Artificial Intelligence, Automation and Industrial Employment of The Future

IN COLLABORATION WITH: THE MONTREAL AI ETHICS INSTITUTE

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ABSTRACT

The impact of automation on manufacturing and industrial applications is an abundantly discussed topic. The proliferation of artificial intelligence (AI) and its increasing scope of influence on these applications is expected to create new waves of jobs transformation and re-allocation. Predications and pundits vary in their analysis from claims of severe future jobs shortage, to relying on market forces to re-achieve equilibrium similar to previous industrial revolutions. Regardless of the outcome, it stands true that a significant number of manufacturing employees will be affected at the individual level, whether in the form of job replacement or job transition. This paper presents a summary of critical themes relevant to ABB in order to navigate an informed and strategic discussion around the impact of AI-induced automation on manufacturing and the future of jobs. Additionally, the paper makes a set of recommendations ABB may wish to consider to lead the charge in ethically capitalizing on the benefits AI is said to bring forward.

The discussion is structured into three parts. Part (1): Manufacturing. Part (2): AI. Part (3): Jobs. With the first part, we commence with a brief history of manufacturing automation and impact on jobs. We then discuss deeper the dichotomy of predications and present the labor forces expected to be at play, with predications regarding which ones to prevail. The discussion takes a global look with commentary on the United States, Europe and China, and includes critical input regarding trade dynamics, off-shoring and re-shoring. The first part ends with a critical conclusion for ABB to diversify the focus of the conversation beyond jobs and occupations to include tasks and skills. We make the point that such an approach yields to more accurate predictions, and facilitates a more action-oriented conscientious approach to transitioning to an AI-powered economy.

The second part presents critical clarifications regarding artificial intelligence as a technology with the intent of putting the third part, jobs and skillsets, within a thought-through framework. The third part presents critical themes regarding the future transformation of manufacturing jobs. The topic discussion is split into two areas: job polarization and designing tasks for the factory of the future. We end the paper with a set of recommendations. The recommendations include human-centered design for roles in the factory of the future, re-skilling and up-skilling accordingly (with special commentary on operationalizing the ABB-sponsored automation readiness index), and diversifying investments in technologies. We, lastly, complement the discussion with a brief commentary on soft skills, wages, youth demographic, and a dedicated section for China.
PART ONE: MANUFACTURING

Brief history of robotics, automation, and impact on jobs

Early signs of automation began in the first half of the 20th century in the automotive sector, with industrial robots brought to market later on in the 1960’s. According to International Federation of Robotics (IFR) (2016), an industrial robot is “an automatically controlled, reprogrammable, multipurpose manipulator programmable in three or more axes, which can be either fixed in place or mobile for use in industrial automation applications”.

The proliferation of industrial robotics impacted manufacturing and industrial jobs in a clear fashion. In its report “The Automation Evolution”, Deloitte writes:

Many U.S.-centric manufacturers, as well as those from other developed countries, have pursued cost arbitrage by growing manufacturing outside the U.S... manufacturing employment as a percent of total nonfarm employment has decreased significantly, from 28 percent in 1962 to less than 9 percent in 2011... Meanwhile, real output in manufacturing has increased steadily over that same period. [1]

The following McKinsey & Company graph tracks the impact of technology at large on employment. While technology created large employment, the three sectors negatively impacted are agriculture, mining, and manufacturing. [2]
Taking a Global Perspective

Deloitte’s report on “Geographic trends in manufacturing job creation” writes:

“The United States is not unique in transitioning from an economy where job creation is highly dependent on the manufacturing sector. Many other countries are heading in the same direction… For most countries, the rate of decline appears to have slowed or leveled off.” Even when accounting for Mexico and China as two anomalies of recent stagnation and more recent decline, respectively, the trend globally has been one of decline in industry employment. [3]

Focus on Europe

In the global context, the use of industrial robots is particularly prevalent in Europe where, on average, every thousand workers were exposed to 0.6 industrial robots in 1995 and 1.9 in 2016. By comparison, in the US the exposure to robots per thousand workers was 0.4 and 1.6 respectively. The growth in the number of robots per thousand workers is particularly high for China, where it exceeds the respective growth rates in the EU and US after 2009.

According to the IFR database, 99 percent of all robots installed in core European countries are in the manufacturing sector. Factors that reinforce the rise of industrial robots include their increased competence and efficiency and the falling prices per output produced. We discuss these factors deeper on in a later section regarding labor forces and the ones expected to prevail; p.8. [4]
Artificial Intelligence-Induced Automation and Impact on Manufacturing Jobs

This section presents critical themes to take note of as ABB navigates an informed and strategic conversation around the future impact of automation, artificial intelligence and the employment landscape. The section draws key messages from critical literature listed in the references section. We begin with the dichotomy in predications.

