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How Technology Wrecks the Middle Class

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In the four years since the Great Recession officially ended, the productivity of American workers — those lucky enough to have jobs — has risen smartly. But the United States still has two million fewer jobs than before the downturn, the unemployment rate is stuck at levels not seen since the early 1990s and the proportion of adults who are working is four percentage points off its peak in 2000.

This job drought has spurred pundits to wonder whether a profound employment sickness has overtaken us. And from there, it's only a short leap to ask whether that illness isn't productivity itself. Have we mechanized and computerized ourselves into obsolescence?

Are we in danger of losing the “race against the machine,” as the M.I.T. scholars [Erik Brynjolfsson](#) and [Andrew McAfee](#) argue in a recent book? Are we becoming enslaved to our “[robot overlords](#),” as the journalist Kevin Drum warned in *Mother Jones*? Do “smart machines” threaten us with “long-term misery,” as the economists Jeffrey D. Sachs and Laurence J. Kotlikoff [prophesied](#) earlier this year? Have we reached “the end of labor,” as Noah Smith [laments](#) in *The Atlantic*?

Of course, anxiety, and even hysteria, about the adverse effects of technological change on employment have a venerable history. In the early 19th century a group of English textile artisans calling themselves the Luddites staged a machine-trashing rebellion. Their brashness earned them a place (rarely positive) in the lexicon, but they had legitimate reasons for concern.

Economists have historically rejected what we call the “lump of labor” fallacy: the supposition that an increase in labor productivity inevitably reduces employment because there is only a finite amount of work to do. While intuitively appealing, this idea is demonstrably false. In 1900, for example, 41 percent of the United States work force was in agriculture. By 2000, that share had fallen to 2 percent, after the Green Revolution transformed crop yields. But the employment-to-population ratio rose over the 20th century as women moved from home to market, and the unemployment rate fluctuated cyclically, with no long-term increase.

Labor-saving technological change necessarily displaces workers performing certain tasks — that’s where the gains in productivity come from — but over the long run, it generates new products and services that raise national income and increase the overall demand for labor. In 1900, no one could foresee that a century later, health care, finance, information technology, consumer electronics, hospitality, leisure and entertainment would employ far more workers than agriculture. Of course, as societies grow more prosperous, citizens often choose to work shorter days, take longer vacations and retire earlier — but that too is progress.

So if technological advances don’t threaten employment, does that mean workers have nothing to fear from “smart machines”? Actually, no — and here’s where the Luddites had a point. Although many 19th-century Britons benefited from the introduction of newer and better automated looms — unskilled laborers were hired as loom operators, and a growing middle class could now afford mass-produced fabrics — it’s unlikely that skilled textile workers benefited on the whole.

Fast-forward to the present. The multi-trillionfold decline in the cost of computing since the 1970s has created enormous incentives for employers to substitute increasingly cheap and capable computers for expensive labor. These rapid advances — which confront us daily as we check in at airports, order books online, pay bills on our banks’ Web sites or consult our smartphones for driving directions — have reawakened fears that workers will be displaced by machinery. Will this time be different?

A starting point for discussion is the observation that although computers are ubiquitous, they cannot do everything. A computer’s ability to accomplish a task quickly and cheaply depends upon a human programmer’s ability to write procedures or rules that direct the machine to take the correct steps at each contingency. Computers excel at “routine” tasks: organizing, storing, retrieving and manipulating information, or executing exactly defined physical movements in production processes. These tasks are most pervasive in middle-skill jobs like bookkeeping, clerical work and repetitive production and quality-assurance jobs.

Logically, computerization has reduced the demand for these jobs, but it has boosted demand for workers who perform “nonroutine” tasks that complement the automated activities. Those tasks happen to lie on opposite ends of the occupational skill distribution.

At one end are so-called abstract tasks that require problem-solving, intuition, persuasion and creativity. These tasks are characteristic of professional, managerial, technical and creative occupations, like law, medicine, science, engineering, advertising and design. People in these jobs typically have high levels of education and analytical capability, and they benefit from computers that facilitate the transmission, organization

and processing of information.

