

Chapter 1 : How Technology Is Destroying Jobs - MIT Technology Review

Technology can help labor markets: Digital talent platforms improve matching between workers and jobs Digital talent platforms have the potential to improve the ways workers and jobs are matched, creating transparency and efficiency in labor markets, and potentially raising GDP.

May 3, The Future of Jobs and Jobs Training As robots, automation and artificial intelligence perform more tasks and there is massive disruption of jobs, experts say a wider array of education and skills-building programs will be created to meet new demands. There are two uncertainties: Will well-prepared workers be able to keep up in the race with AI tools? And will market capitalism survive? Automation, robotics, algorithms and artificial intelligence AI in recent times have shown they can do equal or sometimes even better work than humans who are dermatologists , insurance claims adjusters , lawyers , seismic testers in oil fields , sports journalists and financial reporters , crew members on guided-missile destroyers , hiring managers , psychological testers , retail salespeople , and border patrol agents. Moreover, there is growing anxiety that technology developments on the near horizon will crush the jobs of the millions who drive cars and trucks, analyze medical tests and data , perform middle management chores , dispense medicine , trade stocks and evaluate markets , fight on battlefields , perform government functions , and even replace those who program software – that is, the creators of algorithms. People will create the jobs of the future, not simply train for them, and technology is already central. It will undoubtedly play a greater role in the years ahead. Since that expert canvassing, the future of jobs has been at the top of the agenda at many major conferences globally. Several policy and market-based solutions have been promoted to address the loss of employment and wages forecast by technologists and economists. A key idea emerging from many conversations, including one of the lynchpin discussions at the World Economic Forum in , is that changes in educational and learning environments are necessary to help people stay employable in the labor force of the future. Among the six overall findings in a new page report from the National Academies of Sciences, the experts recommended: At the same time, recent IT advances offer new and potentially more widely accessible ways to access education. This survey noted that employment is much higher among jobs that require an average or above-average level of preparation including education, experience and job training ; average or above-average interpersonal, management and communication skills; and higher levels of analytical skills, such as critical thinking and computer skills. A central question about the future, then, is whether formal and informal learning structures will evolve to meet the changing needs of people who wish to fulfill the workplace expectations of the future. Some 1, responded to the following question, sharing their expectations about what is likely to evolve by In the next 10 years, do you think we will see the emergence of new educational and training programs that can successfully train large numbers of workers in the skills they will need to perform the jobs of the future? Participants were asked to explain their answers and offered the following prompts to consider: What are the most important skills needed to succeed in the workforce of the future? Which of these skills can be taught effectively via online systems – especially those that are self-directed – and other nontraditional settings? Which skills will be most difficult to teach at scale? Will employers be accepting of applicants who rely on new types of credentialing systems, or will they be viewed as less qualified than those who have attended traditional four-year and graduate programs? It is important to note that many respondents listed human behaviors, attributes and competencies in describing desirable work skills. A diversifying education and credentialing ecosystem: Most of these experts expect the education marketplace – especially online learning platforms – to continue to change in an effort to accommodate the widespread needs. Some predict employers will step up their own efforts to train and retrain workers. Respondents see a new education and training ecosystem emerging in which some job preparation functions are performed by formal educational institutions in fairly traditional classroom settings, some elements are offered online, some are created by for-profit firms, some are free, some exploit augmented and virtual reality elements and gaming sensibilities, and a lot of real-time learning takes place in formats that job seekers pursue on their own. A considerable number of respondents to this canvassing focused on the likelihood that the best

education programs will teach people how to be lifelong learners. Accordingly, some say alternative credentialing mechanisms will arise to assess and vouch for the skills people acquire along the way. A focus on nurturing unique human skills that artificial intelligence AI and machines seem unable to replicate: Many of these experts discussed in their responses the human talents they believe machines and automation may not be able to duplicate, noting that these should be the skills developed and nurtured by education and training programs to prepare people to work successfully alongside AI. These respondents suggest that workers of the future will learn to deeply cultivate and exploit creativity, collaborative activity, abstract and systems thinking, complex communication, and the ability to thrive in diverse environments. One such comment came from Simon Gottschalk, a professor in the department of sociology at the University of Nevada, Las Vegas: Still others spoke of more practical needs that could help workers in the medium term “to work with data and algorithms, to implement 3-D modeling and work with 3-D printers, or to implement the newly emerging capabilities in artificial intelligence and augmented and virtual reality. Anonymous scientific editor About a third of respondents expressed no confidence in training and education evolving quickly enough to match demands by Some of the bleakest answers came from some of the most respected technology analysts. They are also struggling with basic issues like identification of individuals taking the courses. Their well-considered comments provide insights about hopeful and concerning trends. These findings do not represent all possible points of view, but they do reveal a wide range of striking observations. Respondents collectively articulated five major themes that are introduced and briefly explained in the page section below and then expanded upon in more-detailed sections. Some responses are lightly edited for style or due to length. The following section presents a brief overview of the most evident themes extracted from the written responses, including a small selection of representative quotes supporting each point. The training ecosystem will evolve, with a mix of innovation in all education formats These experts envision that the next decade will bring a more widely diversified world of education and training options in which various entities design and deliver different services to those who seek to learn. They expect that some innovation will be aimed at emphasizing the development of human talents that machines cannot match and at helping humans partner with technology. They say some parts of the ecosystem will concentrate on delivering real-time learning to workers, often in formats that are self-taught. Commonly occurring ideas among the responses in this category are collected below under headings reflecting subthemes. More learning systems will migrate online. Educators have always found new ways of training the next generation of students for the jobs of the future, and this generation will be no different. College education which will still favor multi-year, residential education will need to be more focused on teaching students to be lifelong learners, followed by more online content, in situ training, and other such [elements] to increase skills in a rapidly changing information world. As automation puts increasing numbers of low- and middle-skill workers out of work, these models will also provide for certifications and training needs to function in an increasingly automated service sector. We will also see what might be called on-demand or on-the-job kind of training programs. We kind of have to, as with continued automation, we will need to retrain a large portion of the workforce. I strongly believe employers will subscribe to this idea wholeheartedly; it increases the overall education of their workforce, which benefits their bottom line. Nevertheless, I am a big believer in the college experience, which I see as a way to learn what you are all about, as a person and in your field of study. The confidence in your own self and your abilities cannot be learned in a short course. It takes life experience, or four years at a tough college. At a good college, you are challenged to be your best “this is very resource-intensive and cannot be scaled at this time. Our established systems of job training, primarily community colleges and state universities, will continue to play a crucial role, though catastrophically declining public support for these institutions will raise serious challenges. One potential future would be for those universities to abandon the idea that they have faculty teaching their own courses and instead consist entirely of a cadre of less well paid teaching assistants who provide support for the students who are taking courses online. They take too long to teach impractical skills and knowledge not connected to the real world, and when they try to tackle critical thinking for a longer time scale, they mostly fail. The sprouts of the next generation of learning tools are already visible. Within the decade, the new shoots will overtake the wilting vines, and we will see all sorts of new initiatives, mostly

