1

TECHNOLOGICAL CHANGE AND THE WORKPLACE

James Timbie

Part I. Advancing Technology and Its Impact

The computation and communication technologies that enabled the information revolution continue to advance rapidly, promising benefits and efficiencies but also raising questions concerning displacement of workers, inequality, and privacy. This chapter outlines further advances in automation and artificial intelligence (AI) and in the scale of collection and exploitation of data that can reasonably be foreseen over the next ten to fifteen years. These technologies are in widespread use today. But impressive new applications of artificial intelligence (such as self-driving vehicles) and dramatic increases in the amount of data collected by the "internet of things" (IoT) and stored in the cloud are on the near horizon. There is potential for further advances in health, safety, and productivity—and also for further disruption of working and personal lives.

Artificial Intelligence[1]

Recent advances in software and hardware, combined with the availability of large sets of digital data, have enabled the development of

machines with the ability to sense their environment, learn by trial and error, solve problems, and take action. It is no longer correct to say that machines only do what they are programmed to do. Machines can now be trained to learn from examination of large amounts of data. Machine learning is the aspect of artificial intelligence responsible for much of the disruption of the workplace.[2]

The twenty-first century has seen unanticipated progress in machine learning that has enabled dramatic advances in practical applications such as speech recognition and language translation. In the near future, we will see autonomous vehicles, better diagnostics for the sick, and better prevention strategies for the healthy. The combination of artificial intelligence and advancements in other technologies such as robotics and 3D printing ensures that the rate of change in many industries will continue to be swift, with accompanying social and economic consequences. This chapter begins with a summary of what can now be expected in certain sectors.

Transportation[3]

Advances in sensors and machine learning have accelerated the development of self-driving vehicles, which are likely to become widely available in the next few years. Autonomous long-haul trucks are expected to be introduced soon; autonomous cars and trucks for city use will come later, as the technology is developed for safely navigating the more complex and less predictable urban environment. Self-driving cars promise to be substantially safer and could transform commuting into an opportunity for constructive activity. Self-driving trucks and autonomous robots will reduce transport and delivery costs. Autonomous vehicles and related transportation services could reduce incentives to own cars, especially in cities, and encourage new forms of public transportation based on smaller vehicles that transport people on demand from point to point. These safety, convenience, and efficiency benefits will come at a cost to those currently driving trucks, buses, taxis, and ride-sharing services.

Health Care[4]

Artificial intelligence technologies have the potential to improve health outcomes and quality of life through better clinical decisions, better monitoring and coaching of patients, and prevention of disease through early identification of possible health risks. Machines could learn which practices and procedures lead to the best outcomes by analyzing vast amounts of data collected in electronic medical records of millions of patients. They could also identify unintended negative effects of procedures and drugs. Machines trained by correlating electronic medical images with data on patient outcomes will enhance the accuracy of interpretation of medical images. The combination of human physicians and machine intelligence will enhance the accuracy of diagnoses of problems and recommendations for therapy and further tests. Additional sources of personal health information from personal fitness devices and social media, for example, and information on individual genomes will support more personalized diagnosis and treatment, along with an emphasis on prevention rather than cure.

We will continue to want a human physician to evaluate the output of machine intelligence in making clinical decisions and recommendations for treatment. The doctor would convey the outcome to the patient and help the patient understand and accept it. The role of nurses, who interact with patients, communicate with them, and make them comfortable, is less susceptible to disruption by automation in the near term.

Education[5]

Machines will not replace teachers. But over the next ten to fifteen years, the use of systems based on AI technologies in the classroom and in the home will expand substantially. Interactive machine tutors are being developed to help educate students and train workers in a variety of subjects, providing personalized coaching and support and monitoring progress. Online courses have promise for providing personalized interaction with students at all levels on a large scale, exposing students

to courses that have proved successful and allowing them to work at their own pace using educational techniques that work for them. Current experimentation and online courses are producing feedback data that will allow the developers of educational systems to learn what works and to improve, including finding the best mix of machines and teaching assistants to provide support. An important application of online courses and intelligent tutoring systems is likely to be the retraining of workers and lifelong learning. Large-scale, personalized adult education and training can be part of the solution to the disruption of the workplace by changes brought about by advancing technologies.