The dichotomy in Predictions

With manufacturers said to invest $267 billion in the IoT by 2020, close to 15 million new jobs will be created in the U.S. alone over the next decade as a direct result of automation and artificial intelligence, equivalent to 10% of the workforce, according to estimates from Forrester Research. With that said, the current trend of manufacturing jobs remains in decline. [5]

Per the American National Bureau of Economic Research’s paper: “Artificial Intelligence, Automation and Work”, by Acemoglu and Restrepo:

*We are far from a satisfactory understanding of how automation in general, and AI and robotics in particular, impact the labor market and productivity... much of the debate in both the popular press and academic circles centers around a false dichotomy. On the one side are the alarmist arguments that the oncoming advances in AI and robotics will spell the end of work by humans, while many economists on the other side claim that because technological breakthroughs in the*
past have eventually increased the demand for labor and wages, there is no reason to be concerned that this time will be any different. [6]

The following presents the arguments and analysis to support either side of the debate.

Market forces induced by automation and AI: displacement vs. reinstatement (new tasks)

Artificial intelligence, complimented by other technologies, will bring further waves of automation. First, we present the market forces created via this increased automation. After which, we take a deeper look at how this nature of automation differs from previous ones given its inducing technology: AI.

In summary, the displacement effect due to automation will continue to take place as machines and AI increases their labor share. But it is counteracted by three effects: (1) productivity effect, resulting from the cost savings generated by automation, which increase the demand for labor in non-automated tasks, (2) additional capital accumulation and (3) the deepening of automation (improvements of existing machinery), all of which further increase the demand for labor.

Reinstatement effect:

The more powerful countervailing force against automation is the creation of new labor-intensive tasks, which reinstates labor in new activities and tends to increase the labor share to counterbalance the impact of automation. The creation of new tasks generates a reinstatement effect directly counterbalancing the displacement effect.

Occupation-based vs. task-based predictions

Frey and Osborne (2013, 2017) sparked a debate by claiming that 47 percent of US occupations are at risk of being automated “over some unspecified number of years, maybe a decade or two”. Bowles (2014) redid these calculations for the European labour market, and found that on average, 54 percent of EU jobs are at risk of computerisation. By contrast, Arntz, Gregory and Zierahn (2016, 2017) argued that a major limitation of Frey and Osborne is that they focused on deriving predictions for occupations under threatened from automation rather than tasks. Their criticism is that in this way, Frey and Osborne overestimated the automation risks. By using information on task-content of jobs at the individual level they conclude that only 9 percent of US jobs are potentially automatable. [4]

These studies can be viewed as feasibility tests of the potential impact of AI; they focus on the potential displacement effect of automation. That is of relevance to mention as we clarify that we rely on task-based predictions for this paper vs. occupation-based predictions.

The following is a deeper definition of each of these forces.

Displacement effect: automation, within the framework of economics, is the expansion in the set of tasks that can be produced with capital. If capital is sufficiently cheap or sufficiently productive at the margin, then automation will lead to the substitution of capital for labor in these tasks. This substitution results in a displacement of workers from the tasks that are being automated, creating the displacement effect.
Productivity effect: By reducing the cost of producing a subset of tasks, automation raises the demand for labor in non-automated tasks. The productivity effect could manifest itself in two complementary ways.

1. First, labor demand might expand in the same sectors that are undergoing automation, as in the case of automated teller machines (ATMs).
2. The productivity effect also leads to higher real incomes and thus to greater demand for all products, including those not experiencing (much) automation. The greater demand for labor from other industries might then counteract the negative displacement effect of automation.

**Critical Conclusion:**

*The real danger for labor may come not from highly productive but from “so-so” automation technologies that are just productive enough to be adopted and cause displacement, but not sufficiently productive to bring about powerful productivity effects.*

**Capital accumulation:** Automation corresponds to an increase in the capital intensity of production. The high demand for capital triggers further accumulation of capital. Capital accumulation then raises the demand for labor. (example, previous industrial revolutions).

**Deepening of automation:** what happens if technological improvements increase the productivity of capital in tasks that have already been automated? This will clearly not create additional displacement, because labor was already replaced by capital in those tasks. But it will generate the same productivity effects we have already pointed out. These productivity effects then raise labor demand.

We, now, move to discuss which of these forces is expected to prevail. One important point to iterate as we close this section is the importance of diversifying the focal point of the discussion from purely one revolving around jobs to one that also focuses on tasks and related skillsets. That is due to two reasons mentioned above: first, task-based predictions on the future of jobs are argued to be more accurate than vs. occupation-based predictions. Second, the re-instatement effect relies on the creation of new labor-intensive tasks to substitute those being replaced.

**Which forces are expected to prevail?**

To analyze holistically the impact of artificial intelligence systems on our industrial production, the question becomes: which of the two effects – displacement or productivity – will prevail in the artificial intelligence (AI) era?

