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IS THERE A FUTURE FOR MANUFACTURING-LED DEVELOPMENT?

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Abstract

Countries, and especially lower-income countries, have traditionally relied on manufacturing and the export of these manufactured goods, as a central driver of economic development, as it provides jobs for unskilled workers, which can relatively easy be transferred from lower productive (agricultural) jobs to higher productive (industrial) jobs, hence increase productivity, and drive economic growth, increasing profits and delivering the (fiscal) dividends necessary for further investments and development. But success in manufacturing and its integration in the global economy, e.g. through joining global value chains, is very concentrated in Western countries, and lately China, leaving other countries with potentially less options. In addition there are other new realities and threats to Manufacturing-Led development, also due to improving and often disruptive technologies, which will change location decisions, and reduce the amount of jobs even if factories are opened in lower-income countries. In this article we will discuss what disruptions and threats may reduce the attractiveness of Manufacturing-Led development; which technologies might change the attractiveness of Manufacturing-Led development; what might be their impact; what opportunities remain, including Service-Led development; and what can be done to grab these opportunities.

Keywords: *Manufacturing-Led development, Service-Led development, (technical) disruption, changes, job losses, opportunities*

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1. Introduction

The world has been changing fundamentally during the last 350 years, which also influenced manufacturing profoundly. These changes are often summarized in and

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describes as “the four industrial revolutions” that have taken place. According to Dimitrieska, Stankovska and Efremova (2018), Prisecary (2016), and Xu, David and Kim (2018), the **First Industrial Revolution** started more or less in 1760, with the invention of the steam engine, allowing mechanization to start off, which changed society profoundly. The agricultural sector, which till then had employed virtually all workers, now needed less manpower, and the excess labor could be shifted to an upcoming manufacturing sector. Coal was used as the main energy, and trains were introduced for faster shipments. Textile and steel were the dominant industries in terms of additional employment, value of output, and capital invested. The **Second Industrial Revolution** began around 1900, with the invention of the internal combustion engine, making mass production possible for the first time. This led to an era of rapid industrialization, using oil and electricity to power mass production. The manufacturing sector was overtaking the agricultural sector as the leading one in the economy. The **Third Industrial Revolution** started around 1960, and was characterized by the implementation of electronics and information technology, which was used to automate production, making products cheaper and more accessible to more people in more places. Also communication technologies made a big jump forward, starting to make the world a “smaller place” and increasing connectivity. The **Fourth Industrial Revolution**, often dated as from 2000, introduced advanced robotics, Internet of Things, 3-D printing and other technologies, which will fundamentally change production processes. (Dimitrieska, Stankovska, Efremova, 2018, pp. 182-187)(Prisecary, 2016, pp. 57-62)(Xu, David &Kim, 2018, pp. 90-95)

According to Schwab (2016) previous industrial revolutions liberated humankind from animal power, made mass production possible, and brought digital capabilities to billions of people. But Schwab sees this Fourth Industrial Revolution as fundamentally different: it is characterized by a range of new technologies, that are fusing the physical, digital and biological worlds, impacting all disciplines, economies and industries, and even challenging ideas about what it means to be human. The resulting shifts and disruptions mean that we live in a time of great promise and great peril. The world has the potential to connect billions more people to digital networks, dramatically improve the efficiency of organizations, and even manage assets in ways that can help regenerate the natural environment, potentially undoing the damage of previous industrial revolutions. But Schwab also sees great challenges brought forward by these changes and disruptions. (Schwab, 2016, pp. 1-183)