outside these schooling, academic and training institutions, which are mostly beyond repair. People will shift to them because they work, because they are far less expensive and because they are always available. In the hopefully near future, we will not segregate schooling from work and real-world thinking and development. And, again, the experience of being a student, now confined to grade school, secondary school and university, will expand to include workers, those looking for work, and those who want or need to retrain – as well as what we now think of as conventional education. Via simulation, gaming, digital presentations – combined with hands-on, real-world experience – learning and re-education will move out of books and into the world. The more likely enhancement will be to take digital enhancements out into the world – again, breaking down the walls of the classroom and school – to inform and enhance experience. Online courses will get a big boost from advances in augmented reality AR, virtual reality VR and artificial intelligence AI. Some respondents expressed confidence in the best of current online education and training options, saying online course options are cost-effective, evolving for the better, and game-changing because they are globally accessible. Already, today there are quite effective online training and education systems, but they are not being implemented to their full potential. These applications will become more widely used with familiarity that is gained during the next decade. Also, populations will be more tech-savvy and be able to make use of these systems with greater personal ease. In addition, the development of virtual reality, AI assistants and other technological advances will add to the effectiveness of these systems. There will be a greater need for such systems as the needs for new expertise in the workforce [increase] and the capacity of traditional education systems proves that it is not capable of meeting the need in a cost-effective manner. These career changes will require retooling, training and education. The adult learners will not be able to visit physical campuses to access this learning; they will learn online. I anticipate the further development and distribution of holoportation technologies such as those developed by Microsoft using HoloLens for real-time, three-dimensional augmented reality. These teaching tools will enable highly sophisticated interactions and engagement with students at a distance. They will further fuel the scaling of learning to reach even more massive online classes. As these tools evolve over the next decade, the academics we work with expect to see radical change in training and workforce development, which will roll into although probably against a longer timeline more traditional institutions of higher learning. They said a residential university education helps build intangible skills that are not replicable online and thus deepens the skills base of those who can afford to pay for such an education, but they expect that job-specific training will be managed by employers on the job and via novel approaches. The most important skills to have in life are gained through interpersonal experiences and the liberal arts. Traditional four-year and graduate programs will better prepare people for jobs in the future, as such an education gives people a general understanding and knowledge about their field, and here people learn how to approach new things, ask questions and find answers, deal with new situations, etc. Special skills for a particular job will be learned on the job. These skills are imperative to focus on, as the future is in danger of losing these skillsets from the workforce. Many people have gained these skills throughout history without any kind of formal schooling, but with the growing emphasis on virtual and digital mediums of production, education and commerce, people will have less and less exposure to other humans in person and other human perspectives. But this does not mean that alternative means and paths of learning and accreditation would not be useful as – complementary to the traditional system that has limitations as well. Respondents in this canvassing overwhelmingly said yes, anticipating that improvements in such education would continue. However, many believe the most vital skills are not easy to teach, learn or evaluate in any education or training setting available today. There will be an increasing economic incentive to develop mass training that better unlocks this value. Functions requiring emotional intelligence, empathy, compassion, and creative judgment and discernment will expand and be increasingly valued in our culture. These skills, interestingly, are the skills specific to human beings that machines and robots cannot do, and you can be taught to strengthen these skills through education. I look forward to seeing innovative live and online programs that can teach these at scale. A mindset of persistence and the necessary passion to succeed are also critical. The jobs of the future will not need large numbers of workers with a fixed set of skills – most things that we can train large numbers of workers for, we will also be able to train computers to do better. This will

include open, online learning experiences e. We will identify opportunities to build a digital version of the apprenticeship learning models that have existed in the past. Alternative credentials and digital badges will provide more granular opportunities to document and archive learning over time from traditional and nontraditional learning sources. Through evolving technologies e. You may get a degree in computer software development, but the truth is that you still need to be taught how to write software for, say, the mortgage company or insurance company that hires you.