Manufacturing[6]

For decades, manufacturing in many industries has moved offshore, driven by low labor costs, efficient freight systems, and trade agreements. Disruption of industries and loss of skilled, well-paying jobs have contributed substantially to the problems of governance. But globalization may have peaked; trade as a fraction of GDP is now declining. The combination of artificial intelligence, robotics, and 3D printing promises further fundamental changes in the way things are made, leading to production of goods, services, energy, and food close to the consumer. The falling costs and increasing capabilities of 3D printing, with its inherent ability to customize each item at no additional cost, will allow production of consumer goods and industrial products built to order for each individual customer. Hospital supplies and parts for cars, trucks, and aircraft can be produced when and where they are needed, rather than stockpiled. With AI, advanced robotics, and 3D printing technologies reducing labor costs and increasing quality and customization, the advantages of manufacturing in countries with low labor costs will be reduced, while the advantages of production of made-to-order products near the customer will grow. As one line of argument goes, "With the cost of labor no longer a significant advantage, it makes little sense to manufacture components in Southeast Asia, assemble them in China, and then

ship them to the rest of the world when the same item can either be manufactured by robots or printed where it will be used."[7] On shoring is the likely trend for the next ten to fifteen years, but the associated new jobs will be different from those that were lost to offshoring.

> *The key factor that is coming out of this is cost of labor advantages are disappearing. Industrial robots are cheaper than Chinese labor.* —T. X. Hammes

Employment and the Workplace[8]

The list of industries where automation and artificial intelligence will change the workplace in fundamental ways is long and diverse, including:

- Health care (automated diagnostics, image interpretation, robotic surgery, patient monitoring, risk assessment, and disease prevention)
- Transportation (autonomous cars, trucks, and taxis; monitoring of aircraft engines)
- Law (pretrial discovery)
- Call centers (voice recognition and responses)
- Education (interactive tutors, online courses)
- Software (machines that write and debug software)
- Logistics (automated warehouses, sensors for supply chain management)
- Agriculture (autonomous vehicles, crop and animal monitoring, local indoor farms)
- Elder care (automated transportation, monitoring, personalized health management, service robots)
- Manufacturing (automated production lines of all kinds)

In all of these endeavors, large numbers of workers now onshore and offshore will be displaced by more efficient machines. In contrast to the nineteenth-century mechanization of manual tasks and the twentieth-century offshoring of routine tasks, twenty-first-century machines will be moving into a wide range of cognitive tasks that until now have been reserved for humans, including professional services. One result will be less expensive, better quality, and more customized goods and services, plus an improved standard of living. Another result will be loss of employment for workers in a broad range of skill and income levels.

A study by Frey and Osborne suggests that 47 percent of workers are in occupations with a high probability of displacement by automation.[9] They conclude:

> While computerization has been historically confined to routine tasks involving explicit rule-based activities, algorithms for big data are now rapidly entering domains reliant upon pattern recognition and can readily substitute for labor in a wide range of non-routine cognitive tasks. In addition, advanced robots are gaining enhanced senses and dexterity, allowing them to perform a broader scope of manual tasks. This is likely to change the nature of work across industries and occupations.[10]

They find workers in service industries to be highly susceptible to automation, as well as workers in transportation and logistics, office and administrative support, and production. Machine learning is even assuming some of the tasks of software engineers.

As in the past, new industries and new jobs will be created. The number and nature of these new jobs are difficult to foresee. Certain tasks will become more important, creating opportunities for expansion, and new categories of employment could be created. The net effect on the total number of jobs is difficult to predict. What is clear is that a substantial fraction of the workforce may lose well-paying "cognitive" jobs to automation, perhaps more over time than the well-paying factory jobs lost to globalization.

The recent evolution of chess may provide a hint about the future. After a long period of development of hardware and software, a computer defeated the best human chess player, Gary Kasparov, in a well-known match in 1997. Today, a laptop computer with off-the-shelf software can play as well. Now there is a new game called free-style chess, in which a human player can draw upon machine support.[11] For successful players, the human provides the strategy and uses a variety of machines to explore tactics and consequences of potential moves. The human-plus-machine combination is widely considered to play at a higher level than either humans or machines, and a human-plus-machine combination can defeat any human or any machine.

This lesson may be broadly applicable, suggesting that the best results will come from humans supported by intelligent machines—a combination of a doctor and a machine, a teacher and a machine, and so on. In the workplace of the near future, humans will do jobs (or portions of jobs) that machines do not do well, and work with machines in areas where machines have advantages. Davenport and Kirby describe future workplaces where machines and humans work together, the machines doing the computational work they do best, augmenting the humans who see the big picture and have interpersonal skills.[12] One example would be insurance underwriting, where machines make detailed risk assessments and premium calculations for each application for insurance, and humans address exceptional cases, manage the company's overall risk profile, and communicate with individuals whose applications were denied.

It is not clear whether the number of jobs created and jobs retained in modified form will match the number of jobs lost to artificial intelligence, automation, and robotics. Those who have studied this question are closely divided.[13] Historically, over the two hundred years since the Luddite rebellion, gains in productivity have, over time, led to new jobs in new industries. That could continue. Or this time could be different.