To reach conclusions, we draw from several resources, including the International Labor Office and the Brussels-based economic think tank: Bruegel. The conclusions span commentary regarding impact on developed vs. developing economies and off-shoring vs. reshoring. Please note the following estimates do not cover the impact of AI on employment across sectors. They pertain to the impact of artificial intelligence and automation, particularly, in manufacturing due to industrial robots. We draw the following conclusions:
Over-all decline, unequal distribution

Robots have a clear disadvantageous effect on employment growth at the global level, more than eleven times stronger in emerging economies than in developed economies. Adding one more robot per thousand workers negatively affects the US employment-to-population ratio by 0.37 percentage points, and 0.16-0.20 pp in the EU. \[4\]

Estimates point to a long-run decline of employment of about 1.3% due to an increase of the number of robots by 24% between 2005 and 2014. In developed countries, this decline of employment amounts to slightly over 0.5%, while in emerging economies it reaches almost 14%. With that said, literature has often alluded to jobs lost in manufacturing being offset by new jobs in the service sector. \[7\]

Offshoring, re-shoring and globalization

The United Nations Conference on Trade and Development, UNCTAD, argued in 2016 that the historical cost advantage of low-income countries is increasingly becoming eroded. According to this scenario, the most affected industry should be manufacturing.

That is due to three reasons \[4\]:

1. **Labor cost**: Growing labor quality in developing countries and the ensuing rise in labor costs. The Boston Consulting Group, for instance, reports that wages in China and Mexico increased by 500 per cent and 67 per cent between 2004 and 2014, respectively (Sirkin et al., 2014).
2. **Robots quality**: Increase in robots’ average quality (or efficiency) index (defined as robots’ production-cost mark-up) between 1990 and 2005. Industrial robots introduced in 2007 were approximately three times more efficient than the robots introduced in 1990.
3. **Robotic cost**: robots’ price index dropped by more than 50 percent between 1990 and 2007 on average. Controlling for the increased quality, the respective drop in the price index becomes greater than 80 percent.

This convergence in cost competitiveness is likely to continue in the future, eroding the incentives for producers to move their activities from developed to developing countries. The International Labour Office estimates the increase of robots in developed countries between 2005 and 2014 will reduce off-shoring by almost 0.7%, which has depressed employment in emerging economies by 5% within the same time period. In sum, the disadvantageous effect of robots on employment is concentrated in emerging economies, taking place both within countries and through the global supply chain. Nevertheless, off-shoring is likely to keep on going for some time. China remains the country receiving most of the investment flows. \[7\]

As we take the global economy in perspective, one critical note to keep in mind is shared by Acemoglu and Restrepo \[6\], and their task-based framework. It highlights that the creation of new, labor-intensive tasks (tasks in which labor has a comparative advantage relative to capital) may be the most powerful force balancing the growth process in the face of rapid automation. In the same way that automation has a displacement effect, we can think of the creation of new tasks as engendering a reinstatement effect.

But if automation tends to reduce the labor share and has mixed effects on labor demand, why did the labor share remain roughly constant and productivity growth go hand-in-hand with
commensurate wage growth (more on wages in a dedicated later section) over the last two centuries? To understand this relationship, we need to recognize different types of technological advances contributing to productivity growth. Historically, as automation technologies were being introduced, other technological advances simultaneously enabled the creation of new tasks in which labor had a competitive advantage. This generated new activities for labor - tasks in which human labor could be reinstated into the production process - and robustly contributed to productivity growth as new tasks improved the division of labor.

Seen from this perspective, then, suggests a different reinterpretation of the history of technology and a different way of thinking about the future of work - as a race between automation and new, labor-intensive tasks. Labor demand has not increased steadily over the last two centuries because of technologies that have made labor more productive in everything. Rather, many new technologies have sought to eliminate labor from tasks in which it previously specialized. All the same, labor has benefited from advances in technology, because other technologies have simultaneously enabled the introduction of new labor-intensive tasks. These new tasks have done more than just reinstate labor as a central input into the production process; they have also played a vital role in productivity growth.

Hence, we arrive to the deduction that two facilitators or possible deterrents for the reinstatement effect are: (1) technology diversification and (2) technology-skill match.

(1) Technology diversification:
Employment and wage growth have been meager over the last two decades partly because productivity growth has been weak, and even more importantly because new tasks have failed to materialize. The future of work will be much brighter if we can mobilize more of the technologies that increase labor demand and ensure vigorous productivity growth.

(2) Technology-skill match:
What might slow down the adjustment of labor demand is the potential mismatch between technology and skills—between the requirements of new technologies and tasks and the skills of the workforce. Furthermore, it could contribute to inequality, and also reduces the productivity gains from both automation and the introduction of new tasks (because it makes the complementary skills necessary for the operation of new tasks and technologies more scarce). This is of critical import as we introduce the skills section below and make suggestions at how ABB as well as other organizations can operationalize the ABB-sponsored automation readiness index.