2. Threats to Manufacturing-Led development

Countries, and especially lower-income countries with lower unit labor costs, have traditionally and especially during the last decades, relied on manufacturing as a central driver of development, as it provides jobs for unskilled workers, which can relatively easy

be transferred from lower productive (agricultural) jobs to higher productive (industrial) jobs, increasing productivity, and driving economic growth, which as such increases profits delivering the (fiscal) dividends necessary for further investments and development. These manufacturing countries were able to remain cost-effective in the production of these labor-intensive tradables, also given the relatively limited automation in their sectors of specialization. However, as Hallward-Driemeier and Nayyar (2018) find, success in manufacturing and global value chains is currently concentrated in a limited number of countries: around 55%-60% of the world's manufactured goods are being produced in high-income countries. In addition China became the world's largest producer, and accounts for another 30% of manufacturing (2015). The other countries hence have the other 10%-15% to divide amongst themselves, trying to gain market share from the high-income countries, while competing with China. The question is thus: where does this leave these other countries? The greatest scope for innovation, productivity growth, and job creation is furthermore concentrated among a relatively small number of firms within countries, and even on the global stage. How well managed these companies are; their strategies for interacting with smaller suppliers; and their own choices on adopting technology, quality upgrading, and pricing can have disproportionate effects on how a sector performs in a country, and even how that country performs on the global stage. (Hallward-Driemeier, Mary and Nayyar, Gaurav, 2018, pp.1-221)

In addition to this concentration of manufacturing power, other big changes are taking place, which might result in fewer manufacturing jobs in the future. Some of the additional changes are for instance: - Improving technologies; - Increasing industrial automation; - Emerging threats of protectionism, which can lead to slowing trade; - Increasing resource substitution (e.g. artificial diamonds made in automated factories, versus labor intensive extraction), and; - China, East Asia, and e.g. South Asia continuing their expansion at the lower end of global value chains.

Bhattacharya, Rastogi, Tan & Buerkner (2013) highlight that the twin forces of rising economic nationalism, and the rapid digitalization are radically redefining globalization. This presents profound implications for business and government leaders. They state that the competitive edge for countries that depend for growth on low-cost labor and exports will likely erode, as technology changes the way manufacturers operate. Technologies such as robotics and digital simulation are allowing manufacturers to make customized products in locations closer to their customers in a more cost-effective way. That is a shift from the traditional practice of producing standardized products in a handful of giant factories in low-cost countries in order to achieve scale. (Bhattacharya, Rastogi, Tan, Buerkner, 2017, pp. 1-12) Hallward-Driemeier and Nayyar (2018) bring forward that the criteria for becoming a desirable manufacturing location are changing. By reducing the relative importance of wages, increased use of robotics, and "smart factories", companies can start to favor locations that can better take advantage of new

technologies to compete in global markets, which might not be the low wages countries, which are now often being used for manufacturing.

Rodrik (2016) finds that the peak shares of manufacturing in value added and employment in many low- and middle-income countries were both lower, and occurred at lower levels of development than in the past. He also shows that this process has been more rapid in successive decades since the 1960s. (Rodnik, 2016, pp.1-33) This fact has been referred to in literature as "**premature deindustrialization**" (Dasgupta and Singh, 2007, pp.435-54).

3. Technologies that might change the attractiveness of Manufacturing-Led development, and what impact these changes might have:

Schwab (2016) finds that the evidence of dramatic change is all around us and it's happening at exponential speed. He mentions: ubiquitous mobile supercomputing; intelligent robots; self-driving cars; neuro-technological brain enhancements; and genetic editing. Based on the number of references to various technologies from a review of 10 studies and reports published in 2015-and-after, on Industry 4.0., Cirera, Cruz, Beisswenger & Schueler (2017) find the following **(disruptive) technologies** emphasized (Cirera, Cruz, Beisswenger, Schueler, 2017) - The Internet of Things (IoT); - Big data; (Espey, 2015, pp. 1-81) - 3D printing; - Advanced (autonomous) robotics; - Smart sensors; - Augmented reality; - Cloud computing; - Energy storage; - AI or machine learning; - Nanotechnology; - Synthetic biology; - Simulation; - Human-machines interface; - Mobile devices; - Cyber security, and; - Quantum Computing. In addition, techniques like Block Chain are creating new ways of doing business with profound effects on all sectors, including services (e.g. FinTech; financial technology), and agriculture (AgriTech). According to EY's "FinTech Adoption Index" in 2017 a third of consumers worldwide were already using two or more FinTech services. The FinTech industry is thriving globally, and received $17.4 billion in investment in 2017 alone. (Gulamhuseinwala, Hatch, Lloyd, 2017, pp. 1-44) Today, banks are increasing the number of channels and platforms used for digital delivery of services, which necessitates the integration of a significant part of the activities and their complex offering to the audience. (Zlateva, 2016, p.88) According to FinTech expert Timur Vorona: the bank of the future will either cease to exist or it will become an IT company. Also manufacturing changes fundamentally. The integration of different techniques can e.g. be used to create so-called "**smart factories**", employing very little manual labor. Creativity and innovation in the approaches used for the distribution of banking products is a prerequisite for successful banking positioning. (Stavrova, Zlateva, 2016, p.192)