What is clear is that in the near term, large-scale disruption of the workplace will continue and probably accelerate. In contrast to the twentieth century, where job loss was concentrated on middle-income,

mid-level skill occupations, the current advances in artificial intelligence and automation in the twenty-first century will affect workers at all skill and income levels (high and low as well as middle), including some well-paying cognitive jobs.

> *I heard someone say the other day that in the factory of the future we're going to have two living creatures: one a man and the other one a dog. The dog's job is to keep the man from touching anything, and the man's job is to feed the dog.* —Sam Nunn

Inequality[14]

For the country as a whole, the advance of technologies that exploit artificial intelligence and automation will likely continue to increase national wealth and income, but these benefits will be distributed unevenly. Some workers performing routine tasks at all skill and income levels will be adversely affected. But low- and middle-income workers without a college education will feel the most pressure on wages and employment. This is a continuation of a well-established trend. Median household income has not risen significantly since 1999, even as GDP has grown 38 percent. All of the gains in income have gone to the upper end (table 1.1).

TABLE 1.1 US Household Income Shares, 2016

	1991		2016
Bottom 20% of households	3.8%	↘	3.1% of total household income
Top 20% of households	46.5%	↗	51.5%
Top 5% of households	18.1%	↗	22.5%

Source: Jessica L. Semega, Kayla R. Fontenot, and Melissa A. Kollar, "Income and Poverty in the United States: 2016," US Census Bureau, Current Population Reports, P60-259 (Washington, DC: Government Printing Office, September 2017).

Other metrics—including median income per capita, total wealth, and life expectancy—also demonstrate growing inequality.[15] The spread of automation contributes to this growing inequality in wealth and income. It is easy to see how this happens. Brynjolfsson and McAfee give the example of TurboTax, a provider of tax preparation software.[16] Many customers find it cheaper, quicker, and more accurate than having tax preparers produce their returns. TurboTax has therefore created a great deal of value for its users. The small cadre who created TurboTax has benefited handsomely. But a much larger number who earned their living as tax preparers now find their jobs and income threatened. Replicating this example throughout the economy, new technology adds to the nation's GDP and standard of living, concentrates new wealth in a small number of entrepreneurs and their skilled employees, and threatens the livelihoods of a larger number of displaced workers.

The failure of median incomes to rise as GDP grows contributes to the widespread perception among low- and middle-income citizens that the present economy does not work for them.

> *Is it us or is it the world? How much of this is because of the way we're doing things, and how much of this is unavoidable because of technological change?* —Burton Richter

Big Data

The recent and surprising advances in artificial intelligence for practical applications are based on the application of innovative processing power and software to very large sets of digital data. For example, machines have recently become quite proficient at translation by comparing vast amounts of digital text collected from many sources. These translation systems are not programmed on grammar, syntax, or spelling; they are trained by examining very large amounts of text in various languages, enabling them to learn how a phrase in one language correlates with the

corresponding phrase in another. Similarly, machines with no knowledge of biology are trained to interpret medical images by finding correlations between digital images and medical outcomes, based on lots of data from very large numbers of cases.

"Big data" is quantitatively very big. Google processes over 3.5 billion search queries each day and saves information on each one. Facebook uploads more than 300 million photographs each day. This enormous growth in scale results in a qualitative change as well. Collection of so much information—all or nearly all of the information on a subject—has facilitated a transformation away from drawing statistical inferences from a sample of data to drawing deeper, more detailed, and more reliable conclusions by examining all the data, not just a sample. Given a very large data set, machines can learn to find patterns and correlations and make reliable predictions without considering the physical or biological processes involved. As the data set continues to grow, the predictions get better. The role of vast amounts of data in the success of artificial intelligence is so central that the entire field is coming to be called "data science," two key components of which are data collection and machine learning to draw conclusions from the data and make predictions.

An illustrative example of the constructive combination of machine learning and big data is Google's use of search queries to detect and track seasonal flu outbreaks.[17] Google researchers programmed machines to examine records of hundreds of billions of search queries between 2003 and 2008, along with historical information collected by the US Centers for Disease Control and Prevention (CDC) on patient visits to doctors reporting flu-like symptoms. Google's automated system was given no information about influenza or how it is treated, but was able to identify forty-five search queries that are correlated with a flu outbreak in a region. The machines looked for and found correlations in a vast quantity of data, succeeding where earlier attempts using less data had failed. Google's system provided accurate estimates of the spread of flu in near real time, without the one- to two-week lag of traditional CDC reporting. This technique was soon put to practical use when the new H1N1 flu virus appeared a few weeks after Google's research results were pub-

lished, enabling Google's system to assist the CDC by providing prompt and reliable tracking of the new outbreak.