Before we embark on the jobs/skills section, we first clarify a number of critical attributes of artificial intelligence as a technology, relevant to the discussion.
PART TWO: ARTIFICIAL INTELLIGENCE

Why Artificial Intelligence warrants a deeper look

AI is what economists call a “general purpose technology” (GPT) that can and likely will affect many different aspects of the economy and a wide variety of its industries. Additionally, MIT professors Erik Brynjolfsson and Andrew McAfee describe GPT’s as technologies that “interrupt and accelerate the normal march of economic progress.” [8]

Narrow AI vs. Artificial General Intelligence

A critical distinction to make is the difference between Artificial Narrow Intelligence (ANI) and artificial general intelligence, the latter not to be confused with general purpose technologies. “ANI, also known as “Weak” AI, is AI that is programmed to perform a single task. ANI systems can attend to a task in real-time, but they pull information from a specific data-set. As a result, these systems don't perform outside of the single task that they are designed to perform. Narrow AI operates within a pre-determined, pre-defined range. Deep learning is what's known as “narrow AI”: intelligence that takes data from a specific domain and uses it to optimize an outcome. Artificial General intelligence or “Strong” AI refers to machines that exhibit human intelligence. In other words, AGI can successfully perform any intellectual task that a human being can. AGI is expected to be able to reason, solve problems, make judgements under uncertainty, plan, learn, integrate prior knowledge in decision-making, and be innovative, imaginative and creative. The transition from narrow to general AI will require a series of foundational scientific breakthroughs.” [9]

AI as a platform technology

Even if we focus on its narrow version, AI should be thought of as a technology platform; i.e: there are many ways AI technology can be developed as a commercial or production technology, with widely varying applications. When it comes to industrial robots, they are already widespread in many manufacturing industries, but their economic use is quite specific, and centers on automation of narrow tasks, that is, substituting machines for certain specific activities and functions previously performed by humans. [10]

AI as a GPT… faster and bias

Economic historians deliberate over which technologies constitute as GPT’s. Three stand-out: the steam engine, electricity, and information and communication technology. As artificial intelligence continues its proliferation and solidifies its status as a GPT, the transition to an AI-driven economy is expected to occur faster than previous GPT’s. The McKinsey Global Institute (2015) estimates that, compared to the Industrial Revolution of the late eighteenth and early nineteenth centuries, AI’s disruption of society is happening ten times faster and at 300 times the scale. [11]

According to Kai-Fu Lee, ex-president of Google China, the fast proliferation of AI is due to three main factors. First, AI products are digital algorithms: infinitely replicable and instantly distributable around the world. Second, venture capital makes it possible for high-risk high potential companies to succeed at scale and speed they could not prior to 1970’s. Lastly, AI
is the first GPT of the modern era where China contributes substantially in both advancing and applying the technology.

In terms of employment, early GPT’s enabled process innovations like the assembly lines which gave millions of former farmers new roles to participate in the economy. Many pundits make the claims AI will have much of the similar effect, and despite the time for labor markets to transition, ultimately the natural market forces of supply and demand will achieve employment balance. Kai-Fu Lee argues that AI has one distinctive factor due to its nature that challenges that assumption: skill bias.

The steam engine and electrification, being crucial pieces in the first and second industrial revolutions, have both facilitated the creation of the modern factory system. Broadly speaking, the modern factory system and its mode of production entailed de-skilling from tasks requiring high-skilled workers (such as handcrafting textiles) to a higher number of low-skilled workers. [12]

ICT technologies, powering the third industrial revolution, differs in that it often – though not always – favors high skilled workers. Lee adds: “By breaking down the barriers of disseminating information, ICT powers the world’s top knowledge workers and undercuts the economic role in the middle.”

Consequently, the question naturally arising is:

**How does AI, powering the fourth industrial revolution, will impact the skills needed to thrive in the economy of the future?**
PART THREE: JOBS

The skills of the future

This section is dedicated to discuss the skills needed in an AI-powered economy. The scope of the discussion focuses on manufacturing and the factory of the future. Naturally, however, some themes extend to skillsets needed across various industries of the economy, including manufacturing and industrial markets.

The discussion is split into two main themes: (1) job polarization and (2) designing the new tasks of the factory floor. Before that, however, and to put the discussion in context, we review how AI is expected to transform the human-machine dynamics, and the re-distribution of tasks.

Kai-Fu Lee shares: jobs will interact with AI in four different ways showcased in the following figure. [12]

1. AI performs repetitive tasks
2. AI tools help scientists & artists amplify creativity
3. AI performs analytical thinking while we add compassion
4. AI adds marginal value

To add, Lee superimposes risk of labor-replacement on the above grid to showcase the following risk analysis. Please note the grid below is pertinent to physical labor, given the manufacturing context. The same grid exists for cognitive labor, as well, but is not presented here.
Job Polarization

Job polarization is not a fresh topic within the manufacturing sector. Chiaccio (et al.) summarize key points from several pieces of literature around job polarization within the manufacturing context: [4]

- Autor, Levy and Murnane (2003) stressed that technology can replace human labour in routine tasks, whether manual or cognitive, but (as yet) cannot replace human labour in non-routine tasks.
- Goos and Manning (2007) argue that the impact of technology leads to rising relative demand in well-paid skilled jobs, which typically require non-routine cognitive skills, and rising relative demand in low-paid least-skilled jobs, which typically require non-routine manual skills. At the same time, demand for ‘middling’ jobs, which have typically required routine manual and cognitive skills, will fall.
- Goos, Manning and Salamons (2014) found evidence that supports the theory of routine-biased technological change, which claims that new technological innovation shifts demand away from workers who perform routine tasks.

