complex. Participants familiar with the system indicated that it now

> *"Jobs disappear, but the tasks don't, they just become invisible."*

contains 7 lines of information for incoming aircraft, and that capabilities of this system are massive. In some European airports, VDGS is used instead of workers, although human oversight is available as a precaution. Ramp workers cited autonomous towing tractors, which, with investments, could at the very least reduce the number of workers needed in this role.

[97] Van Dyke, Don. " Smart airplanes anticipate repair needs." Propilot Mag. 1-8. Pg. 8.
[98] Meeting the Problems of AUTOMATION through Collective Bargaining. International Association of Machinists Washington, D.C. December 1960. Pg. 1-41. Pg. 34

On the cargo side of the business, participants with long careers in that department indicated that Amazon's business model is being adopted, namely, the extent to which the amount of data is collected about customers. E-commerce is a growing global business that is highly competitive, " driven by speed and technology."[99] In terms of transportation, it is one area that hasn't been hindered by the pandemic, if anything, the pandemic has placed additional pressure on this business to meet client and customer demands. Focus groups were conducted prior to the pandemic, so the effects of the pandemic on cargo isn't available. However, long before the pandemic, warehousing for cargo was almost entirely automated, in fact, there are more machines than workers on the floor.

When one of the participants first began in baggage handling, the work was purely physical, however, over time, physical labour has been reduced and shifted to include more decision making. The job title has also changed from load agent, to logistics specialists. With that title change more tasks have been added, but from the perspective of the participants, the wages did not change. If this is the case, the phenomenon of increasing productivity, and stagnating wages is present.

The cargo department is making use of roll-bins, the PMC racking system and electronic ticketing, which have greatly changed the nature and the pace of the work. The barcode ticketing system is accurate and convenient for one person to use, eliminating the need for two persons to handle baggage. Despite the convenience of the new technology, participants indicated that tasks usually done by a second person, have now been absorbed by the one that remains on the job. These are invisible tasks- jobs disappear, but the tasks don't.

Members in cabin services also indicated the extent to which their work is automated, and the emphasis that's placed on efficiency. Devices that streamline information about flights, landing times, gate numbers and outbound details are a daily part of workers in cabin services. This information sets timelines for load times, and stacks a workers' schedules with flights. Schedules that were provided indeed showed workers were given 1 minute in between flights. The devices recognize when the pilot releases the breaks on the plane, indicating to

[99] Air Canada Cargo. Bulletin

the individual worker that the aircraft is ready for cleaning. Workers in this group stated that 90% of their job could be automated, and the remaining work would be supervisory.

Technological change has also impacted non-unionized staff with the introduction of the employee scheduling service, specifically, the reduction of Human Resources staff who would otherwise be involved in scheduling. This change has greatly impacted relations with the company, in that it's reduced face to face communication, and without staff on site, people are self-reliant. Members felt that, ultimately, all responsibility has been shifted on the worker as they absorb responsibilities once done by a designated scheduling person.

Participants indicated that when technology is first introduced, management presents it as a measure that makes work easier, more convenient and ultimately, in more physically demanding jobs, something that prevents strains, injuries and reduced the physical toll. For instance, a system called vacuulux was introduced into the workplace to assist with heavy baggage. Members welcomed the equipment, however, while one type of injury has been eliminated, the movements as a result of this equipment have become more repetitive. Not only does this cause a different type of injury, but in becoming more repetitive, that task then becomes susceptible to automation. This is something that members don't always recognize.

Issues with new technologies are most commonly raised through health and safety committees as a first line of defense. Participants involved with health and safety, indicated that the employer used complaints as feedback to make changes to the system. Despite initial resistance to some of the new technology, the employer continuously made improvements until workers accepted new systems.

As a measure against automation, members see a major role for the union. However, it is clear that automation is not generally understood, and how pervasive and gradual change is. Ongoing job description assessments should be done to track changes in tasks, and ensure compensation follows, where applicable. A major roadblock to achieving adequate protections is lack of member awareness, making it difficult to prioritize technological change in bargaining, as well as, support in advocacy efforts. Participants pointed out that education on the history of technological change, new technologies, how they are used and its effects is necessary to raise awareness. In knowing more about technological change, they believe their locals would be better equipped to have conversations with employers.

Screening Services

This cohort of participants had the most even gender breakdown out of all the groups, with an even split of males and females. The group was also diverse in terms of age, educational backgrounds and ages. Participants noted that their jobs were repetitive and monotonous in terms of tasks, however, that their working environment was dynamic and challenging. Jobs of screening officers are much more controlled given that the jobs are regulated by the Canada Air Transport Security Authority (CATSA). Training is a regular component of work, especially when new methods and technologies are brought in.

Passenger levels are a major driver of changes to operations within airports, particularly, screening and security of passengers. External pressures like 9/11 and now COVID-19, play a role in the procedures that are developed as part of screening and safety. Regulations and oversight from the federal government seems to have slowed the pace of automation, highlighting the importance of advocating for regulations that govern not just automation per se, but work procedures and policies, as well. De-skilling and routinization precedes full automation, which is why policies and procedures are especially important. All this forms part of the external environment that shapes the policies and procedures in the workplace.

All of the participants were unanimous in agreeing that in the last two decades, the workplace has significantly changed, and that there isn't an aspect of the job that hasn't been automated. It was clear to participants that employers are often testing ratios of screeners in certain positions in order to improve

efficiency. However, workers on the ground are aware of problem areas that can be improved, but are never consulted. Participants gauged that in the next 2-7 years, many of their tasks could be fully automated.

In order to manage passenger flows, processes and automation are relied upon. Participants noted that with new technology in place, they felt the pressure to be, "faster, [and] more efficient."[100] Higher passenger levels have certainly resulted in more work, more throughput and a faster pace of work. This area of air transportation is highly susceptible to technological change, not just because tasks are repetitive, but also because of trends in air transportation. The pandemic has also placed pressures on airports and airlines to adapt to the pandemic reality and adopt contact-less methods.

Participants were aware of technological changes in their work environment, but didn't think that the job itself could be automated. Yet, facial recognition, biometrics, iris scanners, fingerprinting were all named as something that was part of the airport work environment. Unlike other workplaces, it is evident that AI type technologies are in the airport, although workers haven't been displaced.

The biggest change that was noted is remote screening. Officers are no longer near a screening line, instead they are in a room where images are reviewed on screens. This has led to a faster pace of screening for potential threats, and while it's been helpful for seasoned screeners, those with less experience struggle. The timeline screeners are given to review an image is 15 seconds, which all participants stated added pressure and set a pace, which wasn't something they faced before. Much like in other workplaces, the pace is set by a machine making a noticeable difference in how quickly the work is done. Added pressure comes from formalized guidelines from the regulating body in CATSA.

Some checkpoints like CATSA+ are highly automated, and participants noted those lines operate with minimal staff. Body scanners have reduced the number of screeners required from two to now just one. "Wanding" of a passenger itself took 30-45 seconds, body scanning takes 4 seconds. The notion of "invisible tasks" came up in this group, too. Participants noticed that in areas where there's been a reduction of workers, those who are left take on remaining tasks that can't be automated.

[100] Local Lodge 16 Focus Group, October 25, 2019.

Automated checkpoints have increased passenger to screener ratios of about 1:4, which has reduced their interactions with passengers. All of the participants in this cohort noted they enjoyed interacting with travelers, but had little time to do so, especially in peak periods. The NEXUS process, from the participant's point of view, wasn't considered an automated process, possibly because very few screeners work in that area.