The Internet of Things

Growing amounts of personal, medical, financial, professional, and business data are being collected through internet activities and stored in "the cloud"—vast collections of servers located on rural campuses operated by internet companies such as Amazon, Microsoft, Google, and Apple. The scale of data collection and storage will continue to expand exponentially with the growth of the "internet of things"—the sensors and associated software connected to the internet that are being embedded in personal devices, appliances, homes, cars, highways, machines, and workplaces. The result is a vast increase in scale of information, including personal information, collected and stored in the cloud and available for commercial exploitation.

The technology driving this expansion is the development of sensors that are smaller and cheaper, require less power, and have more computing capacity. These sensors will soon be everywhere, including the homes, cars, phones, watches, and fitness monitors of individuals, collecting detailed personal data including location, activities, health, and shopping preferences. This explosion of information will have many benefits, including more extensive health records, better traffic flows, safer cars, reduced energy use, more extensive monitoring of air and water quality, and more reliable machines, among many others. It will also lead to refinements in the relationship between retailer and customer, such as offering a special price to a customer in the vicinity of an item in a store based on the customer's present location and past buying profile. There is also potential for abuse, such as using health information in the cloud to adversely affect insurance decisions and rates and to identify desperate people and offer them high-interest payday loans.

Along with the benefits, this massive collection of data—and its exploitation and possible abuse for commercial purposes—could make a further contribution to a perception by many that the economy is not

working for them, with consequent implications for governance. Security and privacy are two particular problems accompanying the increase in scale of data collected by ubiquitous sensors and stored in the cloud.

Security[18]

Security of the internet of things has been identified as a potentially serious issue. The sensors typically are small and have limited computing speed and power, limiting their ability to employ modern security techniques. Many have no ability to be upgraded to counter evolving security threats. Many are embedded in objects (such as appliances and utility meters) that have much longer lives (decades) than the lifetimes normally associated with high-tech equipment. They could still be deployed long after the company that created them no longer exists, with vulnerabilities to threats that emerge during their lifetimes. Many have little physical security, allowing attackers direct physical access. In many cases, the user is not aware of the device and does not monitor its status. The potential consequences of security problems with embedded devices could have implications for internet security generally; an unprotected refrigerator or television infected with malware could send harmful messages worldwide.

These considerations suggest that security should be a primary objective in the design and deployment of the internet of things. This could include the development of standards for best practices in design, security, and field upgradability of embedded devices. Industry standards, rather than government regulations, seem more practical for such a complex and rapidly changing environment.

> *Our systems are vulnerable. One of the first things we can do as we wrestle with this is deal with that reality and harden the systems we have. Then, design resilience into the new systems—not attempt to bolt it on after the fact.* —James O. Ellis, Jr.

Privacy[19]

The vast and exponentially growing amount of data collected from sensors that monitor individuals and their activities, including activities in their homes and cars, together with data collected and stored on their buying habits and professional activities, can be mined to produce detailed individual profiles for commercial purposes. The collection of this information may provide benefits for the device's owner, but often the supplier and manufacturer of the device benefit financially from the information as well. When data streams from multiple devices are combined and correlated, the result can be a quite invasive individual portrait. For example, internet companies can already accurately identify when an individual becomes pregnant, and the due date, from data on search queries and buying habits.

There is potential for conflicting interests between those whose personal data are exposed and those who collect this information and often sell it to third parties. Many of the "free" services on the internet are, in fact, paid for through the sale to brokers of personal data collected through tracking the activities and internet histories of individuals. From a commercial point of view, collection and sale of personal data can support a viable business model for many "free" internet applications. Some individuals, however, may see an unwelcome intrusion into a private space, often without consent or even awareness, adding to a perception that the economy is not working for them.

The legal situation with respect to privacy of electronic information is complex:

- Medical records must be protected; individuals have the right to see them and correct them. By law, medical information may be used or shared for certain specific reasons not directly related to an individual's care, such as monitoring quality of care or reporting disease outbreaks; individuals can generally learn who has seen their medical information. Otherwise, medical information cannot be used for purposes not directly related to care without

permission. Vast amounts of health information are collected by entities not covered by existing privacy laws (from fitness devices and social media, for example). Conversely, achieving the full potential of medical science to detect, treat, and prevent diseases and to reduce costs could require evolution of the existing health information privacy regime.

- Financial institutions must notify their customers about their information-sharing practices and inform them of their right to opt out if they don't want their information shared with nonaffiliated third parties.
- Personal information on children under the age of thirteen cannot be collected without parental consent.
- Except for medical and financial information and information on children as outlined above, the privacy of personal data is governed only by the Federal Trade Commission Act's prohibition on "unfair or deceptive acts or practices." The FTC has taken action against firms (including Google and Facebook) for violating their published privacy policies, as a deceptive trade practice.[20] Otherwise, the collection and use of information, including personal information, is largely unregulated.
- By contrast, EU regulations require notice and consent for collection of personal data; the data can be used only for the stated purpose; and individuals may have access to their data and can make corrections.[21]

The United States is sleepwalking, whereas the Europeans and the Chinese have a strategy. The Chinese one is, "We need to control these network platforms. Let's have our own. Done." The European one is, "Well, we don't have any of our own because we're not good at technology. So let's just regulate the American ones." The US strategy is, "Everything is awesome." It's definitely not.