The following figures showcases job polarization around the world from 2000 to 2021, courtesy of the International Labour organization’s future of work research paper series: “The economics of AI”. [13]
Moreover, the figure below is a more granular display of job polarization based on occupation level. To the left is employment rate, by occupational group in the total economy, and to the right is particularly the manufacturing sector.

It shows occupational groups ordered (descending) conditional on the skill level that is required for a given occupation (ILO, 2012). Based on this, we can see that employment decreased for middle-skill occupations (with the exception of service workers) and increased for both low and high skill jobs.

In manufacturing, where most robots are installed, two major trends can be observed: first, a great reduction of craft and trade workers and of plant and machine operators (especially between 2007 and 2015), and second, a significant increase in professionals and technicians. [4]
To reiterate the beforementioned point regarding opposing effects on employments, we see the following figure. It showcases that robots may have counterbalancing effects for employment within the same sector, and in particular, the sectors that are composed by workers employed in different occupations, which in turn are affected differently by automation. We find a clear negative impact for plant and machine operators and assemblers but a positive impact for technicians. So, there might be counterbalancing effects of the negative impact on employment in the occupational level.
It is predicated that the service industry is posed to absorb a number of jobs displaced due to automation. A worthwhile note to keep in mind is the skillsets reflected by the service industry and the parallelism between that shift and the increase in employment in technicians and service workers within the factory floor.

Employment structure and regional context

In terms of the employment structure, one can observe that regions with high exposure to robots are associated with a smaller increase in the share of highly educated people. This is an interesting observation that might be worth further investigation, especially for regions where the economic structure has been affected by global competition and technological change. The non-significant impact on low-educated workers may be because they carry out different tasks (often manual and cognitive) which are not easily replaceable by industrial robots. Furthermore, on average, the cost of low-skilled workers is lower compared to their more educated counterparts and therefore, they might be less likely to be substituted by capital.[4]

The factory of the future and human-centered design

Due to the digital technologies of the fourth industrial revolution, the future of manufacturing is once again a vital topic. The integration of numerous technologies into the factory floor is altering the labor distribution dynamics and raising questions about near-shoring and re-shoring, which in its turn, dictates complimenting the conversation with the topic of employee training: up-skilling and re-skilling alike.

The World Economic Forum writes about five trends for the future of manufacturing including virtual and augmented reality, 3-D printing, cloud computing and connectivity.[14]

Building on Acemoglu and Restrepo’s commentary regarding the creation of new tasks, AI, in addition to other emerging technologies, presents an opportunity for ABB to re-design the tasks of the factory of the future.

The creation of new tasks need not be an exogenous, autonomous process, entirely unrelated to automation, AI, and robotics. In fact, since AI is not just a rigid set of technologies with specific, pre-determined applications and functionalities but a technology platform, it can be deployed for much more than automation; it can be used to restructure the production process in a way that creates many new, high-productivity tasks for labor. If this type of ‘reinstating AI’ is a possibility, there would be potentially large societal gains both in terms of improved productivity and greater labor demand (which will not only create more inclusive growth but also avoid the social problems created by joblessness and wage declines).[10]

This is where human-centered design can come to offer great value, and ABB may want to consider deploying the methodology to create the above-mentioned “new tasks” ushered by emerging technologies.

Human-centred design is an approach to problem solving, commonly used in design and management frameworks. It is used for interactive systems development that aims to make systems usable and useful by focusing on the users, their needs and requirements, and by applying human factors/ergonomics, usability knowledge, and techniques. This approach enhances effectiveness and efficiency, improves human well-being, user satisfaction, accessibility and
sustainability; and counteracts possible adverse effects of use on human health, safety and performance.

Why human centered design?

The approach has the power to investigate questions around; first, retaining agency and ability to discern for decision-making purposes by the workforce, and second, retaining the knowledge base by the workforce as they transition to a supervisor role vs. the active contributor. The depth of this proposal warrants a separate research endeavor. For now, however, we share the eight different steps of the manufacturing process dissected by CB insights to showcase how the functions of the factory of the future can be re-imagined. [15]

- **Product R&D:** A look at how platforms are democratizing R&D talent, the ways AI is helping materials science, and how the drafting board of tomorrow could be an AR or VR headset.
- **Resource Planning & Sourcing:** On-demand decentralized manufacturing and blockchain projects are working on the complexities of integrating suppliers.
- **Operations Technology Monitoring & Machine Data:** A look at the IT stack and platforms powering future factories. First, factories will get basic digitization, and further along we'll see greater predictive power.
- **Labor Augmentation & Management:** AR, wearables, and exoskeletons are augmenting human capabilities on the factory floor.
- Machining, Production & Assembly: Modular equipment and custom machines like 3D printers are enabling manufacturers to handle greater demand for variety.
- Quality Assurance (QA): A look at how computer vision will find imperfections, and how software and blockchain tech will more quickly be able to identify problems (and implement recalls).
- Warehousing: New warehouse demand could bring "lights-out" warehouses even faster than an unmanned factory, with the help of robotics and vision tracking.
- Transport & Supply Chain Management: Telematics, IoT, and autonomous vehicles will bring greater efficiency and granularity for manufacturers delivering their products.