Chapter 2 : Experts on the Future of Work, Jobs Training and Skills

At least since the Industrial Revolution began in the s, improvements in technology have changed the nature of work and destroyed some types of jobs in the process.

The rise of IT-based work platforms that support new definitions and distributions of work tasks in new ways provides another illustration of the variable potential for application and use of technologies. Such platforms employ Internet-based communications and smartphone applications to make work available, and then assign that work to individuals or groups based on bid, proposal, or contest mechanisms. Crowdsourcing, open-call, and open innovation platforms can be used to redefine the nature of tasks themselves and to change how that work is organized and distributed both within and across organizational bounds. Crowdsourcing platforms, for instance, work on the basis of tasks being decomposed into smaller units, even to the level of microtasks. These are then made available through open-call or auction mechanisms to people beyond strictly defined work teams or organizational bounds, including, but not necessarily beyond, a given firm. In addition, crowdsourcing mechanisms can be used and are used within firms to open up the performance of work tasks broadly to their existing employees. And, although contest-based systems such as Innocentive support the outsourcing of work, such outsourcing is not necessarily inherent to this technological form. Like crowdsourcing, contests can be run internally at a firm among already salaried employees. Even in the case of internal uses of crowdsourcing and contests, designing how work will be performed, managing both the processes and labor of production, and ensuring quality affects the work people do and how they do it. Workers may find that their ability to control their own performance is more tightly circumscribed, or the opposite—they may be responsible for providing a particular output but be free to select how to arrive at that outcome. Collaborations and work relationships can be both forged and weakened by these mechanisms. Page 84 Share Cite Suggested Citation: Information Technology and the U. The National Academies Press. Although contingent work is not new firms such as Kelly Services and Manpower, for example, have been in the business of providing temporary clerical and industrial workers for many years, it has grown and attracted renewed attention recently with the online, open-call work platforms described above. A broader definition of contingent work, including part-time, self-employment, and other nontraditional work arrangements, would place the estimate at more than one-third of the workforce. Ton, , The Good Jobs Strategy: Page 85 Share Cite Suggested Citation: For example, in a review of studies on precarious employment conducted between and , Quinlan, Mayhew, and Bohle found a negative relationship between precarious employment and occupational health and safety, concluding that it leads to a stressful and disorganized work environment. Scholarship is at an early stage when it comes to analyzing the scope of contingent work and the implications of each type for employment structures, employment relations, and the welfare of workers. The use of IT-based platforms to access contingent work adds a new dimension to this category of employment. Standing, , The Precariat: Bohle, , The global expansion of precarious employment, work disorganization, and consequences for occupational health: Page 86 Share Cite Suggested Citation: By hiring such individuals, firms relieve themselves of the costs of paying employment taxes, providing health insurance, contributing to pension funds, or investing in training. A technology-enabled platform, Upwork, provides highly skilled workers similar to high-tech contractors, except that the contractors are often located outside the United States and are subject to different labor laws and employment systems. Other contingent workers use technology platforms to identify short-term and often unskilled personal service jobs for individuals who seek a service provider through websites or apps—for example, Uber drivers, those who perform odd jobs through TaskRabbit, or those delivering meals through GrubHub. These gigs may pay relatively little and are subject to unforeseen developments that may reduce their rate of pay. To make a living, gig workers require a steady stream of gigs. Despite their diversity and the great variation in the duration of their projects, contingent workers often share a number of characteristics that place them outside the traditional system of employment relations in the United States, which assumes a long-term relationship with a single, stable employer. Many contingent workers receive no health-care benefits from their employers, receive no employer contributions to retirement funds,