A feature that is particular to these workers is the heightened surveillance while on the job. While surveillance stemming from new technologies is well documented, it's especially evident in the work of screening officers. This is not specific to IAMAW screeners, screening officers in the United States have noted the same experience, and that management uses tapes to search for the slightest infractions, like gum chewing, or unauthorized trips to the bathroom.[101] Regulator protocols, heavy presence of management, employee passes, camera surveillance, and monitoring of passenger processing are all ways in which workers are tracked. Participants noted that their work environment is, "surveillance to the max", and that every moment while on shift is tracked.

There's evidence to indicate that the more management watches employees, the harder they try to stay under the radar, "they try to never speak up, never stick out, do nothing that might get noticed management, leading to management growing more suspicious and feeling justified in ratcheting up surveillance."[102] Studies of worker surveillance show that it increases stress, promotes worker alienation, lowers job satisfaction, with workers altering their behaviour to suit machines, which ultimately erodes their sense of agency.[103] In rare cases does surveillance improve productivity, so much so that it's unclear under which conditions it is useful and what the limits are.

It came across clearly that automation is not helpful in their job, but it has heightened tracking of employee productivity and compliance. On this issue, sentiments were strong, people felt that the employer, " wishes they could put GPS on us." Participants noted that it is not uncommon for supervisors to question workers about their activities during a break, whether it was a bathroom break, or whether someone took a call.

Guidelines to complete a task, like reviewing an image in 15 seconds is enforced through the machines they work on. During peak periods, in HBS (hold baggage screening system) workers are given as little as 10 seconds to analyze a bag. Failure to meet this deadline results in a review. Workers are on camera 24/7, footage which is reviewed by the regulator, CATSA, in addition to first level supervisors, CATSA personnel and at times, managers. Also, workers have passes they use to check in and out, meaning their break times, and movement around the workplace is highly controlled.

Participants also noted that the time it's taken to train screening officers has been reduced, and that the range of skills of new officers is eroded. There's some uncertainty over whether de-skilling is at play, but there is no confusion over substantial changes that have taken place, and that every aspect of the job is automated. While the job has always been repetitive, participants felt that now it's more so.

Common to both groups in airports is a continuously evolving workplace in terms of automation, an increasing pace of work, higher volumes, and less time to carry out the full range of duties. These participants also expressed that they don't believe their jobs could be automated, with the exception of checking boarding passes. They believe that human contact will continue being an important part of the travel experience.

Skilled Trades: Aerospace, Manufacturing,

[101] Shell, Ellen. " The Employer-Surveillance State". Human Capital. Oct.15, 2018.
[102] Ibid.
[103] Ibid.

Automotive, Shipbuilding

Five focus groups were conducted with skilled tradespeople who were a fairly homogenous group, except when it comes to experience. All participants were males working in heavy construction equipment, shipyards, dealerships, aerospace plants, and aviation. Out of all the groups, skilled tradespeople were most aware of the nature and extent of technological change, and were most likely to think their jobs could not be automated. However, participants were unanimous in that over the last 40 years, substantial changes were noticeable in their professions.

Several themes came out of these discussions, which are unique to skilled tradespeople. From a business model perspective, participants who worked for large global corporations noted that after their employer merged with large corporations, investments in technology followed. Participants also noted that the Amazon business model is changing how their employers conduct business, such as online parts ordering. This move has reduced the connection between the vendor and the customer, but also eliminated jobs supported by parts ordering, shipping and receiving.

Skilled tradespeople noted that automation was not only part of their workplaces, evidence of which was clear in terms of deskilling, and the reduction of autonomy in their work, but also in terms of tools they use, and processes that are now in place. Less hands on work was noted, which they attributed

> *"More self-reliant customers reduce job needs."*

to changes in technology and digitization of work processes. Union representatives who service automotive workplaces noted that automation of tire removal and replacement was a point of discussion with employers. Not surprisingly, it is those types of technologies that were noted in member feedback.

Automotive technicians in the group noted that computerization has driven major changes in their trade. Codes generated by computer systems, which is essentially self-diagnosis, not only determine the issue, but also parts needed for repair. Instead of a

fully qualified journeyman assessing the issue, the computerized system determines parts that are required and an unskilled worker goes out to do repairs. The person who would have taken the call from a customer used to be an experienced and skilled worker, who would diagnose the problem, and communicate with a journeyman to do repairs. Computerized systems have completely changed this. Digitization has irrefutably impacted how skilled trades do their job. An experienced journeyman used to rely on innate knowledge built over time, and as one participant explained, " to diagnose and assess, I'd listen to the sound of a bearing, then add more oil, then listen again to get it right. But now, it's all done by a machine, it gives me all the information I need." While it makes work more efficient, the nature of work for skilled tradespeople is being deconstructed.

Automotive technicians, similar to aircraft technicians, indicated that a lot of their work is digitized. In the past, diagnostics were conducted with the help of books and manuals, and logbooks were used for documentation; now, it's all online. In some shops, technicians are using phone apps that allow for an inspection of a vehicle. The technician can take videos, audio and pictures of issues, send them to the customer, while also uploading them into the system. This has opened communication between technicians and customers, reducing the need for customer service workers. This trend is in line with studies that have proven that systems that produce, " more self-reliant customers reduce job needs."[104]

For employers it's a convenient tool as the database can be used for data mining, and as one participant pointed out, not only has this changed diagnostics, but continuous uploading of pictures and information about issues trains AI. The database also records who inputs the info, when, and which sources were consulted. In this regard, employers can track the work of employees much more efficiently.

Digitization, particularly when it involves AI renders tracking of productivity. Participants indicated that some of the machines they fix in their shops measure how long a machine is idle for, and who has worked on it. In an 8 hour period, a machine that has been at 1500 RPMs for six hours, indicates that it was idle. Since workers are responsible for certain machines, supervisors can quickly find out how productive a worker has been. Members working for a manufacturer in Northern Ontario are witness to precisely this phenomenon. New machines collected data, which made it easier for management to hold individual workers accountable. Management explained to workers that the monitoring system was strictly for head count, but members felt that the system "did management's job for them" by collecting information, and measuring quotas. This added pressure made workers feel like their output was under constant scrutiny.

Members working as machinists noted that they've seen major technological change since the 1980s. Most notably, the introduction of one machine eliminated the need for 10 operators. This trend was consistent across industries in that employers didn't lay-off redundant workers, instead, retired workers wouldn't be replaced, while at the same time new technology would be introduced. For instance, one worker is responsible for four machines, but it's not unusual to monitor more machines than that. More robots required more set- up time, planning, working with more people, especially with engineers, which wasn't the case before. Members noted that when an

> *In 1980 there were 300 workers in one plant, and all machines required manual labour. But, as a senior participant noted, "jobs went away, we didn't realize 100 jobs were lost, because of the cyclical nature of the industry."*

[104] IndustriALL. Pg.15

employer first introduced technology, more workers were needed and hired, but overtime, jobs wouldn't be replaced or were merged. In 1980 there were 300 workers in one plant, and all machines required manual labour. But, as a senior participant noted, "jobs went away, we didn't realize 100 jobs were lost, because of the cyclical nature of the industry."[105]