On the other end are so-called manual tasks, which require situational adaptability, visual and language recognition, and in-person interaction. Preparing a meal, driving a truck through city traffic or cleaning a hotel room present mind-bogglingly complex challenges for computers. But they are straightforward for humans, requiring primarily innate abilities like dexterity, sightedness and language recognition, as well as modest training. These workers can't be replaced by robots, but their skills are not scarce, so they usually make low wages.

Computerization has therefore fostered a polarization of employment, with job growth concentrated in both the highest- and lowest-paid occupations, while jobs in the middle have declined. Surprisingly, overall employment rates have largely been unaffected in states and cities undergoing this rapid polarization. Rather, as employment in routine jobs has ebbed, employment has risen both in high-wage managerial, professional and technical occupations and in low-wage, in-person service occupations.

So computerization is not reducing the quantity of jobs, but rather degrading the quality of jobs for a significant subset of workers. Demand for highly educated workers who excel in abstract tasks is robust, but the middle of the labor market, where the routine task-intensive jobs lie, is sagging. Workers without college education therefore concentrate in manual task-intensive jobs — like food services, cleaning and security — which are numerous but offer low wages, precarious job security and few prospects for upward mobility. This bifurcation of job opportunities has contributed to the historic rise in income inequality.

HOW can we help workers ride the wave of technological change rather than be swamped by it? One common recommendation is that citizens should invest more in their education. Spurred by growing demand for workers performing abstract job tasks, the payoff for college and professional degrees has soared; despite its formidable price tag, higher education has perhaps never been a better investment. But it is far from a comprehensive solution to our labor market problems. Not all high school graduates — let alone displaced mid- and late-career workers — are academically or temperamentally prepared to pursue a four-year college degree. Only 40 percent of Americans enroll in a four-year college after graduating from high school, and more than 30 percent of those who enroll do not complete the degree within eight years.

The good news, however, is that middle-education, middle-wage jobs are not slated to disappear completely. While many middle-skill jobs are susceptible to automation, others demand a mixture of tasks that take advantage of human flexibility. To take one prominent example, medical paraprofessional jobs — radiology technician, phlebotomist, nurse technician — are a rapidly growing category of relatively well-paid, middle-skill

occupations. While these paraprofessions do not typically require a four-year college degree, they do demand some postsecondary vocational training.

These middle-skill jobs will persist, and potentially grow, because they involve tasks that cannot readily be unbundled without a substantial drop in quality. Consider, for example, the frustration of calling a software firm for technical support, only to discover that the technician knows nothing more than the standard answers shown on his or her computer screen — that is, the technician is a mouthpiece reading from a script, not a problem-solver. This is not generally a productive form of work organization because it fails to harness the complementarities between technical and interpersonal skills. Simply put, the quality of a service within any occupation will improve when a worker combines routine (technical) and nonroutine (flexible) tasks.

Following this logic, we predict that the middle-skill jobs that survive will combine routine technical tasks with abstract and manual tasks in which workers have a comparative advantage — interpersonal interaction, adaptability and problem-solving. Along with medical paraprofessionals, this category includes numerous jobs for people in the skilled trades and repair: plumbers; builders; electricians; heating, ventilation and air-conditioning installers; automotive technicians; customer-service representatives; and even clerical workers who are required to do more than type and file. Indeed, even as formerly middle-skill occupations are being “deskilled,” or stripped of their routine technical tasks (brokering stocks, for example), other formerly high-end occupations are becoming accessible to workers with less esoteric technical mastery (for example, the work of the nurse practitioner, who increasingly diagnoses illness and prescribes drugs in lieu of a physician). Lawrence F. Katz, a labor economist at Harvard, memorably called those who fruitfully combine the foundational skills of a high school education with specific vocational skills the “new artisans.”

The outlook for workers who haven’t finished college is uncertain, but not devoid of hope. There will be job opportunities in middle-skill jobs, but not in the traditional blue-collar production and white-collar office jobs of the past. Rather, we expect to see growing employment among the ranks of the “new artisans”: licensed practical nurses and medical assistants; teachers, tutors and learning guides at all educational levels; kitchen designers, construction supervisors and skilled tradespeople of every variety; expert repair and support technicians; and the many people who offer personal training and assistance, like physical therapists, personal trainers, coaches and guides. These workers will adeptly combine technical skills with interpersonal interaction, flexibility and adaptability to offer services that are uniquely human.

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