Technology and technological disruptions can have far-reaching consequences, like e.g.: 1) **Intelligence of Things**: With the Internet of Things "all will be connected and communicate". But the connected "things", like machines, products and people, can be

made smart, adding “intellect”, so that they can make digital links in all sorts of areas, collect and combine valuable information, and take decisions. Thus humans become (only) a part of the intellect in the world. Objects can become tools for understanding complexity and responding to it swiftly, and increasing numbers of objects will work largely without human intervention. This will have a significant impact on society, people, and businesses and their revenue models. Intellect of Things will disrupt and scare, but at the same time, it offers unprecedented opportunities for new products and services;(Vermeend &Timmer, 2016, pp. 1-72) 2) Progress in **3D printing** technology will, according to Leering (2017), see 25% of world trade wiped out by 2060, with carmakers, industrial machinery and consumer products among the most affected. 3D printing would lead to less trade growth and jobs, because 3D printers use far less labor, and reduce the need to import intermediate and final goods from (low wage) countries. At current growth rates, half of all manufactured goods will be printed in 40 years, or even as early as 2040, if investments in 3D technology keep growing fast. This will highly influence Global Value Chains, and the choice of manufacturing locations; (Leering, 2017) 3) De Soto (2017) gives an example of **Block Chain use in development**: Many of the world's conflicts can be traced to disputes over e.g. land rights, or not knowing “who owns what”. Block Chain is a very effective tool for registering property rights. In addition giving people the title to their home, business or land gives them security, and a chance to borrow money and start a businesses, which opens up investment opportunities that can lead to economic development. (De Soto, 2017, pp. 18-21) Block Chain can also be used to digitalize and follow transactions (e.g. government documentation like visa applications, payments, properties, license renewals). Singapore's central bank announced March 2017 that it has completed a trial of using Block Chain to power all domestic inter-bank payments. In the longer run Block Chain seems likely to destroy millions of jobs worldwide in record-keeping and transactions, like those in the back ends of banks. It is still not clear if, and what form the replacements for those jobs take, and where they will land.

In addition to the threat of mass unemployment, **other threats** are discussed like e.g. the risk of: - war and destruction (e.g. killer robots); - too fast introductions of new technologies (with possible devastating side effects); - mass surveillance society (e.g. facial recognition, taping); - discrimination (e.g. facial recognition, social media); - lack of privacy rules and regulations (especially given storage systems, and big data analytics); - cyber security. (Rossi, Venable, Walsh, 2011, pp. 1-102) These changes in technology, trade etc. will define where and how production happens, where different types of jobs are being created and destroyed and how many, and hence the extent of economic opportunities around the world. Fewer businesses may move to lower-cost locations, and local firms will face steeper competition. Rodrik (2016), and Rodrik, McMillan & Sepulveda (2017) e.g. state that there is a risk that manufacturing might offer fewer opportunities for companies to obtain very high growth rates. (Rodrik, McMillan,

Sepulveda, 2017, pp. 1-44) Others think that there may no longer be a possible or accessible pathway to development for low-income countries.