and are responsible for their own training and development as well as paying employment taxes. Downtime between jobs is to be expected, although how well workers can manage or circumvent downtime depends on the type of contingent worker. Some contingent workers have a great deal of control over when they work, while others have very little control. Certain types of contingent work resemble the system of contract employment used in manufacturing during the late 19th century. Osnowitz, , *Freelancing Expertise*: Philips, , *The transition from outwork to factory production in the boot and shoe industry*, , in *Masters to Managers*: Page 87 Share Cite Suggested Citation: One example may be to stimulate the formation of organizations or occupational associations, similar to the Freelancers Union, that provide contingent workers with avenues for acquiring portable health insurance and retirement savings programs. Regulations could also be shaped to better enable contingent workers who have been traditionally categorized as independent contractors to access benefits and protections through their employer, ensuring protection of their rights under U. There is already mounting political pressure to both use existing regulations and introduce new ones to prevent the rise of contingent work in certain areas such as the taxicab market. Much of this pressure might be motivated by narrow-interest politics e. There are limited data on the nature and extent of contingent work in the U. A clear and longitudinally valid system for characterizing contingent jobs could help to clarify the economic and social effects of different forms of contingent work and how they are changing. It is worth noting that was the last year that the Bureau of Labor Statistics collected data on the contingent workforce, although plans for another survey are under way and an independent, standalone version of a similar survey was conducted through the RAND Corporation, as contracted by economists Alan Krueger and Larry Katz. Dynamism and fluidity are inherently linked because much of the flow of workers across jobs stems from business expansion, contraction, entry, and exit. Page 88 Share Cite Suggested Citation: All statistics are percentages of employment. Scope is employer firms firms with one or more paid employees in U. Historically, the United States has exhibited strong indicators of dynamism, such as a high pace of job and worker reallocation, job hopping, and geographic mobility. This dynamism has enabled the United States to reallocate resources from less productive to more productive businesses with less time and resource costs than other countries e. In the last several decadesâ€”and especially since â€”there has been a decline in several indicators of business dynamism and labor market fluidity. As illustrated in Figure 4. This is linked to declines in related measures of labor market fluidity. The pace of job hopping, as measured by the fraction of workers switching directly from one job to another, often called Page 89 Share Cite Suggested Citation: Workers moving directly from job to job in the United States have largely reflected workers moving up the job ladder, defined in terms of firm wages or productivity. Geographic mobility has also declined, although the U. New companies accounted for about 13 percent of all firms in the late s, but only 8 percent in Since the year , there has been a similar decline in the number of high-growth start-ups and the amount of employment in these firms, as indicated in Figure 4. There is no doubt, however, that the decline in dynamism and start-ups are connected to the decline in labor market fluidity. Young firms exhibit an especially high pace of job reallocation, with some firms rapidly expanding while others contract and exit. This implies a high pace of hires and separations at such firms. The implication is that a decline in start-ups translates into a decline in labor market fluidity. Moreover, dynamism and flexibility have arguably facilitated the ability of the United States to adapt to past periods of rapid technological change. Davis and Haltiwanger provide evidence that the decline in labor market fluidity has had an adverse effect on labor force participation, especially among the young and less educated. These are the most vulnerable groups that may be left behind by technology. Page 90 Share Cite Suggested Citation: Data shown as Hendrick-Prescott trends. These findings seem inconsistent with an increase in contingent workers engaged in short-duration gig jobs. As noted above, there is currently not much evidence that gig economy jobs are quantitatively significant in the overall U. Changes in the Prevalence of Start-up Companies Underlying part of this decline is a decline in dynamism in the pace of start-ups and high-growth young firms. Before , this phenomenon was concentrated in certain sectors, such as retail trade, where there has been a shift in the business model toward large national chains see Figure 4. Tabulations from Longitudinal Business Database. FIRE, finance, insurance, and real estate. Miranda, , *Where has all the skewness gone?* This highlights the fact that a high pace of start-ups and business dynamism is not an economic objective in and of

itself. Instead, the optimal pace of start-ups and reallocation should balance productivity and economic growth benefits with the costs of this reallocation. The latter can be high for certain firms and individuals who experience the most change. As argued above, in retail trade this change in the business model has arguably had some positive effects where the decline in startups and dynamism is associated with improved productivity in this sector. Evidence suggests that this change has been facilitated by IT, which has enabled large multinational retail firms to develop efficient distribution networks and supply chains globally. Of potentially greater concern is the decline in high-tech start-ups and in Page 92 Share Cite Suggested Citation: Prior to , high-growth firms in high tech those with an employment-weighted growth rate in the 90th percentile had annual net employment growth rates more than 30 percent higher than the median firms; these firms were predominantly young. Since , high-growth firms declined, and the differential dropped to less than 20 percent. This is the same period in which there has been a decline in the growth of productivity in the high-tech sectors. One interpretation is that changes in IT and automation have favored larger organizations. Network externalities imply common adoption of software and hardware platforms. Consistent with this, it may be that as the information and technology revolution has matured, the objective of start-ups developing new innovations has changed from internal high growth to being acquired by dominant firms in their industry. These patterns do not imply that high-growth start-ups in high tech are no longer playing an important role. It is evident that there are rapid increases in start-ups in the sharing economy; however, the business model of such start-ups is to grow via partnerships rather than by increasing numbers of paid employees. It is also possible that high-tech companies with potential for high growth are increasingly basing their production activities worldwide and thus not increasing their domestic employment. Overall, the organizational structure and incentives of start-ups may underlie these changes, which are also driven by changes in IT. The demographics of the U. Hecker, , High-technology employment: It includes all of the sectors normally considered part of the ICT industries in the information, service and manufacturing industries. The millennial generation, which recently surpassed the baby boomers as the largest generation, 40 is also the most racially and ethnically diverse. As more millennials enter the workforce and older individuals retire, the racial and ethnic diversity of the workforce is expected to continue to increase. Social, economic, racial, and political backgrounds are highly correlated with academic achievement, economic opportunity, income, and social mobility. For example, the wealth gap between racial and ethnic groups has widened since the Great Recession; the Pew Research Center estimated that the median net worth of white households was 13 times that of African American households up from a factor of 10 in , and a factor of 6 from and 10 times that of Hispanic households up slightly from a factor of 8 in Of the net new enrollments from to , the majority more than 80 percent of white students went to selective colleges, while the majority more than 70 percent of African American and Hispanic students attended open-admissions 2- and 4-year colleges. Page 94 Share Cite Suggested Citation:

Chapter 3 : The impact of technology on employment | World Economic Forum

In an era marked by rapid advances in automation and artificial intelligence, new research assesses the jobs lost and jobs gained under different scenarios through The technology-driven world in which we live is a world filled with promise but also challenges. Cars that drive themselves.