—Niall Ferguson

Inequality

The potential drawbacks of big data will not necessarily be evenly distributed. There are well-documented areas where data analytics systematically discriminate against the poor, including algorithms used for sentencing individuals, for screening job applicants, for setting rates for mortgages and automobile insurance, and for finding desperate people and targeting them with ads for high-interest payday loans.[22] In all these cases, nontransparent algorithms give low scores to the poor, in part because of where they live. Since both the algorithms and the data they use are not transparent, there is no way to learn the reasons for adverse decisions or to correct errors.

Advancing technology and data collection could allow the dynamic pricing now common for airline seats and sports events to spread to the rest of the economy, with prices set by nontransparent algorithms for goods and services offered to some that are different from the prices offered to others.

As algorithms operating on data that include detailed personal information come to play key roles in decision-making in the workplace, in retail, in the courtroom, and in insurance of all kinds, inequality and discrimination fostered by nontransparent algorithms can become a further source for a perception that the economy is not working for many citizens.

Part II. Mitigating the Impact of Advancing Technology

Transitions to New Jobs

Availability of New Jobs in New Occupations

While perhaps half of today's workers are in positions vulnerable to disruption by artificial intelligence, automation, and related technologies, other fields will expand and new jobs and new industries will be created. Machines will not generally replace humans for the foreseeable

future. Many tasks will be best done by a combination of humans and machines, and many occupations requiring creative, management, and technical skills will remain human domains. The challenge will be to facilitate transitions of displaced workers to new occupations, including training in new skills.

A closely related issue concerns the large number of positions available today but not filled because employers cannot find qualified candidates. The Department of Labor estimates that in June 2017 there were 6.2 million job openings in the United States. "Employers struggle to fill well-paying jobs in health care, advanced manufacturing, information technology, construction, transportation and logistics with workers sufficiently skilled to handle the work."[23] Some of these existing unfilled job openings would potentially be available for displaced workers, with appropriate training.

It is therefore likely that jobs will be available for displaced workers, drawing on (1) the half of the workforce that will not be disrupted in the near term, (2) the new jobs created even as traditional jobs disappear, and (3) job openings that cannot now be filled due to lack of qualified workers.

New jobs would not necessarily be in the same locations, would not necessarily pay as well, at least initially, and would require investment in training to learn new skills, but they would eventually allow displaced workers to regain the considerable individual, family, and community benefits of gainful employment.

I think the respect for "skill" is something underemphasized in this country. . . . I remember Helmut Schmidt when he was German chancellor would take four, five, six of the top skilled tradespeople in Germany with him on his diplomatic trips abroad—you can imagine the respect those guys had when they came back. It was an intangible that we here need to really think about. —Sam Nunn

---

Training for New Occupations: Partnerships between Employers and Community Colleges

A key resource that displaced workers can draw upon in moving to a second career is the widespread establishment of partnerships between employers and community colleges. Successful partnerships include:

- *A group of employers in an industry sector with similar workforce needs and located in the same geographic region (a portion of a state).* The group of employers defines the skills needed in the workforce. Participation of employers provides a concrete and visible prospect of a new job, which can serve as an incentive to devote the time, effort, and resources necessary to complete the retraining process. In some cases, employers can potentially offer internships as stepping-stones to new jobs.
- *A community college training program that provides the skills to match the workforce needs sought by the employers.* Partnerships between community college training programs and employers are established through industry participation on advisory boards, personal contacts between instructors and their industry counterparts, instructors with experience in industry, adjunct instructors currently in industry who teach courses at night, and feedback from graduates now working in industry. In this model, feedback from close partnerships with employers allows training programs to adapt to the evolving needs of employers (which can change rapidly). Experience has shown that in addition to technical skills, employers seek English and math skills, business skills (e.g., familiarity with Microsoft Office), and social skills (e.g., good communications, good interview). Many community colleges integrate the appropriate English and math into their technical programs so that students learn English and math in the context of their future careers.[24] Community colleges can also provide certificates and credentials required in certain fields. Moreover, community college

costs are low. In California, two-year training programs generally are in the $2,000 to $3,000 range, and much of that can be waived according to circumstances.