Inevitably, the nature of work changed. People noted their pace was faster and more intense, but also more repetitive. The highly routinized job has reached a point where there is no difference between, " an off the street worker and one that's trained." Veteran machinists noted that a lot of the skills learned through manual work are now lost, and that, "nothing is hands on anymore." New generation of machinists, on the other hand, noted that they don't know how to read measurements on the old machines because everything is digitized, and that training today taught them, " how to run the part, not the machine." Studies stemming back to the 1960s point to the same trend, " the introduction of numerical control machines rendered machinists deskilled by separating concept from execution."[106]

In automotive settings, parts retrieval is already automated, with one person noting, "we don't need a parts department anymore, machines get parts for you."[107] Similarly in maintenance, automatic greasers have replaced people who used to do that job. They noted that things that are custom made and require specialized knowledge are harder to automate, and are for the time being, protected from replacement, however, " it's coming…I work for a large corporation, it's what they do."[108]

> *"The highly routinized job has reached a point where there is no difference between "an off the street worker and one that's trained."*

Millwrights were unanimous in agreeing that automation has eroded their trade. One person pointed out that grain terminals have been heavily impacted through automated technologies, which has led to job losses. However, in ship yards automation has increased employment, which unlike aerospace and the automotive industry tends to require more human labour given that each ship

[105] IAMAW Focus Group, Nov.8, 2019.
[106] "Workerless Factory."
[107] Focus group District Lodge 250. Oct.24, 2019.
[108] District Lodge 250.



is more or less custom built, making automation more difficult.[109] As technology becomes available, and heavy industrial robots are developed, ship building will succumb to automation of the manufacturing process.[110] But, another reason was noted by participants explaining why there hasn't been a reduction in the workforce; "reshuffling of bottlenecks." [111]
One participant illustrated the impact automation

> *"The parts guy in our plant is starting to feel like the blacksmith."*

has had on processes, explaining that robotics have re-organized work. Robots in his workplace worked on larger panels, reducing both time needed to complete a task, and the amount of people needed. At the same time, things machines aren't able to complete, like welding seams and welding in tight places, are left for workers to do. The issue is that the pace of work is set by the robot, and the workers who finish the panels need to keep up with the pace of the robot. As a result, more people have been hired to do the finishing, and more workers are needed in the maintenance department.

This raises an important issue, "how will workers compete when their work is measured against that of a machine? How will productivity be measured… when a clear relationship between hours worked and production no longer exists?" [112]

In some of the participants' workplaces, higher paid jobs have been reduced, while lower paid jobs have grown. Research also supports this phenomenon and studies have shown that, "the jobs lost and jobs created have very different profiles and requirements that require intense additional education and training and cannot be matched ad hoc."[113] For instance, drivers of forklifts in the tar sands industry earn anywhere between $150-165,000 annually. With a growing demand for autonomous forklifts, those jobs are being eliminated and other jobs may be created,

[109] IndustriALL,Pg.22
[110] INdustriALL, pg. 22
[111] District Lodge 250.
[112] IndustriALL. Pg.9
[113] IndustriALL.

but not at the same wage scale. Moreover, for those who lose highly paid jobs, it is unlikely they will find other employment that pays as well. Even if workers are hired to do maintenance, the question is at what wage scale?

Proponents of technological change defend automation on the premise that new jobs will be created, however, the issue isn't about the quantity of jobs created, rather quality. Evidence from our focus groups shows that the quality of jobs tends to be reduced, through deskilling of skilled work and elimination of jobs that are replaced by lower-skilled and lower paid jobs. Participants noted that even skilled mechanics are no longer required to be skilled in different areas, rather at one specific job. One participant said that he's under the impression that the trend is for workers to not be skilled at many things, " it's as if they want you to just be good at one thing."

"The trend is for workers to not be skilled at many things, "it's as if they want you to just be good at one thing."

The erosion of trades is perhaps most notable for Red Seal tradespeople. A couple of participants were Red Seal millwrights, a certification that qualifies them to perform the full scope of that job. In the United States, the occupation has been deconstructed, and rather than receiving full certification, millwrights can be certified in specific tasks like, alignment, leveling, basic hand tools, rigging, to name a few tasks. For example, certification in torque wrench use is a two day course. The trade has been completely deconstructed, and people get certified for tasks. A Red Seal millwright in Canada receives one diploma, whereas, millwrights in the U.S. receive a card for each skill. This is perhaps the most blatant example of the level of deconstruction of tasks and deskilling.

A Red Seal service technician noted the same trend in his trade, noting his work used to be much more hands on than it is now. The work is now mostly

based in electronics and half of his 8 hour day is spent on programming, and following protocols from the manufacturer. A complaint from a customer generates a procedure, and the technician doesn't have insight into the issue, the manufacturer does. Tesla's auto technologies are being used as a standard, eliminating the need for dealerships, since cars' software is updated through the manufacturer. Essentially, the system drives the decision making. Most cars that are brought into the participant's dealership require a system update, rather than a mechanical intervention, which doesn't require hands on work.

"Workplace policies and procedures are standardized to the extent that people can't think outside the box to solve a problem, it's all programmed."

Not only is deskilling evident, but, loss of autonomy as well. Skilled tradespeople traditionally had ultimate control over their work and autonomy, since they possessed the knowledge and skill through diagnostics and repairs. Through technological change, that knowledge is being shifted to computerized systems that drive decisions and inform steps to be taken. Participants also noted that workplace policies and procedures are standardized to the extent that people can't think outside the box to solve a problem, it's all programmed. Not following procedures ends up being a problem, stated one participant, noting that it can even lead to discipline.

Part of this deconstruction is consistent influence of employers for faster training of skilled trades, and getting them " job ready." In response to this, schools have cut down on training, while the level of knowledge is lower. Unfortunately, the trend in training of skilled trades continues to be micro credentialing, which further de-skills trades. This development is in response to labor shortage.

However, employers play a role in shaping labour markets, giving the narrative of labour shortages nuances. In some cases, labour shortages are a problem created by employers. In a rural community in Northern Ontario, the demand for machinists had grown to an all-time high prior to the pandemic, and the supply of labour was sufficient. However, graduates were not being hired, with employers indicating that most were not job ready, but in reality, employers wanted the flexibility to outsource the work, which would have been limited by the collective agreement. This shows the power employers hold, including the ability to shape regional labour markets.

From member's personal experience, for-profit colleges have cut unprofitable training, making it more difficult to enroll. At the same time, colleges that offer programs for skilled trades have significantly changed their programs in order to get students into the workplace quicker. While automation is certainly leading to de-skilling, changes in training are only exacerbating this trend. All participants in the skilled trades group indicated "dilution" or deskilling within their trade is not only evident now, but has been in motion for several decades. This is supported by academic research that has tracked automation in manufacturing settings since the 1990s.