When it comes to artificial intelligence, specifically, and its impact on transforming tasks, one resource to review is the International Labour Office’s paper: The Economics of AI: Implications for the Future of Work. It showcases the three main group of tasks that have become the focus of AI applications. They are: matching tasks, classification tasks, and process-management tasks. [13]

**Proposition**

*With the entirety of information presented above, we re-iterate the case to be made for ABB to shift the conversation from one solely focusing on jobs to one focusing on tasks and related skill-sets as well.* With a rapidly changing economy, the forces of automation, digitization, and globalization are leading to fluid, mobile and resilient labor markets where employers’ skills requirements evolve quickly.

Why ABB? ABB is in an at advantage to lead the conversation of the impact of AI on manufacturing jobs, by nurturing the topic of re-skilling and up-skilling due to two main reasons.

1. ABB, being a manufacturer itself as it serves the manufacturing industry, can embody case 0. The question becomes: how does ABB prepare its own workforce, blue-collar and white-collar alike, for the factories of the future?
2. Positioning in the European union. Historically, US government used public-private partnerships to encourage socially beneficial research. In a predominantly private sector-driven framework in the west, the public sector utilized such mechanisms to guide the creation and deployment of technology, with other social objectives (such as employment creation). More recently, however, the US government has been more frugal in its support for research and more timid in its determination to steer the direction of technological change. Part of this shift is due to the reduction in resources devoted to government support of innovation and the increasingly dominant role of the private sector in setting the agenda in high-tech areas. In the East, however, technology creation and deployment is heavily steered by governmental policies in contrast to the Western private sector-driven framework. One my argue companies in the European union sit in the middle of that spectrum.

How? ABB may consider investing in re-skilling and up-skilling both internally (via Learning & Development Programs) as well as externally (via partnerships).

*Internally, ABB could consider creating a L&D track dedicated for skilling the manufacturing workforce of the future. Currently, L&D programs are focused on management and functional tracks geared more towards white collar roles.*
Building on designing the factory of the future, ABB would be able to design for the new human-centered tasks and related skillsets and train the future workforce accordingly. As previously-mentioned, the depth of this endeavor warrants its own research pursuit.

Externally, Few countries have undertaken large-scale and forward-looking policy action in preparing their population for the workforce of the future. That includes Canada, Singapore, Denmark, France, the United Kingdom, Australia, and the U.S.

For example, in the UK, the UKCES Futures Programme starting 2014 trialed innovative approaches to workforce development through co-investments with employers and industry. [16]

In Canada, the advisory council on economic growth in 2017 proposed the formation of a national non-governmental organization to operate as a laboratory for skills development and measurement in Canada. Dubbed: the FutureSkills Lab, this proposition will be led by an executive team drawn from the private, non-profit, and education sectors, and would invite all levels of government, private sector organizations, labor unions, not-for-profits, and other interested parties to partner on an opt-in basis. Through project partnerships and co-financing opportunities, new and innovative approaches to skills development and outcome measurement will be explored. Drawing from these experiences, the FutureSkills Lab would amass learnings and best practices. By sharing these learnings, the Lab could help inform skills and training program funding decisions of multiple players, including government ministries, researchers, employers, and organizations dealing with labor market information.

ABB may wish to consider supporting such initiatives by; first, collaborating on innovative and future-looking skill-development pilot programs, and second, support such entities in filling the data gaps regarding labor markets, particularly in the manufacturing sector. The following is an
example proposed by the council on pilot projects submitted by manufacturing companies. It is suggested to replicate this example for blue-collar talent alike:

A group of manufacturing companies determines that their employees need stronger soft skills such as communication, teamwork, management, and problem solving. They submit a proposal for a program of coaching for managers and directors, in which coaches provide regular virtual help over 12 months. The program calls for specific key performance indicators (KPIs) for each participating manager and director. At the end of the pilot, results are measured against the KPIs and shared, along with best practices, with governments, companies and other organizations. Because the soft skills being developed are highly transferable to other employers, and important for building a resilient and successful future workforce, the FutureSkills Lab would commit to co-financing of perhaps 70 to 80 per cent.

Soft skills

The topic of interpersonal skills calls for a worthy mention. Soft skills have consistently appeared in various searches on the skills of the future. In fact the Harvard Business Review listed seven skillsets not to be automated. They include: communication, content, context, emotional competence, teaching, connections and an ethical compass. [17]

Soft skills in the factory setting: case study in India [18]

Namrata Kala, an assistant professor of economics at MIT Sloan, with colleagues at the University of Michigan and Boston College, partnered with Indian garment manufacturer Shahi Exports, Private Limited. They ran a randomized controlled trial across five factories in Bangalore. They found that a 12-month soft skills training program that focused on communication, problem solving and decision-making, time and stress management, financial literacy, legal literacy and social entitlements, and execution excellence delivered substantial returns.

