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HOW SOFTWARE AUTOMATION CHANGES WORK – AND CREATES NEW WORKFORCE CHALLENGES – IN THE DIGITAL AGE

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Are smart machines coming for our jobs? In recent years, many social scientists, technologists, and journalists have warned that rapid advances in artificial intelligence are poised to create mass joblessness. Other analysts, however, argue that the future of work will be more complex. According to them, although technological innovations will replace some human workers, new jobs will also emerge in and around software systems. Who is right? How do recent developments in software automation work? Are there limitations to computerization? And how might policymakers respond to the challenges it poses?

My own research reveals how humans and software are working together on the frontiers of the digital economy. I spent 19 months investigating the inner workings of a startup company that ran an online market connecting buyers and sellers of local services such as house cleaning, plumbing, tutoring, and photography.

In the company I studied, software algorithms did not function autonomously, but instead worked in tandem with two forms of complementary labor. People across the Philippines worked on digital assembly lines to complete or augment the tasks performed by software algorithms, while workers in the Las Vegas area spoke with customers over the phone to sustain trust in the company and its fast-changing product. This company provides only one example of interactions between automation and human workers, but it is an instructive one. Rather than developing generalized artificial intelligence designed to replace human thought, many of today's software engineers strive to create useful assemblages of technology and workers that can jointly perform tasks better and more efficiently than either could alone.

Is This Era Different?

Fears of technological unemployment have beset societies since the dawn of industrial capitalism, but the direst predictions have not yet come to pass. Examining recent developments in light of historical trends reveals the complexity and dynamism of the relationship between work and technology. Researchers have identified four important factors that hold full automation in check:

- **"Automated" machinery rarely functions autonomously.** During the industrial revolution, some worried that new machines would reduce aggregate demand for work. Instead, automated equipment intensified physical labor in and around fast-paced machines. Today, software algorithms that appear to function autonomously often rely on human workers to train, monitor, and modify them. For example, Google's search algorithms rely in part on human trainers who rate their results. Humans must also painstakingly label thousands of images to train self-driving cars to "see" roads, pedestrians, street signs, and other objects.

- **Machinery's capabilities are limited.** Many jobs will be automated, but others will remain impossible or impractical for computers and robots to perform. Because machine learning can only offer approximations of human mental processes, its performance has thus far been useful but inconsistent. Computers that can reason exactly as humans do probably remain decades away, if not longer. Furthermore, the high cost, fragility, and rigidity of machinery can lead organizations to prefer adaptable human workers even when automated solutions are available.

- **As machinery replaces some workers, new complementary jobs also emerge.** It is easy – and often frightening – to observe how innovative technologies replace workers. But it is much more difficult to predict how new machinery will be complemented by human labor. At the dawn of the 20th century, over 40% of U.S. workers were employed in agriculture; few could have envisioned exactly how work would move from farms to factories to offices and retail establishments. Nor would they have foreseen how technological advances would spawn employment in entirely new industries. The same is likely true today.

- **Demand for labor can increase when automation reduces its cost.** As economist James Bessen has shown, when power looms automated an estimated 98% of the labor required to weave a yard of cloth in the 19th century, consumer demand increased so sharply that the number of weaving jobs actually rose and workers' remaining tasks became more valuable.

Sharing the Benefits of Artificial Intelligence

The debate about job loss from software automation obscures more pressing issues. As in the past, workers and policymakers can help to shape the outcomes of technological progress.

Current advances in computerization appear to be contributing to the "hollowing out" of the U.S. occupational spectrum. Middle-income jobs requiring some technical or on-the-job training, but whose tasks can be broken down into known procedures, are increasingly susceptible to automation. This includes many manufacturing jobs, plus clerical and administrative support positions. The good news for workers is that demand and wages are growing for some of the jobs that cannot be easily automated – for higher-educated professionals, managers, and technicians whose work is complemented by computers. Unfortunately, demand is growing even faster for low-wage, in-person service jobs in food service, cleaning, and health care that do not require higher education. An abundant supply of applicants for such positions – including workers who have lost jobs in part due to automation – suppresses wages and benefits.

What can be done? Some advocate bolstering public school training in science, technology, engineering, and mathematics to give less advantaged children a better chance to gain higher education and fill high-wage jobs that are complemented by new technologies. Helping workers become lifelong learners can spur the development of increasingly important skills in problem solving, writing, and interpersonal communication; and professional organizations can develop certifications to help employers recognize qualified job candidates without college degrees.

Other analysts focus on how societies should distribute the wealth generated by labor-saving technologies. Given that many of the new jobs that cannot be automated are likely to be in low-wage fields, many workers would benefit from an increased minimum wage. The Earned Income Tax Credit could also be expanded to make such posts more rewarding. Following this logic, every citizen could enjoy a guaranteed minimum income that would help all workers deal with predicable dislocations in the era of digital automation.