Outsourcing came through as a key concern, and participants pointed out the relationship between deskilling and outsourcing. In some cases, work that was too costly to perform in the plant, or was basic, was outsourced to plants that had the technological capability to complete the work. A government policy paper, points to the likelihood of outsourcing, not

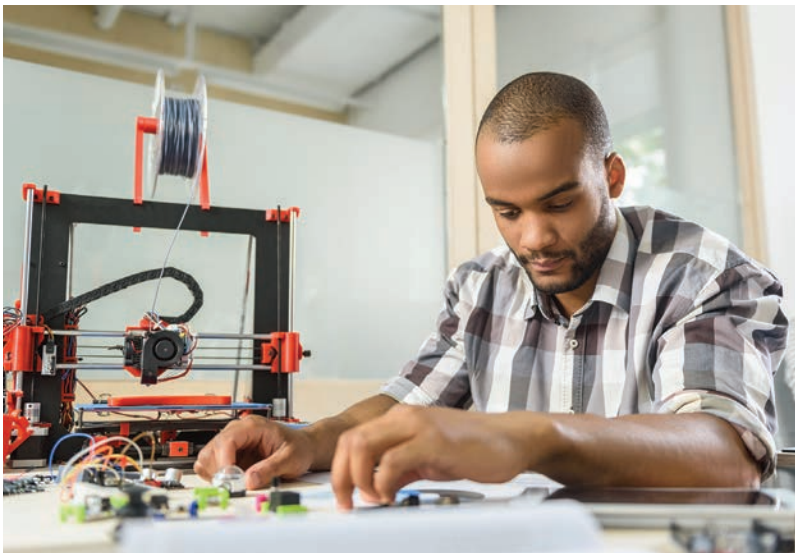
[114] G7 Multistakeholder Conference on Artificial Intelligence. "Theme 4: The Future of Work." 6.12.2018, Montreal, Canada. 1-16. Pg. 3.

because of cheaper labour, but due to a specialized technological infrastructure.[114] Focus groups in B.C., Quebec and Ontario raised the issue of outsourcing and the connection to automation. Based on our focus groups, this assumption is supported by real-world experience.

In some plants, jobs are not in danger of elimination, however, with work re-organization, and jobs that are not core activity to a business, or those that are too expensive to complete in a Canadian plant, are outsourced. Outsourcing came up several times throughout the conversation, noting that some employers are outsourcing work to automated plants in other countries. Participants felt they were in direct competition with robots in outsourced plants.

An emphasis was placed on apprenticeship programs and training, as it's the most effective way of training workers that are job ready. Apprenticeship programs are gaining traction as a training option for preparing the workforce for changes brought on by AI. It was noted that governments have cut funding, but that employers have also exerted pressure on colleges to cut training times, reducing the quality of training.

Collective agreements were seen as essential in managing technological change. One workplace successfully negotiated language for 3D printing, new machines, and improved language for outsourcing. Participants suggested that language be developed that prevents people from being pigeonholed to avoid erosion of skills in a trade. Similarly, workers should be encouraged to diversify their skills, as a measure of protection against automation. There is ample evidence that jobs that contain repetitive tasks are easier to automate, so diversification is one way to protect workers from being replaced by automation.



Employer associations are pushing for micro-credentialing and cross-training of skilled workers. Participants were concerned that these trends would dilute skilled trades, and would only support a program that truly cross-trains workers. Participants noted that cross-training should be based on re-training, where a machinist is trained into a comparable trade that is equally compensated. The ratios of apprentices to journeypersons should be adjusted. Without this, the danger of de-skilling and creating a pool of partly skilled workers is a likely scenario.

Participants also suggested that workers who remain after a workplace undergoes automation, should receive an increase in wages, and benefits due to productivity gains. On the other hand, those who lose their jobs should be significantly compensated, and their benefits extended. The group was unanimous in calling for more training in the workplace, namely through apprenticeship and mentorship programs.

Members also said that the government should invest heavily in training programs like co-ops and hands on training. They also recommended that re-training programs through EI be strengthened, given their value in the 1990s when people transitioned out of jobs and industries that were reducing their workforces. Another government intervention that was popular among participants was a "robot tax", which would be applied to employers who displace workers with robots. This idea has been brought up by American politicians, is in the Green's Party platform, and has already been implemented by the South Korean government.

One participant was a dual union member, and noted that the International Brotherhood of Carpenters set up a training facility aimed at upgrading members' skills in the area of new technologies. The training centre has been helpful in helping members learn about new technologies, and upgrade their skills. Last but not least, participants indicate the importance of the union educating members about technological change and AI, however, given that the phrase has become a buzz word, and a catch all phrase, it's a challenging task to educate members effectively.

"White Collar" Workers

The effect of computerization is perhaps most noticeable in office settings where nearly every task now requires computers and other computerized tools. Participants in this group represent a small portion of the IAMAW's membership, but their experiences are indicative of the wide spread effects of automation, and differential impact based on occupation. Their experience is consistent with academic research which points to AI and automation increasingly being used in specialized software used by workers in accounting, sales, logistics, trading and even those in management positions.[115] Members who participated in this focus group work in aerospace, and perform roles in supply chain management, shipping and receiving, engine inspection, and testing. All participants had post-secondary education, and more than five years' experience in their occupation.

> *"There is a difference between making a job inefficient verus obsolete."*

Participants in the "white collar" category, noted that when they first began in their roles, much of the work was done by hand and manual filing of files. In the late 1990s and early 2000s, participants noted that completion of job tasks was based on knowledge, and

[115] Acemoglu.

experience, leaving room for autonomous decision making. Reports giving instructions to technicians on the floor who perform maintenance, repair and overhaul of engines (MRO), were maintained by technicians and kept in a central database. Inspection cards were also manual, and matrix based, whereby a technician would manually go through the checklist. A computerized system now captures all of the elements, and the system guides the process. Procedures were standardized across the board, with the goal of streamlining operations in a consistent manner, instead, the centralized system became disjointed. This has led to a growth in tasks, and "busy work", which based on discussions with participants, made work chaotic. While computerization allowed for streamlining of a process, it also sped up the pace and increased the volume of work.

It's clear that autonomous decision making has been reduced due to computerized and standardized processes that guide completion of tasks. Members noted that the initial programming and procedures that were developed standardized certain tasks, resulting in routinization.

Participants noted that the work environment used to be more relaxed, without any real time limits, with the exception of critical parts orders. Similarly, participants shared that work used to be less stressful and was more manageable. Work was smoother, it was a different pace, and as one participant explained, "now we're all over the place, we're doing everything, but nothing good, and we're always so far behind." Another participant went so far as to say that with computerization the work environment is, "literally chaos."

> *"Over time, lower level jobs in the bargaining unit disappeared and are now in the minority; the workplace is a different landscape."*

Participants who work in supply chain management noted that supply chain inventory used to be done by a designated person, without the use of computers. This task is now entirely computerized. In fact, members estimated that 50% of their jobs could be automated, which would allow them to perform more valuable tasks. An interesting observation is that over time, lower level jobs in the bargaining unit disappeared and are now in the minority; the workplace is a different landscape. Participants estimated that within a five year period, if the employer chooses to automate the workplace, there will be job losses, and not just work re-organization. However, the employer is slow to adopt technology, and is also poor in communicating continuing computerization.

Participants working in supply chain management also discussed the tools they regularly use in their jobs, noting that spreadsheets were always one of the tools they worked with; however, job tasks were much more diverse in that they would also conduct on-site visits, reviews and audits. When they first began in this role, the role was clearer, the processes were clear, there were fewer tools to assist with the work, but it made work easier, whereas now, the process is cumbersome. Participants explained that overtime, more clerical tasks are being added to their

jobs, which they relate to increasing computerization, standardization, and new procedures. Additionally, members noted that there are too many platforms and tools to complete the tasks, which without a doubt can be done in a simpler way. A participant's story is telling of the effect of computerization, "the core of the job has been diluted by so much information, we are so behind in our real job."