4. The extent of the challenges and threats

If disruptive technology should be considered as a threat, or a positive development is extensively analyzed and discussed. What the **net effect on job creation**, and the overall future (of manufacturing) is depends on the study and the time horizon of the study, and runs from a positive to a very bleak view of the future. Some scholars are very or modestly optimistic, but even positive predictions do not throw out the fact that technical disruptions will result in steep layoffs around the world, although most scholars propagate that, at least in the short to middle term, technological change will also lead to the creation of new, and new kinds of jobs. Frey and Osborne (2013) point out that some of the most **replaceable jobs** include brokerage clerks, bank tellers, insurance underwriters and tax preparers, which are critical, though less skilled occupations that keep the financial industry in motion. (Frey & Osborne, 2013, pp. 1-71) Manyika, Seong, Chui & Joshi (2018) find that professions most susceptible to automation include physical ones in "predictable environments," including operating machinery and preparing fast food. Alternatively, automation will have a more muted effect on jobs that involve managing people, expertise, and those that require frequent social interactions. “Unpredictable" jobs such as gardeners, plumbers, or providers of child - and elder-care are also less likely to see automation over the next decade, as they remain challenging to automate, and don't usually pay high wages. If reemployment is slow, frictional unemployment will likely rise in the short-term, and wages could face downward pressure. (Manyika, Seong, Chui, Joshi, 2018, pp. 1-61)

According to Hallward-Driemeier and Nayyar (2018) the **threat of automation to today’s jobs** may be a relatively modest 2-8% for developing economies. The bigger unknown is “tomorrow’s jobs”, and the loss out on jobs that are never created. On the other hand, new technology could also lead to entirely new occupations that can’t be predicted today. Leopold, Ratcheva & Zahidi (2018) argue that machines will overtake humans in terms of performing more tasks at the workplace by 2025. Machines are expected to perform about 42 percent of all current tasks in the workplace by 2022, compared to only 29 percent in 2018, according to the surveyed firms. (Leopold, Ratcheva, Zahidi, 2018, pp. 1-133) Rao, Verweij & Cameron (2018) state that AI, robotics and other forms of "smart automation technologies” could boost productivity and create better products and services. While some jobs will be displaced or fundamentally changed in nature, new jobs will also be created, and the long-term net effect should be positive for the economy as a whole. They conclude that: - Artificial Intelligence (AI) can transform and increase the productivity and GDP potential of the global economy, if strategic investments in different types of AI technology are made; - Labor productivity improvements will drive initial GDP gains as firms seek to "augment" the productivity of

their labor force with AI technologies, and automate some tasks and roles; - 45% Of total economic gains by 2030 will come from product enhancements, stimulating consumer demand, because AI will drive greater product variety, with increased personalization, attractiveness and affordability over time; - The greatest economic gains from AI will be in China (26% boost to GDP in 2030) and North America (14.5% boost), equivalent to a total of $10.7 trillion, and accounting for almost 70% of the global economic impact. (Rao, Verweij, Cameron, 2018, pp. 1-27) Lee (2018) predicts that robots are likely to replace 50% of all jobs in the next decade. According to Lee China will win the technological battle, because it has the edge in the four determinants of AI success: data, regulation, brains, and capital; and in addition the right mindset, being: collaboration versus sole competition; focus on education; long-term (investment) attitude and approach; focus on having a global impact; and accepting creative destruction. In addition Lee sees China having developed manufacturing ecosystems, evolved supply chain management, and (still) low costs, that will continue to make China a powerful force when it comes to tech. Positive, but potentially negative, are China's centrally controlled marketplace, picking winner and losers, and protecting market segments in order to build the necessary skills and resources to be competitive on a global stage, which is the opposite of the American free market ethos. (Lee, 2018, pp. 1-272)