Neoclassical economists predicted that this would not happen, because people would find other jobs, albeit possibly after a long period of painful adjustment. By and large, that prediction has proven to be correct. Two hundred years of breathtaking innovation since the dawn of the industrial age have produced rising living standards for ordinary people in much of the world, with no sharply rising trend for unemployment. Yes, there have been many problems, notably bouts of staggering inequality and increasingly horrific wars. On balance, however, throughout much of the world, people live longer, work much fewer hours, and lead generally healthier lives. But there is no denying that technological change nowadays has accelerated, potentially leading to deeper and more profound dislocations. In a much-cited article, the great economist Wassily Leontief worried that the pace of modern technological change is so rapid that many workers, unable to adjust, will simply become obsolete, like horses after the rise of the automobile. Are millions of workers headed for the glue factory? As Asian wages rise, factory managers are already looking for opportunities to replace employees with robots, even in China. As the advent of cheap smartphones fuels a boom in Internet access, online purchases will eliminate a vast number of retail jobs. Back-of-the-envelope calculations suggest that, worldwide, technological change could easily lead to the loss of million jobs each year. Fortunately, until now, market economies have proved stunningly flexible in absorbing the impact of these changes. A peculiar but perhaps instructive example comes from the world of professional chess. Soon, potential chess sponsors began to balk at paying millions of dollars to host championship matches between humans. Today, the top few players still earn a very good living, but less than at the peak. Nevertheless, a curious thing has happened: Thanks partly to the availability of computer programs and online matches, there has been a mini-boom in chess interest among young people in many countries. Many parents see chess as an attractive alternative to mindless video games. A few countries, such as Armenia and Moldova, have actually legislated the teaching of chess in schools. As a result, thousands of players nowadays earn surprisingly good incomes teaching chess to children, whereas in the days before Deep Blue, only a few hundred players could truly make a living as professionals. In fact, this is one example where technology might actually have contributed to equalizing incomes. Second-tier chess players who are good teachers often earn as much as top tournament players €” or more. Of course, the factors governing the market for chess incomes are complex, and I have vastly over-simplified the situation. But the basic point is that the market has a way of transforming jobs and opportunities in ways that no one can predict. Technological change is not all upside, and transitions can be painful. An unemployed autoworker in Detroit may be fully capable of retraining to become a hospital technician. Yet, after years of taking pride in his work, he could be very reluctant to make the switch. I know a chess grandmaster who, 20 years ago, prided himself on his success at winning money in tournaments. Still, it beats being sent to the knacker. Of course, this time technological change could be different, and one should be careful in extrapolating the experience of the last two centuries to the next two. For one thing, mankind will be confronted with more complex economic and moral questions as technology accelerates. Still, even as technological change accelerates, nothing suggests a massive upward shift in unemployment over the next few decades. Of course, some increase in unemployment as a result of more rapid technological change is certainly likely, especially in places like Europe, where a plethora of rigidities inhibit smooth adjustment. For now, however, the high unemployment of the past several years should be mainly attributed to the financial crisis, and should ultimately retreat toward historical benchmark levels. Humans are not horsies. The opinions expressed here are those of the author, not necessarily those of the World Economic Forum. Robots weld a car at a car company in USA.

Chapter 4 : BBC - Future - Will machines eventually take on every job?

Technology's Future Impact on Jobs Still So Many Questions than it creates noted that historically more jobs have been created with increased automation and that the nature of work has.

Rather, it is simply one that is available and pays decently. Unlike a plethora of other jobs that have declined in recent years, truck driving has remained immune to the forces that have elbowed out different lines of work. In the past decades, computers, cash machines and self-serve pumps have largely replaced secretaries, bank tellers and gas station attendants, respectively. Door-to-door deliveries, on the other hand, cannot be outsourced to another country, while long haul driving has yet to be automated. Yet truck drivers might be next in line on the endangered jobs list. Google, Uber and Tesla are all working on self-driving vehicles, beginning with those that make long-haul journeys. In the US alone up to 4, lives each year are lost in crashes with large trucks driver error is almost always to blame. View image of Credit: Critics point out that, should this breakthrough be realised, there will be a significant knock-on effect for employment. In the US, up to 3. Additionally, countless pit stops along well-worn trucking routes could become ghost towns. Self-driving trucks, in other words, might wreck millions of lives and bring disaster to a significant sector of the economy. As machines, software and robots become more sophisticated, some fear that we stand to lose millions of jobs. But is there any truth to such projections, and if so, how concerned should we be? Will the robots take over, rendering us all professional couch potatoes, as imagined in the film Wall-E , or will technological innovation give us the freedom to pursue more creative, rewarding endeavours? The hand that feeds Examining these questions begins with the realisation that technology, innovation and shifting cultural norms have always fuelled a turnover in workforce composition. Machines have been taking our jobs for centuries. Artisanal skills “ an indispensable commodity in in England “ were replaced by factory work when industrial-scale manufacturing took over in the 19th Century. But by the s, many of the Industrial Revolution-era assembly-line jobs had themselves fallen into the figurative hands of machines. Overall, these changes have brought about more positive than negative results for society. Boosts in quality of life and health and safety also often accompanied such developments. Getty Images Compared to the past, however, what is different about today is the pace at which market transformations are taking place. Aside, perhaps, from the Industrial Revolution, never before have we seen such rapid rates of societal and workforce change. This means that a large chunk of the population that could have maintained a middle-class lifestyle in past decades can no longer do so. Coming years will likely only see this problem intensify, as jobs that involve any kind of routine or repetitive work “ mental or physical “ are increasingly at risk of being ousted by automation. The endangered jobs list of the near future includes fast food workers, cashiers, telemarketers, accountants, waiters and even short-form journalists. Jobs that used to be very interesting start to look more like computer operator jobs In addition, jobs that were once challenging and required highly skilled expertise could become mundane, thanks to automation. There are hints of this happening today. As X-rays and other medical records are digitised and computer algorithms become better at interpreting them, radiologists, for example, find themselves collaborating with machines, acting more as fact checkers than as medical sleuths. So long as jobs are available that require some degree of human involvement, there will be room for people to continue to hold them. Instead, openings for librarians actually increased, although new skills were needed to excel at the job. So far, humans are vastly superior at any work that relies on creativity, entrepreneurialism, interpersonal skills and emotional intelligence. Jobs that fall into these categories “ including clergymen, nurses, motivational speakers, caretakers, trainers, entertainers and more “ will probably fare well in a more automated world. Even if restaurants begin using tablets installed on tables to take orders, and robots to deliver the food and refill beverages, society might not necessarily take to that change. It could turn out that people simply want to be served food “ or have their groceries run up, or their taxis driven “ by other people, not by machines. This phenomenon is reflected in the recent resurgence of artisans in urban centres around the world, from Brooklyn to London to Berlin to Portland. It turns out that there is a booming market for handcrafted furniture made from salvaged factory beams, hand built headphones , gourmet small-batch