> *"Instead of management giving us tools that help, they implement technology without consulting the very people that will work with those platforms. They're giving us a hammer when we need a screwdriver."*

For instance, to help with orders, the company put to use a robot that generates emails to vendors, known as order books. The vendor replies to the email, which is automatically uploaded to the system (System Application and Products, SAP). The tool isn't seen as being effective in that robot generated emails and notifications go out to everyone performing tasks in handling orders, from all vendors the company deals with. Before, one would only receive relevant notifications that pertain to vendors they specifically deal with, now they receive notifications for the entire department. Their inboxes are jammed with emails, reports, graphs, which are not helpful unless it's related to one's own vendors. Participants noted that this process is distracting and creates, "a lot of noise." In effect, the robot sends out whichever information is input into the system, and then generates related information without a means of discerning who gets which notifications. Participants noted that work would be easier if, "they let me decide what goes in and out." The group unanimously agreed that the robot isn't helpful, as it creates unnecessary busy work.

The company also introduced a tool to assist with purchase orders, which consists of several platforms, none of which are connected to one another. A platform that manages supplier data does not match up to where supplier approvals are confirmed. Although the systems exist, they are not connected in a streamlined way, so workers in this department have to manually keep track. Despite inefficiencies of the system and supplier objections, upper management insists that those systems are used.

The role of one participant is supply improvement, but based on changes in the last five years, the job according to him has been diluted. Originally, the participant would visit struggling suppliers and problem solve, whereas now, the job is less focused on making improvements to supply; instead, he only deals with suppliers when there's a serious issue. In that sense, the job is more about crisis management than supply improvement. As computerization routinizes tasks, individuals in supply improvement felt that a big part of the job could be automated. "They'd love nothing more than to automate parts of the job, but, they can't… yet."

With parts of the job carved out, outsourcing has become an issue, not just off-site outsourcing, but within the plant, too. This supports the notion that continuous re-organization of work defines core and ancillary tasks, making ancillary tasks easier to outsource or automate. Likewise, remote work, although convenient, lends itself to a discussion about the value of hiring workers within a region, instead of less expensive workers abroad. As one participant astutely pointed out, "my lap top is my office," however, the absence of people in the workplace made participants think employers would be motivated to outsource or continue automating tasks. Union activists in the participant group said they often caution co-workers about remote work, in that they could be working themselves out of a job.

Those who inspect parts note that when they first began their jobs, everything was handwritten and filed manually. Inspectors had full control over their files. (SAP) was initially used in production of new

engines, but technicians adapted the system to MRO tasks, putting in place necessary checks and balances. Since the company dealt with a foreign parent entity, the system in Canada was not in line with the parent company's system, and a computerized system that would have been helpful, and was adapted by workers to their work, was scrapped. Instead, a new system was put in place, which was designed for many people to use to complete mundane tasks. For instance, a participant noted that the new system lacked checks and balances, and overlooked a major issue; the blades that were on an engine were not compatible with the disk. The new system didn't have the necessary parameters to flag this issue, and unless an experienced and knowledgeable inspector was dealing with the file, the mistake wouldn't be caught in time.

> *"We're not in the business of making engines, we're in the business of making profit."*

Common to all the participants is the extent to which computerization and standardization increased workloads, limited their ability to apply expert knowledge and experience, routinized tasks, and reduced autonomy in decision making.

The pressures and effects of on-time delivery were expressed in other groups, but no other group felt the explicit and direct effect like this cohort. One person noted that, "our boss is obsessed with the on-time delivery status, and KPIs, because it's tied to his bonus." Those working in supply management expressed the daily pressure of ensuring parts are delivered within parameters of on-time delivery. Participants explained that picking a date is tricky, as they don't have control over shipping and how long it takes. Workers in this department are only notified by the shipping company when the part is shipped, and when the part arrives at the border. In fact, approximately 8 different reports are issued relating to on-time delivery, which only complicates matters. In the past, a part that was two days late was acceptable, however, with new shipping and tracking methods, there is pressure to be more specific. Workers whose on-time delivery status is below the threshold are advised that 6-10 hours of overtime are to be put in per week to improve and manage delivery dates. Participants noted they often take work home, which is compounded by working with international suppliers in different time zones.

One area where computerization did not have a significant effect was in laboratories where testing is conducted. The processes in this line of work are too varied. In the course of the participant's career nothing had really changed. There was an attempt to partially automate the processes for emissions measurements, but it wasn't successful. The participant noted that jet fuel analysis, adhesives for use on the floor, and other

> *"Automation, AI and remote work equate to the same thing: the absence of people. The absence of people makes employers think they can automate, or outsource work."*

processes are too dynamic to be easily automated. There hasn't been a reduction in the number of people working, nor have additional tasks been added. It's the only area where there isn't evidence of automation. This fits in with academic research in that diversified jobs that tend to be highly skilled, with diverse tasks are less susceptible to automation.

Although the group of participants were highly skilled and educated, they were not entirely immune to the re-organizing effects of automation. Depending on the role, much of their jobs could be automated or outsourced. While some research indicates that education and skill level protect against job loss due to automation, those two factors don't protect against re-organization and de-skilling. Computerization is insidious and gradually changes the nature of jobs through processes and continuing efforts to standardize practices.

Regarding recommendations, participants expressed concerns about those who lose jobs due to automation stressing that, "not many will have a place to land and stay unionized." They also noted that although re-training is important, for some workers this won't be possible, and will require government intervention. Given the gradual change in the makeup of the bargaining unit, with an increasing proportion of "white collar" members, participants stressed the importance of unions adapting and organizing workers that are in what is categorized as "white collar" labour.

RECOMMENDATIONS

The pace and nature of technological change in the 21st century gives an element of unpredictability to the impact on jobs and skill needs in the future. Some opportunities will open up for more fulfilling and stimulating jobs, but mass unemployment and disruption of labour markets is also likely. It is not necessary to know nor speculate about the precise effect, there is consistency in studies that clearly indicate that some actions can be taken now to mitigate risks. Policy development can target several areas acting not just as a buffer, but as a means of preparing for changes in the labour market.

It's well established that technological change disproportionately affects low-skilled workers, with limited job mobility, including young workers, and racialized workers. It's also known that certain regions are much more susceptible than others. With an abundance of information on the most vulnerable groups, the government should consider targeted policies to not just support re-training and upskilling, but providing supports to high schools in highly susceptible regions.

Regional susceptibilities are becoming evident as more research becomes available, and to avoid devastation of entire communities as industries die out, municipal, provincial and federal levels of government must work together to develop supports, education and training to offset adverse effects of technological change. It shouldn't be lost on policy makers that in communities that experience mass job losses, communities bear social costs, such as addiction, mental health problems, poverty, and crime, which are much costlier than investments in education and training.

The World Economic Forum stressed the importance of governments and businesses, insisting that governments" will need to profoundly change their approach to education, skills, and employment, and their approach to working with each other."[116]

State institutions, and all levels of government will also need to work closely, especially the federal and provincial governments as they prepare training and educational institutions for new realities. A systemic issue in the Canadian education system and accreditation is limited transferability of trained individuals' credentials. In fact, those who are most susceptible to risks of automation, are the very workers who would benefit from interprovincial mobility.

Without a comprehensive education and training strategy that addresses challenges posed by automation, the pool of available labour will shrink, while many workers will struggle to find employment. Even workers who may not be impacted by automation will need skills. The issue of training and education is broad and requires creative solutions.