- *Tracking and feedback.* An important element of successful partnerships is the tracking of individuals after they complete the program. (Did they get a job? Did they get a job they trained for? What salary?) For successful career technical training programs, most of the individuals who complete the program get jobs in their field of study.[25] Tracking of employers is also important. (Did they interview individuals who completed the program? Did they hire those people? Did the applicants have the skills the employers were looking for?) These partnerships between employers and community colleges are dynamic entities, constantly evolving to meet the changing workforce needs of today's employers.
- *Other organizations can be involved to help overcome barriers faced by some job seekers.* Examples include organizations that provide day care support, transportation to and from training sites, and assistance in overcoming issues raised in background checks, including help in navigating the criminal justice system.

Connecting Displaced Workers to Available Jobs and Training

Even as jobs are eliminated by advancing technology, new jobs are created, and many jobs today are unfilled for lack of qualified workers. Community colleges in partnership with employers offer training programs at affordable cost in technical, business, and social skills that have successfully led to new jobs in new fields. The remaining question is how to connect displaced workers to new occupations with available jobs and to corresponding training programs.

In principle, an informed decision by a displaced worker would require information on new occupations with available jobs nearby, on the larger set of new occupations with available jobs at some distance from his or her current location, and the still larger set of new occupa-

tions with available jobs in other states, along with salary expectations and living costs for each case. Also important would be information on availability, cost, and time required for corresponding technical training necessary to prepare for a new job in a new occupation. The displaced worker could weigh options on a range of industry sectors, locations, salary structures, and training possibilities, and then make an informed decision on how to proceed, taking into account his or her personal and family situation.

Some resources are available to unemployed workers to help them acquire the large amount of information necessary to make an informed decision on a new occupation and perhaps a new location. Together with the states, the Department of Labor has established Job Centers, which provide online information on job openings and educational opportunities to support job seekers of all ages and circumstances, including a database of jobs that have been posted on the internet by employers and of training programs. Job seekers can explore information on a range of careers, prepare a self-assessment, learn about the job application process, write a résumé, and prepare for an interview. The 2,500 Job Centers throughout the country provide workstations that job seekers can use to access a database of jobs and training programs. The centers also offer counseling and sponsor job fairs with local employers.

While these resources available to job seekers represent a useful step in the process of transitioning to a new job, they are not a solution to the problem of finding new jobs for displaced workers:

- Not all jobs are posted on the internet. Many employers prefer candidates referred by current employees. Some jobs are reserved for internal candidates. Some employers work with recruiting agencies.
- Some jobs posted on the internet are not available for filling in the near term but are intended to collect information on candidates for potential future use.
- Not all training programs are included in the database.

- The large databases of jobs are generally accessed by a complex automated process using keywords, which is difficult to navigate. This problem is compounded by a lack of generally agreed-upon terminology for job titles. (For example, a "maintenance technician" could refer to a skilled person who controls the operation of an automated factory and is capable of troubleshooting potential problems to keep it running smoothly. But the same words could refer to a janitor.)

A more fundamental problem is that the process of getting a job, especially a good job, is complex and difficult. Networking is generally a more productive approach than responding to postings on the internet. Many jobs go to candidates referred by current employees, who can be connected to job seekers by personal networks.

Social media plays an increasing role in job searches and hiring. Potential employers can learn a great deal about prospective employees from social media such as LinkedIn and Facebook. Social media can facilitate networking and can allow a job seeker to convey a résumé to a hiring manager. A résumé is likely to be effective only if it includes appropriate keywords that will be noticed by automated systems that scan résumés.

Gaining new skills, and a new job in a new field, with an adequate salary (probably less than the previous salary) is likely to be a difficult and time-consuming process. A good fit to a good job is likely to be the result of research, introspection, networking, and hard work. An appropriate strategy would begin with research into potential occupations with openings and community college training programs to acquire the necessary new skills. It would proceed with a mix of networking with friends, family, colleagues, and acquaintances, using social media, responding to internet job boards, and getting coaching on résumés and interviews.

There is a special opportunity here around land grant colleges, too. They have a tradition of application of knowledge to locally

defined problems. And there is a correlation between land grants and the ability to sustain and even grow local manufacturing, especially when the land grant has that extension-service mentality of applied engineering. —Ernest Moniz

Counselors, Coaches, and Caseworkers

Displaced workers would benefit from counselors or coaches who could assist them as they navigate this process to an acceptable outcome. Helping guide displaced workers to new careers is likely to be a task best undertaken by skilled humans working with automated systems, just as the combination of a doctor and a machine is the optimum approach to medicine and the combination of a teacher and a machine is the best approach to education.