foods ranging from marshmallows to mayonnaise “ and much more. While these products are valued precisely because automation plays no part in their production, many artisanal companies rely heavily on technology, like the Etsy peer-to-peer e-commerce website, to find a market for their goods. Science Photo Library Indeed, for all of the career doors technology shuts, there will also be a wave of new professional paths for people to create and explore. But we can make educated guesses based on data and social trends. Sander envisions a future in which genetic counsellors, software debuggers, biobankers, augmented reality authors, anti-ageing specialists and urban natural disaster mitigation experts all occupy hot sectors of the economy. As more people move into cities, she also predicts jobs like urban farmers, anxiety counsellors, clutter consultants and even pet psychologists will become more favourable. Automation makes us more prosperous, but it creates income distribution challenges At the same time, though, we should not automatically assume that the economy will naturally smooth itself out and self-correct. To make the transition as painless as possible for everyone, we should be proactive about ensuring that the creative destruction of jobs is paired with adequate provisions for those who are displaced. Ensuring education keeps pace with societal change is also necessary. Many of the skills being taught today are no longer relevant for current jobs, she says, which has already led to significant mismatches in demand and supply. Getty Images Some countries, industries and companies are responding to these changes better than others. On one end of the spectrum regulatory regimes can prevent innovation, Sander says, as France is doing with the recent ban on Uber. On the other hand, some places are aggressively pursuing innovation. Likewise, more than 4, companies around the world have built training campuses, the largest of which, run by Infosys and located in Mysore, India, has churned out more than , newly minted engineers since Others are tuning in to shifting demographics to try and prevent job loss in the first place. For instance, BMW is modifying manufacturing plants to meet the needs of older workers, rather than forcing them to retire. Eventually, though, it very well could be that machines and artificial intelligence do displace the majority of professional tasks that humans currently perform. Thanks to oil, Norway, for example, enjoys one of the highest GDPs in the world, but one of the shortest average workweeks:

Chapter 5 : How technology will change the future of work | World Economic Forum

Information technology - often shortened to just IT - is a buzz phrase you've probably heard ad nauseum if you happen to work with IT personnel or went to school for anything related to computers.