Given the repetitive labor required in garment assembly lines, “it wasn’t immediately obvious that soft skills were going to matter in this setting,” said Kala. After all, how relevant is clear communication when sewing the same hemline over and over? “But we found they did matter. When you’re on a production line for eight hours you need to communicate with other team members, you need to meet the deadline, and you need to listen closely to your boss who is walking up and down giving instructions.”

When comparing the final program costs against increased revenue, Kala and her colleagues found that in-factory soft skills training returned roughly 250 percent on investment within eight months of its conclusion. Boosts in worker productivity accounted for much of this gain, but a number of other factors contributed, like the ability to perform complex tasks more quickly, short-term gains in improved attendance, and increased retention during the training.

Soft skills and the young demographic

Starting early in their careers, young workers are increasingly expected to take on more than a rigidly functional role. In a 2016 survey, large Canadian companies reported they are looking for “soft skills” like teamwork, problem solving, and communication in addition to—and sometimes in
preference to—functional knowledge and industry-specific experience. Further, in the 2016 Global University Employability Survey, nearly 90 per cent of employers define employability as “a set of job-related aptitudes, attitudes and behaviours,” naming adaptability, teamwork, and communication as some of these traits. [16]

Call to Action: Operationalizing the automation readiness index

One potential avenue of operationalizing the ABB-sponsored automation readiness index, is to identify countries more vulnerable to the impact of AI's wave of automation, and investing in re-skilling and up-skilling the workforce of said country consequently. The major challenge that presents itself is that such proposition relies on public-private partnerships and public policy in a given country needs to be aligned and proactive in this regard. On that note, one particular case that warrants attention is China.

Before that, however, and to put China’s perspective in context, one critically relevant piece of research to share at this point is by Chiaccio (et al.) and pertains to the young demographics.

Young demographic

Employment rates for different age categories helps us understand better the dynamics of the competition between robots and workers. Estimates indicate that the youngest cohort in particular is the most negatively affected, whereas there is a significant but less negative impact for the 25-54 age group. This result is in line with evidence from the German labour market from Dauth et al (2017), who suggested that firms create fewer vacancies that could be filled by young workers, but employ incumbent workers in different tasks after the installation of new industrial robots. But, this could also be relevant with the capacity of the education sector adjust in real time to labour market demands that are shifted due to technology advancements. Hence, robotisation makes more difficult for young individuals to enter the labour market. The type of the task might also be a factor that contributes to this finding. Since industrial robots are often used to perform physically demanding tasks, it is less likely that they directly affect the oldest age group that typically shift to tasks that are not so demanding. [4]

China

China stands out as the country that has installed more robots than any other country in the world since 2013 and is expected to expand even more, given the planned target of 100,000 robots per year by 2030. Given China’s size of economy, and its significant role in developing and deploying artificial intelligence, it warrants a dedicated look. To that end, this research has solicited the input of Dr. Jenny Chan. Jenny Chan is assistant professor of sociology at The Hong Kong Polytechnic University and vice president of the International Sociological Association’s Research Committee on Labour Movements. She is a contributor at the South China Morning Post.

Her recommendations stress heavily on investing in vocational training. Please find her following commentary:

First –

“By 2020, vocational education in China is expected to reach as many as 23.5 million students aged 15 – 18 (when they have completed nine years basic schooling, that is, comprising of 6-year primary
education and 3-year middle school). But the official goal for the vocational high school student enrollment won’t likely be achieved.

As of end of 2017, the number of vocational high school students was only 16 million in China (and the downward trend in student enrollment had actually happened since 2011). By contrast, the number of high school students remained fairly stable.

See the official China data, [here](#).

Even when we consider the low birth rates in China, and the greater opportunities for some to study overseas (including in Hong Kong), the loss of attraction in vocational education needs to be explained.

Second –

*I would recommend the revitalization of vocational education reforms, in particular, the fitting of internship with workplace-based skills training.*

Vocational students may master their skills and contribute to China and the world."

Based on her collaborative research of other private employers since 2010 (mainly Foxconn – the largest private sector employer in China), Chan comments that they did not provide teenage students with meaningful training. It is worth mentioning her remarks had a stern tone.

Chan adds: “School curriculum and workplace-based training modules must align with each other. Companies are ill-advised to treat “student interns” as in-expensive labor, while not providing opportunities to learn.”

She further recommends: “If appropriate, local governments should offer subsidies to committed firms to design good training for interns. After, the firms may retain the trained interns as full-time, regular employees.”

Third –

“Academics can conduct interviews or surveys with interns throughout the training period to understand their learning and progress, as well as skills needs / skills gaps. This kind of participatory research requires cooperation and trust with the schools, enterprises, and perhaps local governments (who funds public vocational schools). Funding support for independent, professional research is also important.

In the long term, on-job training at home and abroad will benefit employees to equip new knowledge and facilitate knowledge exchange.

On the whole, the government should strengthen legal and social protection for students, interns, and employees across sectors / industries.”