Each displaced worker is a special case with his or her own abilities, ambitions, limitations, resources, and responsibilities. A good counselor would encourage reflection and self-assessment, help identify and assess options for new occupations, suggest networking possibilities, and recommend approaches to identifying and securing a job that have proved successful. A good counselor would be skilled in communication with a displaced worker (who would be going through a difficult and traumatic period in his or her life), skilled in the use of automated systems and other sources of information on occupations with available jobs and associated training programs, and aware of other resources and organizations that are available to help overcome obstacles that may arise in each case.

While skilled counselors, coaches, and caseworkers could be crucial to success in connecting displaced workers to available jobs and available training programs, such counseling is not currently an occupation supported by training programs. Upgrading the capabilities of counselors, coaches, and caseworkers may be the single most effective way to facilitate the transitions of displaced workers to new careers. The Markle Foundation, through its Skillful program, is seeking to develop a coaching

corps by upgrading the skills of individuals now working as counselors at workforce centers and elsewhere, and by networking them together.

Another useful initiative would be to establish a system to track the progress of each unemployed worker through the process of transitioning to a new job. Collection of such data, while a difficult and expensive task, would lead to an understanding of what works and what doesn't and would help develop best practices for facilitating successful transitions.

Other Possibilities for Mitigation

While the great majority of new jobs will be in the private sector, public policies can play a key role in this process:

- *Economic growth*. A growing economy would make a substantial contribution to job creation, including jobs for those displaced by automation.
- *Lifelong education*. With the rapid advance of technology, education is no longer primarily for the young. Workers in all fields are well advised to stay current on technical and business skills and to learn new subjects in order to keep pace with developments in current occupations and provide a head start if and when it becomes necessary to prepare for a new career. Community colleges and internet courses provide low-cost education and training in a wide variety of fields.
- *Adjustment benefits*.[26] The prospect of further large-scale job dislocation has led to calls for consideration of a guaranteed basic income, which would be paid to everyone and provide a subsistence living without a job. Both individuals and society as a whole, however, would benefit from re-employing displaced workers in new occupations rather than paying them not to work. From the perspective of our society, there is no shortage of work to be done and problems to be solved. For individuals, income is not the only benefit of a job. A sense of self-worth and standing in the community are equally important. Rather than

paying people not to work, the focus should be on facilitating transitions to new jobs, with the possibility of support through the adjustment period. The narrowly defined Trade Adjustment Assistance program did little to counter the impact of job losses attributed to globalization. A broader adjustment benefit would cover layoffs due to automation and recession as well as foreign competition and would provide income and assistance for training and relocation during the transition period.

Studies were done in wartime Britain about how people reacted to the Blitz. People who felt most aggrieved, hurt, victimized weren't the people at the center of the blast radius. They were the people in the next ring out. Why? Because they could see, beyond them, people who weren't scarred at all. —David M. Kennedy

---

Implications for Governance

While the coming disruption of the workplace by advancing technology promises to exceed past job losses attributed to globalization, many elements are in place that can support transitions to new occupations for affected workers. In particular, partnerships between employers and community colleges provide effective and affordable training for new careers. Governments can help mitigate job losses and their political consequences by providing sufficient support for community college technical training programs to meet the demand by displaced workers.

Also in place are programs to assist unemployed workers generally, which displaced workers can draw upon. Success in securing a new job in a new occupation with an adequate salary is likely, however, to depend heavily on individual efforts and networking skills. Governments could support the work of the nonprofit sector to upgrade the capabilities of coaches to help job seekers navigate the difficult path to a good fit with a good job in a new occupation.

Recognizing that the length of training programs for new careers often exceeds the six-month duration of unemployment benefits, governments could expand the Trade Adjustment Assistance program (which supports displaced workers in full-time training for up to two years) to cover job loss due to automation and recession as well as foreign competition.

Finally, governments could invest in tracking each unemployed worker through the process of training, job search, job placement, and subsequent career path. On the basis of such information, the process could be continually adapted to emphasize approaches that prove to work.

The goal here is to try to expand access to the positive aspects of these emerging technologies and, at the same time, protect citizens from their adverse consequences. —Christopher Stubbs

---

Privacy

It would not be easy to develop practical solutions to privacy questions raised by the rapidly increasing collection of information from internet activities and from sensors that are already widely deployed and will soon be ubiquitous. Industry standards for privacy seem to be a more practical approach than regulations, given the complexity and rapidly changing nature of the problem.

Present practice is for companies engaged in internet commerce to post their privacy policies on their websites. Google, for example, has on its website a nine-page privacy policy with numerous links to added detail.[27] (As part of a 2011 settlement with the FTC on charges of violating its own privacy commitments, Google is required to implement a comprehensive privacy policy program with regular independent audits.) The privacy statement outlines the information Google collects and how this information is used and shared. There is a detailed description of the information automatically collected and stored on server logs every time a user makes a request or views content on Google sites.