Are we facing a future of stagnant income and worsening inequality? Even more ominous for workers, the MIT academics foresee dismal prospects for many types of jobs as these powerful new technologies are increasingly adopted not only in manufacturing, clerical, and retail work but in professions such as law, financial services, education, and medicine. They believe that rapid technological change has been destroying jobs faster than it is creating them, contributing to the stagnation of median income and the growth of inequality in the United States. And, they suspect, something similar is happening in other technologically advanced countries. Perhaps the most damning piece of evidence, according to Brynjolfsson, is a chart that only an economist could love. In economics, productivity—the amount of economic value created for a given unit of input, such as an hour of labor—is a crucial indicator of growth and wealth creation. It is a measure of progress. On the chart Brynjolfsson likes to show, separate lines represent productivity and total employment in the United States. For years after World War II, the two lines closely tracked each other, with increases in jobs corresponding to increases in productivity. The pattern is clear: Then, beginning in , the lines diverge; productivity continues to rise robustly, but employment suddenly wilts. By , a significant gap appears between the two lines, showing economic growth with no parallel increase in job creation. Brynjolfsson and McAfee still believe that technology boosts productivity and makes societies wealthier, but they think that it can also have a dark side: Indeed, they are sometimes accused of being too optimistic about the extent and speed of recent digital advances. Brynjolfsson says they began writing *Race Against the Machine*, the book in which they laid out much of their argument, because they wanted to explain the economic benefits of these new technologies. Brynjolfsson spent much of the s sniffing out evidence that information technology was boosting rates of productivity. But it became clear to them that the same technologies making many jobs safer, easier, and more productive were also reducing the demand for many types of human workers. Anecdotal evidence that digital technologies threaten jobs is, of course, everywhere. Robots and advanced automation have been common in many types of manufacturing for decades. Modern automotive plants, many of which were transformed by industrial robotics in the s, routinely use machines that autonomously weld and paint body parts—tasks that were once handled by humans. The website of a Silicon Valley startup called Industrial Perception features a video of the robot it has designed for use in warehouses picking up and throwing boxes like a bored elephant. A less dramatic change, but one with a potentially far larger impact on employment, is taking place in clerical work and professional services. Technologies like the Web, artificial intelligence, big data, and improved analytics—all made possible by the ever increasing availability of cheap computing power and storage capacity—are automating many routine tasks. Countless traditional white-collar jobs, such as many in the post office and in customer service, have disappeared. It is this onslaught of digital processes, says Arthur, that primarily explains how productivity has grown without a significant increase in human labor. But are these new technologies really responsible for a decade of lackluster job growth? Many labor economists say the data are, at best, far from conclusive. Several other plausible explanations, including events related to global trade and the financial crises of the early and late s, could account for the relative slowness of job creation since the turn of the century. Employment trends have polarized the workforce and hollowed out the middle class. David Autor, an economist at MIT who has extensively studied the connections between jobs and technology, also doubts that technology could account for such an abrupt change in total employment. At the same time, higher-paying jobs requiring creativity and problem-solving skills, often aided by computers, have proliferated. So have low-skill jobs: That, at least, has always been the pattern. At least since the Industrial Revolution began in the s, improvements in technology have changed the nature of work and destroyed some types of jobs in the process. In , 41 percent of Americans worked in agriculture; by , it was only 2 percent. Likewise, the proportion of Americans employed in manufacturing has dropped from 30 percent in the post-World War II years to around 10 percent today—partly because of increasing

automation, especially during the s. While such changes can be painful for workers whose skills no longer match the needs of employers, Lawrence Katz, a Harvard economist, says that no historical pattern shows these shifts leading to a net decrease in jobs over an extended period. Katz has done extensive research on how technological advances have affected jobs over the last few centuries—describing, for example, how highly skilled artisans in the mid-th century were displaced by lower-skilled workers in factories. There is no long-term trend of eliminating work for people. Over the long term, employment rates are fairly stable. People have always been able to create new jobs. People come up with new things to do. The question, he says, is whether economic history will serve as a useful guide. Will the job disruptions caused by technology be temporary as the workforce adapts, or will we see a science-fiction scenario in which automated processes and robots with superhuman skills take over a broad swath of human tasks? Though these technologies have undoubtedly taken over some human jobs, finding evidence of workers being displaced by machines on a large scale is not all that easy. One reason it is difficult to pinpoint the net impact on jobs is that automation is often used to make human workers more efficient, not necessarily to replace them. Rising productivity means businesses can do the same work with fewer employees, but it can also enable the businesses to expand production with their existing workers, and even to enter new markets. Take the bright-orange Kiva robot, a boon to fledgling e-commerce companies. A warehouse equipped with Kiva robots can handle up to four times as many orders as a similar unautomated warehouse, where workers might spend as much as 70 percent of their time walking about to retrieve goods. By making distribution operations cheaper and more efficient, the robotic technology has helped many of these retailers survive and even expand. Automation can solve that problem. Meanwhile, Kiva itself is hiring. Orange balloons—the same color as the robots—hover over multiple cubicles in its sprawling office, signaling that the occupants arrived within the last month. Most of these new employees are software engineers: These algorithms help make the system adaptable. It can learn, for example, that a certain product is seldom ordered, so it should be stored in a remote area. Though advances like these suggest how some aspects of work could be subject to automation, they also illustrate that humans still excel at certain tasks—for example, packaging various items together. Many of the traditional problems in robotics—such as how to teach a machine to recognize an object as, say, a chair—remain largely intractable and are especially difficult to solve when the robots are free to move about a relatively unstructured environment like a factory or office. Techniques using vast amounts of computational power have gone a long way toward helping robots understand their surroundings, but John Leonard, a professor of engineering at MIT and a member of its Computer Science and Artificial Intelligence Laboratory CSAIL, says many familiar difficulties remain. The big challenge is uncertainty. For that reason, Leonard says, it is easier to see how robots could work with humans than on their own in many applications. The semiautonomous taxi will still have a driver. The idea, says Brooks, is to have the robots take care of dull, repetitive jobs that no one wants to do. Robots, he says, can be to factory workers as electric drills are to construction workers: But clerical and some professional jobs could be more vulnerable. Even if the economy is only going through a transition, it is an extremely painful one for many. In the tony northern suburbs of New York City, IBM Research is pushing super-smart computing into the realms of such professions as medicine, finance, and customer service. That version of Watson now sits in a corner of a large data center at the research facility in Yorktown Heights, marked with a glowing plaque commemorating its glory days. Meanwhile, researchers there are already testing new generations of Watson in medicine, where the technology could help physicians diagnose diseases like cancer, evaluate patients, and prescribe treatments. IBM likes to call it cognitive computing. The rapid acceleration of technological progress, they say, has greatly widened the gap between economic winners and losers—the income inequalities that many economists have worried about for decades. For example, someone who creates a computer program to automate tax preparation might earn millions or billions of dollars while eliminating the need for countless accountants. The result, at least through the s, was an increase in educated workers who found jobs in the industrial sectors, boosting incomes and reducing inequality. But that, he suggests, will depend on recognizing the problem and taking steps such as investing more in the training and education of workers. I used to say that if we took care of productivity, everything else would take care of itself; it was the single most important economic statistic. Keep up with the latest in robotics at EmTech

Digital.