LEGISLATIVE PROTECTIONS

The potential for disruption in terms of both economic and societal development, the importance of addressing socio-economic effects of AI and advanced automation is crucial.[117] Changes in regulations, legislation and policies are inevitable, in fact, changes are already being tabled in preparation for new technologies such as autonomous driving. Some countries are taking a proactive approach and putting in place protocols that prevent misuse of technology and harm to society. Others are taking a more casual approach, the "wait and see" approach in efforts not to stifle the tech industry.

The focus of legislative changes, at present, is focused on removing barriers to development and adoption of new technologies, while labour law is not being considered. Currently, the law, both federally and provincially, requires minimal notice in unionized workplaces of technological change.

[116] World Economic Forum.
[117] G7 Multistakeholder Conference on Artificial Intelligence. " Unleashing Innovation Reducing Barriers to Inovation/Enhanncing Market Confidence. Dec.6, 2018. Pg.6

RECOMMENDATIONS

CANADA

To date, Canada's Montreal Declaration on the Responsible Development of AI serves as a framework for ethical guidelines.[118] The first draft outlines seven principles in relation to AI development, such as, "the well-being, autonomy, justice, privacy, knowledge, democracy and accountability."[119] The G7 conference on AI outlined in one of its themes the importance of sectoral working groups and inclusion of civil society, however, what is sorely lacking, is any mention or engagement with groups who are known to be affected by AI, workers.

There is recognition by the Canadian government, and the G7 stakeholders that several sectors will be affected by technological change, and that indeed, " transformation is happening at a much higher rate than in the past, [posing a challenge] for workers to retrain for new jobs."[120] However, a fulsome training and education strategy has not been developed.

Recent efforts have focused on ethical and effective use of AI in government services. The government developed guiding principles, such as measuring the impact of AI, and transparency in when and how AI is used. There's also recognition of the need to provide meaningful explanations about AI decision making, while also offering opportunities to review results and challenge these decisions. The framework supports the principle of openness in sharing source code, training data, and other relevant information, all the while protecting personal information, system integration, and national security and defence. Last but not least, the government has committed to providing training to government employees who develop and use AI.[121]

UNITED STATES: THE WAIT AND SEE APPROACH

The United States has developed an approach to manage AI, which while comprehensive is limited in its scope. The U.S. is focused on incorporating AI for the purposes of improving public health, national security and integration into the economy. Research and development is a key part of the approach, but even more important is removal of regulatory barriers to AI innovation.

Some consideration is being given to preparing the workforce for the next wave of technological change through apprenticeships, reskilling programs, and investments in computer science and STEM (Science, Technology, Engineering, and Math). The American government is also keen on expanding public-private partnerships. Findings from IAM focus groups indicate that privatization of education has actually led to labour shortages, and systematic de-skilling of skilled workers.

The main focus of AI applications is transportation, given the impact of AI on how the U.S. transportation system functions.[122] The U.S. Department of Transportation is looking to enable safe uses of AI technology, such as automated vehicles, accessible transport, drones, vertical take-off and aircraft. In 2017, the government took steps to develop protocols for the safe integration of automated vehicles, which allowed states and localities to conduct commercial and public unmanned systems. The government is also assessing how AI will impact decision making, traffic management and mobility tools.[123]

[118] G7 Multistakeholder Conference on Artificial Intelligence. " Theme 3: Accountability in AI". Dec.6, 2018. 1-15. Pg. 8.
[119] Ibid. pg. 15
[120] G7 Multistakeholder Conference on Artificial Intelligence. " Theme 4: The Future of Work." Dec.6, 2018. 1-16. Pg.2
[121] https://www.canada.ca/en/government/system/digital-government/digital-government-innovations/responsible-use-ai.html March, 2021.
[122] Ibid. pg.6
[123] Ibid. pg.7

In 2018, the White House convened a meeting of 100 senior level officials and technical experts, which included business leaders who are making use of AI to develop priorities.[124] Leaders from the labour community were not present, despite the fact that one of the priorities was the effect on the American workforce. When a framework is developed without the inclusion of workers, it becomes that much more difficult for workers to affect changes to a pre-determined strategy.

Another notable initiative in the United States, is the New York City Automated Decision System Task Force, which is working towards developing a process for reviewing government automated decision systems, such as algorithms. The goal is to ensure that algorithms are, "used appropriately and align with the goal of making New York City a fairer and more equitable place for all its residents." Bias in AI is well documented, both racism and sexism, which must be eliminated if AI becomes a regular feature of government services.[125]

THE EUROPEAN UNION: THE PRO-ACTIVE APPROACH

Much like the United States, the European Union has placed significant emphasis on research and development with the goal of advancing industrial leadership. With existing technologies, the EU Commission sees potential for AI use in areas of health, transportation and agrifood. Additionally, investments will be made to foster Digital Innovation Hubs, testing and experimentation, and development of industrial data platforms where information is shared.

Unlike the U.S., the EU is giving some consideration to the social context, ensuring that the AI framework is consistent with the EU's values and fundamental rights. The European Union's framework serves as the blueprint for many countries. EU policy structures take into account the ways in which individuals could be harmed, such as when AI makes decisions about allocation of public services like income support, or when it's used in the context of criminal law.

The European Commission appointed a High Level Expert Group on AI in 2018, which consisted of experts from around the world with varying backgrounds, including those from civil society, industry and academia. The group specifically looked at drafting AI Ethics Guidelines and AI policy and investment recommendations.[126] Ethical guidelines will serve as guidelines in the development and uses of AI, its success measured by the extent to which privacy is protected and dignity and non-discrimination are enshrined.[127] The aim of assembling a group of experts was not only to develop guidelines about innovation, but to also study potential threats to society, which would erode fundamental rights of citizens. This piece of the guidelines is key in social acceptance of AI.

The expert group has, among other recommendations, also urged for modernization of education, "at all levels, [stressing that education is] a priority for governments, [including] supporting labour market transitions and adaptation of social protection systems. The EU is also placing an emphasis on fostering gender balance and diversity.[128]

Specifically, the European Commission proposed that in order to prepare the workforce and avoid job polarization, the following should be part and parcel of training and education; [129]

[124] Ibid. pg. 8
[125] Ibid pg.9.
[126] Ibid. g pg.8
[127] Ibid, pg. 9.
[128] European Commission. COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE EUROPEAN COUNCIL, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS. " Artificial Intelligence for Europe. 1-2-. Pg.
[129] https://digital-strategy.ec.europa.eu/en/policies/ai-people January, 2020.

- Traineeships in digital areas, with an increased focus on AI skills. Traineeships should follow the principle of non-discrimination and gender equality as outlined in the Digital Education Program
- Specialized education programs and courses in key areas, under the Digital Europe Program
- Networks of AI excellence centers to retain talent and develop PhD programs and AI modules under the Horizon Europe program
- Funding doctoral networks, postdoctoral fellowships and staff exchange projects in AI under the Marie Skłodowska-Curie actions
- Support the development of new skills under the Skills Agenda

Although somewhat vague, and heavily focused on higher education, the EU has developed some sort of pathway in preparation for the technological change that's coming.

Equally important, is the approach taken to implementing AI that is trustworthy, which is based on a risk approach. Certain industries have been deemed as high risk, and will be subject to more stringent monitoring, and will also be required to provide risk assessments, and documentation on the extent of AI decision making. In these cases, human oversight is mandatory. Certainly, "AI systems considered a clear threat to the safety, livelihoods and rights of people will be banned."[130] Last, but not least, the EU reserves the right to fine offending companies up to 6% of their global sales.