Other scholars are more **negative about the impact** of the coming changes: Aghion, Jones & Jones (2017) find that balanced growth with nearly complete automation is possible, but that it leads to a decline in the share of manufacturing and/or agriculture. AI increasingly replaces people in generating ideas, and may in part discourage future innovation by speeding up imitation. Resulting rapid creative destruction, which will be limiting the returns to an innovation, may impose its own limit on the growth process. (Aghion, Jones, Jones, 2017, pp. 1-56) Frey and Osborne (2013) estimate that 47 percent of U.S. jobs could be replaced by robots and automated technology within 20 years. Shiller (2012-a) warns that Artificial Intelligence (AI) is probably the biggest challenge facing the jobs market, and quite possibly all of society: it creates tremendous uncertainty and impacts different people differently, while some people could be left out, with career risks like never seen before. (Shiller, 2012-a, pp. 1-434) Kurzweil (2005) predicts that the exponential computing power growth (Moore's law) will continue, and that in a few decades the computing power of all computers will exceed that of human brains, with superhuman AI appearing around the same time. He sees the next step in this inexorable evolutionary process being the union of human and machine, in which the knowledge and skills embedded in our brains will be combined with the vastly greater capacity, speed, and knowledge-sharing ability of our own creations, making our brains "trillions times more powerful than they are today"; the beginning of a new civilization. While the social and philosophical ramifications of these changes will be profound, and the threats they pose considerable, Kurzweil maintains an optimistic view of the future course of human development. (Kurzweil, 2005, pp. 1-434) The IMF (2018) sees a problem for "older

workers", who will loose their jobs faster, and will have a bigger problem reintegrating in new environments. (IMF, 2018, pp. 1-33) Schwab (2016) fears that organizations might be unable to adapt; governments could fail to employ and regulate new technologies to capture their benefits; shifting power will create important new security concerns; inequality may grow; and societies can fragment.

And some scholars have an **outright bleak long-term vision**. Harari (2015, 2018) sees over time a total replacement of workers, creating a "useless class". The AI revolution will create constant and increasing disruptions, without any "equilibrium" moment in sight, making retraining a very difficult and basically useless activity. For some time humans might still be needed as consumers, but already today computers and algorithms are beginning to function as clients in addition to producers. So humans might not be needed as producers or consumers. (Harari, 2015, pp. 1-513)

5. The remaining opportunities for Manufacturing-Led development, and how to grab these opportunities

Leopold, Ratcheva & Zahidi (2018) indicate that adaptation to new realities already started and that more jobs could be created, as firms now have a better understanding of how technology creates new business opportunities. Hallward-Driemeier and Nayyar (2018) suggest a policy agenda focused on three dimensions:

1) **Increase competitiveness**: by shifting from a focus on low wages to broader considerations of the business environment, increasing the rule of law, and the use of technology, while developing firm ecosystems;

2) **Increase capabilities**: by equipping government, companies and workers with new skills; building stronger firms; and developing the necessary infrastructure to adopt new technologies;

3) **Increase connectedness**: by improving logistics, infrastructure, and lower trade restrictions on manufactured goods and services.

Other possible opportunities as mentioned in literature:

4) **Equip society for the upcoming changes**: Leopold, Ratcheva & Zahidi (2018) point to the need to equip leaders with the knowledge, tools and structure to navigate the change, and improve the business environment, including upgrading "the whole infrastructure" of society. Policy makers need to identify concrete ways for their country to position itself to address the disruptions of technology and take advantage of globalization. Lee (2018) suggests transforming the country, and companies' culture to make them rapidly adaptable to AI-related opportunities and threats, and organize for flexibility, and focusing more attention on positioning firms and workers to take advantage of new opportunities. IMF (2018) suggests the creation of broader decision bases on all levels (including in companies), to increase knowledge, and future looking capabilities, and increase "other points of views";