Chapter 6 : Top 10 Jobs in Information Technology | Experience

But many current occupations will thrive and new ones will be created, as the way work is done—and our lives progress—will continue to change. I'm Managing Partner at gPress, a marketing.

IT workers are also essential to just about every modern business model. Excellent pay is your reward, more often than not. As the economy finds its footing and more jobs open up, expect the requirements of IT professionals to be vast as ever. Curious what you might like to do and how much someone will pay you to do it? Consider these 10 leading fields and their median salary ranges. In this position, your job is to evaluate the systems and do the research that no one else entirely understands. CNN also recommends that an IT consultant specialize in a niche category to help focus on the kind of experience he or she gets. Computer forensic investigator Computer crime detectives — The Best Schools reports that computer forensic investigators search for, identify and evaluate information from computer systems, often for trial evidence. Certification from a computer examiner board also helps. Health IT specialist Health IT is a blossoming field, especially with major changes going on in healthcare due to the Affordable Care Act and the gradual transition to electronic health records. Health IT specialists will mix computer knowledge with record-keeping skills, but specialties in medical coding, billing and cancer registry are also in demand, according to TBS. According to CareerRealism, the use of mobile tech is predicted to exceed personal computers at some time in , so businesses are more heavily relying on IT professionals with experience in this field than ever before. Using basic coding languages, developers will create programs for future iOS and Android devices. Web developer Web developers are jacks of all trades. Software engineer Like video games? Want to design the next Facebook? This is for you. Information technology vendor manager Slightly more hands-off compared to some tech positions, vendor managers oversee supply when it comes to software and hardware. Computer science degrees are helpful, but a deep understanding of business or even an MBA could clinch a job. Geospatial professionals Sound confusing? Geographic information systems are complicated, but exciting and getting more so every day. GIS tech uses geographic data to evaluate and communicate trends and patterns in visually stylish and comprehensive ways, according to CareerRealism. Certificate programs and degrees both improve job outlook. Data Modeler Another position that translates poorly without jargon, these IT professionals create data designs and define relationships between data fields, according to TBS.

Chapter 7 : Technology's Impact on Workers | Pew Research Center

The pace of technological change in the time I've been in work is only a shadow of what we will see over the next 15 to 20 years. This next wave of change will fundamentally reshape all of our careers, my own included.

Explore the latest strategic trends, research and analysis How many of us can say, with certainty, what jobs we would choose if we were kids today? This next wave of change will fundamentally reshape all of our careers, my own included. We expect the pace of change in the job market to start to accelerate by Office and administrative functions, along with manufacturing and production roles, will see dramatic declines accounting for over six million roles over the next four years. Conversely, business and financial operations along with computer and mathematical functions will see steep rises. There is a central driver for many of these transformations, and it is technology. Artificial intelligence, 3D printing, resource-efficient sustainable production and robotics will factor into the ways we currently make, manage and mend products and deliver services. The latter two have the potential to create jobs in the architectural and engineering sectors, following high demand for advanced automated production systems. Concurrently, advances in mobile and cloud technology allowing remote and instant access were singled out as the most important technological driver of change, enabling the rapid spread of internet-based service models. Our future place of work might not be an open plan office, but interconnected workspaces not tied to one place, but many. They will be underpinned by virtual conferencing, complete and constant connection and portability. Our working day will be fundamentally different. Leveraging big data, like real-time traffic information, could cut journey times, making the school run easier, and the morning commute more manageable. That is, if you have to commute: Personally owned assets, from cars to spare bedrooms, will expand entrepreneurship, diversifying revenue streams. These disruptive business models will fundamentally reshape how we do business, both individually and as companies. For example, digitally enabling smallholder farmers can allow them to operate as a collective, transferring knowledge and sharing vital learnings with each other from proper crop irrigation technology to water efficiency. Critically, these very technologies might help us unlock the solutions to some of the biggest societal challenges we currently grapple with. The ICT underpinning these technologies, in consort with the transformational power of big data, could support smart systems that will help tackle climate challenges. Connected homes, factories and farms leveraging smart energy management systems could mean dramatically lower energy use, which would contribute to the decarbonisation of our economies. And yet we must be vigilant. Not of technological change; we have the power and innovation to harness and use its power as we see fit. But of access to the connectivity and opportunity it brings. What will be absolutely decisive is how we equip our children, our students and our colleagues to harness the power of this technology to transform our world for the better. That means ensuring the ICT skills of current school leavers are fit for the future. It means providing incentives for lifelong learning as the pace of technological advancement quickens. And it means reinventing the HR function, equipping it to continually assess and provide for the training needs of employees. If we get this right the prize is clear. We have the potential to revolutionise the way we live and work and do it in a way that avoids the vicissitudes of previous industrial revolutions, creating new economic opportunities that, even as children, we would not have before imagined. Lastly, we must use every tool within our armoury to ensure the current and future generations are not left behind in the global digital skills race. The Future of Jobs report is available [here](#).