The risk approach flagged several areas as high risk, such employment, workers management and access to self-employment (e.g. CV-sorting software for recruitment procedures); Essential private and public services (e.g. credit scoring denying citizens opportunity to obtain a loan); Law enforcement that may interfere with people's fundamental rights (e.g. evaluation of the reliability of evidence); Migration, asylum and border control management (e.g. verification of authenticity of travel documents).[131] Of particular interest, given the use of biometrics throughout airports where the IAM represents the majority of workers, the EU has identified as high risk placing strict conditions.[132] In high risk areas, human oversight will be a necessary stop gap measure to prevent any negative effects, including independent third parties in conformity assessment procedures.[133]

Another feature of the regulatory framework is transparency, which applies to systems that, "(i) interact with humans, (ii) are used to detect emotions or determine association with (social) categories based on biometric data, or (iii) generate or manipulate content ('deep fakes'). When persons interact with an AI system or their emotions or characteristics are recognized through automated means, people must be informed of that circumstance."[134] The principle behind this regulation is awareness, which allows individuals to make informed choices about the extent of engagement with a system that is high risk.

The Commission has also developed, "monitoring and reporting obligations for providers of AI systems with regard to post-market monitoring and reporting and investigating on AI-related incidents and malfunctioning. Market surveillance authorities would also control the market and investigate compliance

[130] https://ec.europa.eu/commission/presscorner/detail/en/IP_21_1682 January 2020.
[131] Ibid.
[132] Ibid.
[133] European Commission. REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL LAYING DOWN HARMONISED RULES ON ARTIFICIAL INTELLIGENCE (ARTIFICIAL INTELLIGENCE ACT) AND AMENDING CERTAIN UNION LEGISLATIVE ACTS. 21.4.2021, 1-108. Pg. 15.
[134] Ibid. pg. 14

with the obligations and requirements for all high-risk AI systems already placed on the market."[135]

SECTOR SPECIFIC CODE OF ETHICS

As part of legislative changes, we encourage the development of a code of ethics that guide the Fourth Industrial revolution. A Code of Ethics specific to individual sectors would be most logical, given the unique circumstances of different sectors. An ethical Code should be developed in consultation with varied stakeholders, including unions, and consumer groups if the business model includes clients, third parties and broadly speaking, the public.

Given advanced technological implementation in airports across the world, the Port of Seattle, most notably, developed a Code of Ethics that serves as a template for airports, but in a general sense, as a template for other sectors. The code specifically addresses the biometrics policy, with a clear understanding of the possible negative impacts and challenges in adopting new biometrics technologies.

The Port of Seattle conducted a study assessing the use of biometrics and exchange of information from the airport level, to airlines, vendors and the federal government. Vendors in particular have to demonstrate in their proposals how their business plan meets the Port's ethical code.

The Port of Seattle's guidelines are premised on several principles, first and foremost, that uses of biometrics are justified, and only used for a clear and intended purpose and not for surveillance of large groups without a lawful purpose. Participation should be voluntary, and US citizens ought to be given a choice to opt-out. Privacy is an important element of the ethical code, stressing the importance of protection of information and storing of information as required by applicable law or regulations and should be protected against unauthorized use or access.

Research is indicating that AI is not a neutral tool, as it replicates and amplifies social, racial, and gender biases, which can cause harm. As a way to mitigate these effects, the Code requires that the technology should be reasonably accurate in identifying people of all backgrounds, and systems should be in place to treat mismatching issues. Transparency is cited as another guideline in communicating when and how AI is being used with both travelers and visitors. Last but not least, all Port of Seattle staff are being asked to use and manage the technology ethically and responsibly.[136]

Given complexities in gathering and exchange of information, it's encouraging to see initiatives like the Port of Seattle, and the IAMAW supports similar initiatives in Canada. As a union with the greatest number of airport workers across the country, we are committed to development of ethical codes that protect workers and the public.

FIRM LEVEL

Retraining and upskilling will be a major problem, and companies will have a role to play. A Gallup poll of American workers showed a strong preference for on-the-job training as a way of keeping up with changes brought on by automation.[137] This also may be the most effective way of upskilling, which benefits both workers and employers. A study done by the World Economic Forum of employers in 15 key sectors, found that most employers are aware of looming changes, yet are slow to react. Approximately, "two thirds of respondents indicate that future workforce

[135] Ibid. pg. 15
[136] Port of Seattle. " Port of Seattle Public-Facing Biometrics Policy Biometric Air Exit Recommendations". March 2020.
[137] Schwartz, pg.3

planning and change management is a very high priority on the agenda of their company's senior leadership."[138] The same number of respondents indicated they had intentions of reskilling current employees as part of future workforce planning efforts, making retraining the most common strategy in response to labour market changes[139] among employers.

Firms that are preparing for inevitable changes due to automation are much more likely to invest in reskilling, as well, as recruiting women, and racialized workers, and " 50% more likely to be supporting employee's mobility and job rotation within the firm."[140]

Most of the employers who were proactive indicated that they were making investments in reskilling current employees, supporting job mobility and rotation, and were working with educational institutions as part of their strategy to offset effects of automation.[141] It's interesting that about a quarter of employers were offering apprenticeships in an effort to recruit young workers. Skilled trades focus groups also highlighted the importance of job mobility and rotation to mitigate against automation. Apprenticeships may also be effective in workplaces where there are a lot of young workers, and when re-training isn't possible.

> *"Apprenticeship programs bring real value to an economy, in Germany for instance, " a steady flow of apprentices has helped prop up the nation's strong manufacturing industry."[142]*

Apprenticeship programs bring real value to an economy, in Germany for instance, " a steady flow of apprentices has helped prop up the nation's strong manufacturing industry."[142] The U.S. Department of Labor received $ 183 million to train 85,000 apprentices in health care, advanced manufacturing and information technology[143] but, the main obstacle to successful apprenticeship programs are willing employers. This must change if industries and sectors are to prepare for upcoming changes.

Firms like Amazon have invested into re-training of workers, given the expected impact of technological changes. One possibility is for companies to do assessments of the impact of technological change, notify the provincial government and work with authorities to streamline and support affected workers.

On the other hand, there is enough information about the susceptibility of certain occupations. Employers should conduct a study to get a better understanding of occupations within their organizations at risk of automation, and develop strategies to upskill or re-train. For instance, the Brookfield Institute examined high risk occupations, and compared them to similar jobs to assess chances of re-training. While these jobs are at high risk of automation, targeting these workers in an effort to retrain or upskill workers into similar jobs is critical. An assessment of job occupations, found that motor vehicle assemblers had 15 similar occupations and therefore employment pathways, aircraft assemblers and aircraft assembly inspectors had 22, woodworking machine operators 13, tool and die makers 8, machine operators (metalworking) 21, binding and finishing machine operators 12. Equipped with this knowledge, firms could develop internal programs or work with training institutions to streamline workers into programs.

[138] The Future of Jobs: Employment Skills, and the Workforce Strategy for the Fourth Industrial Revolution. World Economic Forum. January 2016.
[139] Ibid.
[140] Ibid.
[141] Ibid.
[142] Schwartz. Pg. 5.
[143] Ibid. pg 5.