Chan has enclosed her chapter on the economy and Chinese labor, in the book: “Contemporary China”. It is appended to this report.

Given ABB’s endeavor inaug urating the world’s largest robotics factory in Shanghai in 2020, it might prove worthwhile to examine the training opportunities the factory offers the Chinese workforce, particularly within the young demographic.
Lastly, one piece recommended to review to contextualize the labor’s response to further automation in China is: **Man vs machine: China’s workforce starting to feel the strain from threat of robotic automation.**

**Wages**

We end the discussion on jobs with a brief commentary on wages. The topic of wages warrants a dedicated focus on its own. In fact, the effect of GPT’s on wages is not a clear-cut correlation. This is not exclusive to the effect of automation on wages due to AI. Even concerning the third industrial revolution, ICT, its impact on labor markets and wealth inequality has been far more ambiguous than the first two that clearly had a positive impact on wages as productivity increased. Brynjolfsson and McAfee of MIT, call this effect: the great de-coupling. Over the past 30 years, The US has seen steady growth in worker productivity but stagnant growth in median income and employment. After decased when productivity, wages, and jobs rose in almost lockstep fashion, they describe that the once tightly woven thread has begun to fray. While productivity has continued to shoot upward, wages and jobs have flat-lined or fallen. [12]

On that note, referring to the countervailing effects combatting displacement, literature has sited that even when they are strong, automation increases output per worker more than wages and reduce the share of labor in national income.

Corresponding to the statistic that one additional robot per thousand workers reduces the US employment-to-population ratio by 0.37 percent, it reduces wages by 0.25-0.5 percent on average, and in Europe as much as 0.63 percentage points. [4]

Furthermore and regarding polarization, while we find a clear pattern of job polarization, the picture is less clear for wages. While there is only mild wage growth for workers in skilled agriculture, other middle-skilled occupations saw a significant income gain relative to other groups. *Interestingly, plant and machine operators/assemblers, who are believed to be heavily affected by technological change, are among those workers who on average had the highest wage growth.*

Thus, the literature is much less confident to conclude that automation has had a significant impact on wages, even if some results point to negative effects.

*With that said, Chiaccio (et al.) believe that future research on the topic should focus on exploiting more granular data, to explore whether insignificant aggregate effects (on wages) are to the result of counterbalancing developments happening at the firm level. One possibility, for instance, is that the overall impact of automation depends on firm-level investment in human capital (which might be amplified by national/regional policies).*
Recommendations

We end the report with a summary of the areas ABB may choose to further dedicate its attention regarding the topic of artificial intelligence and its implications on jobs.

1. Diversifying research & development, internally and via academic collaboration. As noted above, the creation of new tasks to facilitate the re-instatement effect and counter the displacement effect relies on new technologies that create new types of work and an original demand of new jobs. This consideration is critical as the vast resources of several leading companies pour into academia and shaping the teaching and research missions of leading universities. It is no surprise that the best minds in the current generation are gravitating towards computer science, AI and machine learning, but with a heavy emphasis on automation. *An ecosystem that is biased would become much more stifling for the direction of technological change when it becomes all-encompassing. ABB may wish to review investments in R&D to assess diversification of complimentary technologies, and advocate for external eco-systems that reflect said principle; with public sector, academia and fellow peers in the private sector.*

2. Dedicating a taskforce for defining and designing the tasks (and corresponding skillsets) required for the factory of the future. ABB may consider utilizing human-centered design to create an intentionally devised dynamic between human and machine, where the strengths of either party is utilized optimally. *Restructuring the production process in a way that creates many new, high-productivity tasks for labor is a type of ’reinstating AI’ with large societal gains both in terms of improved productivity and greater labor demand (which will not only create more inclusive growth but also avoid the social problems created by joblessness and wage declines).*

3. Skilling for the future. ABB may consider investing in re-skilling and up-skilling blue collar and white collar talent alike, based on the skillsets identified in need for the factory of the future. ABB may consider achieving that effort via novel learning and development initiatives internally as well as public-private partnerships with skilling programs externally. To that end, ABB can lead the charge in operationalizing the automation readiness index in identifying the countries to commence such efforts with based on availability of publicly-supported skilling platforms and vulnerability to reshoring effects. Two special considerations to make:
   a. China warrants a dedicated focus from a skilling perspective in light of the size of its robotics market as well as what seems to be a lack in affordable re-skilling opportunities and vocational training programs, particularly for younger demographics. Pertaining to ABB’s inaugural largest robotics factory in the world in Shanghai in 2020, it might prove worthwhile examining the training opportunities offered within the facility, particularly targeting young demographics.
   b. It is highly advised to focus on building *resilient skilling initiatives,* whether internally or externally; the reason being the volatility and the speed by which the skills needed would change as well as the imperfect ability of making accurate predications in that regard. The recommendation is to focus just as much on the skilling systems as on the skills themselves.
REFERENCES


[12] AI Superpowers: China, Silicon Valley, and the New World Order, Kai-Fu Lee, 2018