5) Step up public policies: a) Manyika et al. (2017), (Manyika, Lund, Chui, Bughin, Woetzel, Batra, Sanghvi, 2017, pp. 1-148) and Manyika, Seong, Chui & Joshi (2018) suggest that governments can and should help **retrain workers**; b) As well as **increasing public assistance in finding work**; c) And organize for **portable benefits** that follow workers between jobs, due to increasing creative destruction of jobs; d) And they suggest **stronger regulations**, and even "**break-up power houses**" to contra attack the possible extreme concentration of e.g. knowledge and market control and power; e) Shiller (2012-a) proposes **improving the safety net**, with e.g.: - More generous supplements to income as people adjust; - Insurance programs "for individuals and their careers"; f) Frey and Osborne (2013) suggest to introduce more **comprehensive minimum wage policies**; and **wage gains tied to productivity**; g) Delvaux (2016), and Shiller (2017-b), propose to introduce a **robot tax**, in order to e.g. finance the safety net, and up-skilling; (Delvaux, 2016, pp. 1-22) h) Several scholars propagate the introduction of **a universal basic income**; i) IMF (2018), and Gates (2018) propose taking **actions against wealth and income inequality**, to diminish the resulting increase in inequality between the have's and the have not's; (Gates, 2017)

6) Increase innovation: Lee (2018) proposes policies for stimulating and managing emerging technologies e.g. through increased public and private research and development; improved connectedness; stimulation of startups creation; developing the necessary hard and soft infrastructure to adopt new technologies; and aiming at creating new sectors, industries and companies;

7) **Grab concrete manufacturing opportunities**: Leopold, Ratcheva & Zahidi (2018) find that manufacturing will remain a part of development strategies, although its contribution to inclusive growth is likely to be lower than in the past. For instance the production of tradable goods such as textiles, garments, and footwear continue to be labor-intensive, and do not feature much automation yet. Commodity-based manufactures, such as food processing, wood, paper products, and basic metals will also remain an entry point for less-industrialized countries;

8) **Increase and serve the local market**: According to Hallward-Driemeier and Nayyar (2018) domestic or regional markets for lower-quality, lower-price manufactures across industries will likely remain viable for some time to come. Bhattacharya, Rastogi, Tan & Buerkner (2013) find that countries need to step up domestic demand and consumption**;**

9) **Stimulate regionalization and integration**: Accelerating e.g. intra-African or Asian trade can boost inter country and regional trade and the need for manufacturing, and (institutionalized) collaboration can in addition improve global trade negotiation power; (au.int/en/cfta; asean.org/asean-economic-community/asean-free-trade-area-afta-council)

10) **Increase the share and export of services**: The World Bank (2013) and others see **Service-Led development** as a possible step to soften the negative effects of

manufacturing losses, with services now accounting for around 70 per cent of global GDP, more than double in size compared to the manufacturing sector. Cost differentials in the production of services across the world are enormous, and technology makes it possible for service providers to sell services without crossing national borders. For instance financial, touristic, health care, education, and entertainment services can contribute big to less and high-developed countries. (World Bank, 2013) Eichengreen and Gupta (2010, 2012) state that it is useful to make a clear disaggregation of the overall concept "services", as services are characterized by a high degree of heterogeneity in productivity, exportability, potential to produce positive spillovers, and hence the contribution to an economy. They state that it is as crucial for Service-Led development that the level of education and skill building is increased, as it is for Manufacturing-Led development. (Eichengreen & Gupta, 2010, pp. 1-38) Huang (2013) and other scholars are critical on Service-Led development, and think that it is not a sufficient enough development model, and that "leapfrogging" manufacturing is not really possible. Services can play a role, and even an important one, but do not suffice for early, or overall development. (Huang, 2013, pp. 1-385) Basher (2014) finds that a country cannot just "jump in", but needs to define and find its competitive and comparative advantage within the (broad) service sector: A comprehensive, and consistent service-sector-focused development policy is crucial for Service-Led development. (Basher, 2014) Ghani (2010) sees a clear alternative growth path for developing countries, including those in Africa, as the globalization of service exports provides alternative opportunities for developing countries to find niches, beyond manufacturing, where they can specialize, scale up and achieve explosive growth, just like the industrializers. The policy discussion could now usefully be expanded to services, asking how to build on a country's comparative advantages. Education, telecommunications, and connectivity are the keys to ignite a Service-Led growth revolution. The comparative advantage can just as easily be in services as in manufacturing or agriculture; (Ghani, 2010, pp. 1-382)