UNIONS

Collective bargaining remains the best inoculation against adverse effects of automation. The presence of unions is helpful to workers in a number of ways. Unions not only prevent a decline of worker earnings, but strong collective agreements protect earnings of workers whose jobs are susceptible to automation, and ensure wages don't decline.[144]

Given the IAMAW's long history in the international labour movement, there are many examples collective agreement clauses. In 1960, the IAMAW prepared a report detailing bargaining options available to reps. At the time, the IAMAW through the Executive Council developed an 8-point collective bargaining program to deal with issues stemming from automation.[145] Key components included advance notice and consultation, transfer rights to other plants, including moving costs, training at full pay, preservation of original rates of pay for downgraded workers, early retirement, continuation of fringe benefits during a lay-off, negotiations of new classifications and rates of pay.

Last but not least, equitable distribution of gains stemming from greater productivity through general wage increases were also commended. Additionally, regular reviews of jobs descriptions should be conducted to track any changes in jobs and compensation. Reviews of jobs, and studies that illuminate the nature and effect of technological change can also help in planning mitigation strategies, and tailoring solutions to the needs of a bargaining unit.

Traditionally, unions have advocated for retraining of workers. But the next industrial revolution may make some jobs obsolete or the training gap will be so substantial that training won't be possible. Setting up training and education funds will be essential to help those who have been made obsolete. Likewise, government programs designed specifically for such workers must be developed.

As much as possible, lay-offs should be avoided, and history shows that some employers have, in consultation with the union, managed technological changes through regular attrition rather than dismissals.[146]

Advance notice is essential, but there are variations on what constitutes advance notice. Through this report we advocate for at least, 12 months' advance notice. Regular meetings and communication with full transparency is essential in preparing the bargaining unit for changes.

Collective agreement language could also make it possible to allow displaced workers, "to first pick a new position, and be offered moving and other assistance, if needed."[147] Unions should also consider voluntary recognition of the union where new jobs are created,[148] or expand the scope clause.

Surveillance of workers is definitely heightened with new technologies, which is not only supported by research, but by our members' experiences, too. Concerns about the collection, analysis, manipulation of data are legitimate, and need to be addressed through strong collective agreement language, and legislative protections.

Sectors function as ecosystems, and regional impacts of automation have been demonstrated, making regional and sectoral bargaining necessary on issues of joint importance, not excluding issues related to income protection, active labour market policies, school to work transitions,[149] and upskilling on the job.

[144] Parolin, Zachary. " Automation, Occupational Earnings Trends, and the Moderating Role of Organized Labor." Social Forces. Oxford University Press. 2020. 1-26. Pg. 8
[145] IAMAW Bargaining for Technological Change, 1968
[146] IAM pg. 8
[147] IndustriaALL. Pg. 29.
[148] Ibid. pg. 29.

Italian trade unions have proposed that "Competence Centers" be established with union involvement geared towards acquisition and delivery of skills,[150] which could take place through formal training or through a "competency center."

The Australian Workers' Union (AWU) has proposed some solutions in preparation for upcoming changes. It's expected that Industry 4.0 will reduce the number of workers needed in certain industries, and as a measure of protection, AWU proposed 4 day work weeks, or 4 hour days or some combination of the two.[151] In terms of social policies, AWU has advocated for strengthening social welfare programs, including pensions through revenue from taxation on automation.[152] It's thought that the automation tax would, "price the loss of jobs and resulting re-education and welfare expenses." [153]

Outside of bargaining, it is critical for unions to educate members on technological change. By far the greatest challenge is lack of awareness, or misinformation. While the reality is neither catastrophic, nor overly positive, it's important to address the situation as it is and implement solutions that work.

UNION ORGANIZING

Job losses and shifts in labour markets will ultimately define the pool of workers of the future. Jobs considered " white collar" will become more common, as middle skilled jobs are either lost or transformed, leading to lower union density. Engineers, technicians, salespeople and service providers are largely non-unionized, and unions, "not open to these new employee groups will become obsolete." [154] In one of IAM's workplaces, the composition of the bargaining unit has changed, with a steady growth of members in professional categories, away from trades and those considered "blue collar." Participants in the white collar focus group stressed the importance of the IAMAW adapting to new realities, and connecting with members in non-traditional occupations. The impetus for joining a union will be there due to new modes of work that will deteriorate working conditions. It's recommended unions change organizing models in preparation for the changing world of work and potential new members.

> *Participants in the white collar focus group stressed the importance of the IAMAW adapting to new realities, and connecting with members in non-traditional occupations.*

As evidence of de-skilling is clear, we look to research that indicates that deskilling may actually promote common interests between veteran and young workers, and foster solidarity.[155] These groups are traditionally thought to have different needs, but automation may actually align their interests. This may open new opportunities and approaches to organizing. On the other hand, automation tends to eliminate unionized jobs, leading to a growth of managerial, non-unionized positions, which has been an effective means of curbing union activism.

TRAINING INSTITUTIONS

The workforce of the future is likely to be engaged in life-long learning and upgrading of skills, meaning that employers will not be able to provide all of the training that is required. Even now, more adult learners are returning to colleges to upgrade their skills, which given training models leaves gaps for alternative learning.[156] The trend seems to be faster and cheaper pathways for gaining credentials and better jobs.[157]

[149] Ibid. pg. 31.
[150] Ibid. pg.16
[151] Ibid. pg.26.
[152] Ibid. pg. 26
[153] Ibid. pg.26
[154] Ibid. pg. 26
[155] " Workerless Factory"
[156] Schwartz, pg. 3
[157] Ibid. pg.4.

The challenge will be that as a new niche for learning is created, lack of standardization and understanding which credentials have value will pose problems. Currently, there are efforts in the United States to help colleges and other educational providers use a common language to standardize credentials, and firm up employer needs so colleges can provide those programs.[158]

On the other hand, micro-credentialing has already proven to deconstruct occupations and trades, presumably increasing susceptibility to automation, through "pigeonholing" workers. Rather than building on a broad scope of skills, through this model of training, workers' knowledge is turned into a piecemeal process.

TAXATION POLICIES

Without a proper taxation policy, governments where robot use is extensive saw a drop in their budgets for security, education, healthcare housing and other public goods.[159] This could result in a serious crisis in the provision of public goods. There has been some discussion about taxation of companies that use robotics per robot used. Imposing a taxation policy on such employers may not discourage employers from using robots. However, money from robot taxes could be invested into training programs for workers to upgrade skills and transition into a new occupation.

Studies have shown that to remain competitive within their industry, one competitor's reliance on new technologies could have a domino effect. In regions that are heavily concentrated in a single industry, and where there is a high probability of automation, the municipal government must work with the province to assess the effect on labour markets, and put in place supports to offset negative effects on communities. Labour markets and economies continue to be regional in nature so, a regional approach and credentialing that is tied to needs of the industry in the region[160] has some value. In doing so, policy makers need to consider the mobility of workers, so that when an industry exits a particular region, workers are able to transfer their skills to other regions where their skills are in demand.

Problems posed by automation are not entirely new, but those that are will require creative problem solving. Not only will our workplaces change, but so must our public policies and institutions to meet challenges of the future.

[158] Ibid.Pg. 4.
[159] " From Workerless Factory to Robots Create Jobs"
[160] Schwartz, pg. 7.

INTERNATIONAL ASSOCIATION OF MACHINISTS & AEROSPACE WORKERS - CANADA

18 Wynford Drive, Suite 310
North York, ON M3C 3S2, Canada

Tel: 1-877-426-1426 • (416) 386-1789

Website: info@iamaw.ca • www.iamaw.ca

IAMAW Canada