Automated Google systems analyze user activities to support, among other things, tailored advertising. Google offers options for opting out of storage and sharing of certain types of information.

Other internet companies post privacy policies that are similar in size and complexity, but differ in detail. Companies are generally open about the vast amount of information collected and how it is used and shared. The commercial use and sale of this information support "free" internet services. As noted earlier, the FTC can and does take action against companies for practices inconsistent with their stated privacy policies.

In addition to these privacy policies of individual companies, there are collective self-regulatory efforts:

- The Network Advertising Initiative, a consortium of online advertising providers, has produced a code of conduct for data collection, transfer, and use practices in online advertising, including an opt-out mechanism that individuals can exercise on its website.[28] These are the companies that provide the infrastructure behind interest-based advertising, and most internet ads displayed in the United States involve one or more subscribers to the code. The FTC has taken enforcement actions against companies that failed to honor opt-outs.[29]
- Internet companies involved in K-12 education services, including Apple and Google, have taken a pledge not to collect, maintain, use, or share student personal information beyond that needed for authorized educational purposes.[30]

The present framework of published voluntary privacy policies on data collection, use, and distribution, including provision for opting out of certain uses, backed up by the potential for FTC enforcement in event of violation of those stated policies, can be the baseline for consideration of further steps:

- Greater transparency for data brokers.[31] Several nearly invisible entities called data brokers buy and sell personal information

collected from numerous sources, including internet activities (web pages visited, items purchased, social media posts, etc.), largely without consumer knowledge. They use it to form detailed descriptions of the online and offline lives of nearly everyone.[32] These files on nearly every individual include health and financial information. This personal information is used to facilitate targeting of advertising (via web pages, email, and direct mail), to help identify fraudulent transactions, and to locate people. There is now no meaningful way for individuals to know the full spectrum of information collected about them and the way it is reused. The problem will continue to grow as the data collected by ubiquitous sensors expands the information collected on personal activities. Following the lead of the online advertising industry, the data services industry could collectively produce a website identifying data services companies, describing their data practices, and providing a mechanism for individuals to gain access to their data and to opt out of certain uses.

- Consumer choice for unrelated use of data.[33] Individuals could also have a choice about uses of information about them that are not related to the service provided. Many internet applications collect data not related to the service performed, which can then be sold. For example, some applications that enable a smartphone to be used as a flashlight collect GPS data on the location of the user. Geolocation information is obviously not necessary for the flashlight; the tracking data are collected and sold to provide a separate income stream. This collection of extraneous data is disclosed, and while these disclosure statements are rarely read before downloading an app, analysis of disclosure statements has led to public awareness of the risks of flashlight apps.[34] Industry standards could require that collection of personal data not related to the service provided be prominently displayed in disclosure statements so that consumers could make an informed choice.

Enhancing Public Information on Privacy Policies and Algorithms

A great deal of public information is already provided in lengthy, complex notifications of privacy policies that are often clicked but rarely read. A nonprofit organization could usefully be established whose mission is to carefully read and compare privacy policies and then publish reports calling public attention to privacy risks, comparable to the reports that brought public attention to the risks of phone flashlight applications.

Stronger protections, such as a requirement for consent to data collection, do not seem realistic given the deployment of sensors already under way and the broad acceptance of collection and use of electronic data in many areas, such as the workplace, banking, and retailing.

Most Americans seem to accept the current provision of "free" services supported by the sharing of personal information, even as they may not be fully aware of the scope and detail of the personal information involved. Individuals who have strong feelings about the privacy of their personal electronic data could take appropriate action based on existing public disclosures of privacy policies, perhaps augmented by reports from an organization dedicated to advising the public on privacy risks of personal data collection and use, and accept whatever inconvenience is associated with that decision.

The European Union is moving in the opposite direction, placing increasingly stringent restrictions on the collection and sharing of personal data. Given the low level of expressed concern about privacy of electronic personal information in the United States, establishment of an organization to increase awareness of privacy risks based on publicly disclosed privacy policies seems a more practical approach for this country.

While there would be resistance to exposing proprietary business practices, some degree of transparency could also be established for algorithms that are used in decisions that increasingly affect the personal and professional lives of many citizens (including algorithms used for sentencing individuals, for screening job applicants, for determining

mortgage rates, and for setting rates for insurance of all kinds). This is another area where consideration could be given to the establishment of a nonprofit organization staffed with appropriate expertise that could assess algorithms widely used in the courtroom, in the workplace, and in commerce, and report to the public on the capabilities and limitations of these algorithms, including the accuracy of their predictions.

We have these frightening technologies. What do we do with them? I want to express the sentiment that technology will always go forward. It cannot be stopped. Anything that thinks about stopping it or even slowing it down is just not going to work, and so we have to deal with it. —Persis Drell

---