11) **Intensify collaboration**: Schwab (2016) is convinced that the Fourth Industrial Revolution is within the control of all of us as long as we are able to collaborate across geographies, sectors and disciplines to grasp the opportunities it presents and together shape a future that works for all by putting people first, empowering them and constantly reminding ourselves that all of these new technologies are first and foremost tools made by people for people;

12) **Create new societal models**: Harari (2015, 2018) suggests that we develop complete new societal models, like post-work societies, post-work economies, post-work politics, and find new ways to provide "senses of purpose" and fulfillment in order to overcome the "useless class" problem.

To conclude, a quote of Allan Moore: "For whatever the future holds, one thing is certain: it just won't be the same." Ideally we prepare, and will be ready for it!

6. Conclusions

Countries, and especially lower-income countries, have traditionally relied on manufacturing and the export of these manufactured goods as a central driver of economic development. But given: the concentration of manufacturing in Western countries and China; continuing expansion of other countries at the lower end of global value chains; threats of protectionism; and the introduction of disruptive technologies, the question is if Manufacturing-Led development is still a viable development option. There are different points of view about the seriousness of consequences, depending on the kind of study, and the time horizon of the analyzes, but nearly all scholars are agreeing that technical disruptions will result in steep layoffs around the world, although most propagate that, at least in the short to middle term, technological change will also lead to the creation of new, and new kinds of jobs. Whatever happens, disruptive societal and manufacturing changes will occur, manufacturing locations will change, and smart factories in future might employ very little manual labor. Some of the mentioned disruptive technologies with great future impact are: - The Internet of Things; - Big data; - 3D printing; - Advanced (autonomous) robotics; - Smart sensors; - Augmented reality; - Cloud computing; - Energy storage; - AI or machine learning; - Nanotechnology; - Synthetic biology; - Simulation; - Human-machines interface; - Mobile devices; - Cyber security; - Quantum Computing, and; Block Chain. Some jobs, like physical jobs in predictable environments, are clearly more and sooner replaceable than others. Looking at it positively, new techniques and smart automation will boost productivity and create enhanced and new products and services. But some scholars fear an overall negative outcome, with the next step in this inexorable evolutionary process being the union of human and machine, in which the knowledge and skills embedded in our brains will be combined with the vastly greater capacity, speed, and knowledge-sharing ability of our own creations, making our brains "trillions times more powerful than they are today"; the beginning of a new civilization. Some even see the (nearly) total disappearance of jobs, as we know them now, through constant and increasing disruptions, without any "equilibrium" moment in sight, making retraining a very difficult and basically useless activity, with at the end the creation of a "useless class".

The solutions, at least for the short and medium term, are seen to be: 1) Increasing competitiveness; 2) Increasing capabilities on all levels; 3) Increasing connectedness; 4) Equipping society for the upcoming changes; 5) Stepping up public policies, like: retraining workers; offering public assistance in finding work; providing portable benefits; implementing stronger regulations, and "break-up power houses" to contra attack power and knowledge concentration; improving the safety net; introducing insurance programs "for individuals and their careers", comprehensive minimum wage policies, and wage gains tied to productivity; launching a robot tax to finance programs, trying to soften the effects of disruption; introducing universal basic income; starting actions against wealth

and income inequality; 6) Increasing innovation; 7) Grabbing concrete ("leftover") manufacturing opportunities; 8) Increasing and serve the local market; 9) Stimulating regionalization and integration; 10) Increasing the size, share and export of services (Service-Led development), as services now account for around 70 per cent of global GDP; 11) Intensifying national and especially international collaboration; 12) Creating new societal models, in order to overcome the "useless class" problem.
To conclude, a quote of Allan Moore: "For whatever the future holds, one thing is certain: it just won't be the same." Ideally we prepare, and will be ready for it!

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