



International
Labour
Office
Geneva

Bureau
international
du Travail
Genève

Oficina
Internacional
del Trabajo
Ginebra



ACT/EMP

Technology Anxiety Past and Present

David Autor, David Dorn

5-6
December
Décembre
Diciembre
2013

Geneva
Genève
Ginebra

International Symposium for Employers on
THE FUTURE OF WORK

Symposium international des employeurs sur
L'AVENIR DU TRAVAIL

Coloquio internacional de empleadores sobre
EL FUTURO DEL TRABAJO

www.ilo.org/employersymposium

Technology Anxiety Past and Present

Written by: David Autor
David Dorn

Bureau for Employers' Activities, International Labour Office
2013

Copyright © International Labour Organization 2013
First published 2013

Publications of the International Labour Office enjoy copyright under Protocol 2 of the Universal Copyright Convention. Nevertheless, short excerpts from them may be reproduced without authorization, on condition that the source is indicated. For rights of reproduction or translation, application should be made to ILO Publications (Rights and Permissions), International Labour Office, CH-1211 Geneva 22, Switzerland, or by email: pubdroit@ilo.org. The International Labour Office welcomes such applications.

Libraries, institutions and other users registered with reproduction rights organizations may make copies in accordance with the licences issued to them for this purpose. Visit www.ifrro.org to find the reproduction rights organization in your country.

An abridged version of this essay appeared in the New York Times on Saturday, August 24, 2013.

ILO Cataloguing in Publication Data

Autor, David and Dorn, David

Technology anxiety past and present : ILO International Symposium on the Future of Work, 5-6 December 2013, Geneva, Switzerland / David Autor and David Dorn ; International Labour Office, Bureau for Employers' Activities (ACT/EMP).- Geneva: ILO, 2013

ISBN 9789221281795; 9789221281801 (web pdf)

International Labour Office and Bureau for Employers' Activities; ILO International Symposium on the Future of Work (2013, Geneva, Switzerland)

future of work / technological change / work organization

13.01.1 Also available in (French): *Technologie, anxiété, passé et présent* (ISBN 978-92-2-228179-4)

Geneva, 2013, in Spanish: *Inquietud y tecnología, pasado y presente* (ISBN 978-92-2-328179-3), Geneva, 2013.

ILO Cataloguing in Publication Data

The designations employed in ILO publications, which are in conformity with United Nations practice, and the presentation of material therein do not imply the expression of any opinion whatsoever on the part of the International Labour Office concerning the legal status of any country, area or territory or of its authorities, or concerning the delimitation of its frontiers.

The responsibility for opinions expressed in signed articles, studies and other contributions rests solely with their authors, and publication does not constitute an endorsement by the International Labour Office of the opinions expressed in them.

Reference to names of firms and commercial products and processes does not imply their endorsement by the International Labour Office, and any failure to mention a particular firm, commercial product or process is not a sign of disapproval.

ILO publications and electronic products can be obtained through major booksellers or ILO local offices in many countries, or direct from ILO Publications, International Labour Office, CH-1211 Geneva 22, Switzerland. Catalogues or lists of new publications are available free of charge from the above address, or by email: pubvente@ilo.org

Visit our website: www.ilo.org/publns

Printed in Switzerland

Technology Anxiety Past and Present

David Autor and David Dorn¹

12 October 2013

In the four years since the official “end” of the Great Recession, U.S. productivity has risen smartly. Yet U.S. employment remains two million jobs shy of its pre-recession count, the unemployment rate hovers near a two-decade high, and the fraction of adults working is four percentage points off its year 2000 high water mark. This ongoing employment drought has spurred many economists and popular commentators to wonder aloud if a more profound employment malady has overtaken us. And from there, it’s only a short leap to ask whether that malady is not productivity itself. Have we mechanized and computerized ourselves into obsolescence? Are we in danger of losing the “race against the machine” as MIT economists Erik Brynjolfsson and Andrew McAfee argue in a recent book? Is the slack labour market of 2013 one of the “five horsemen of the robotic apocalypse,” as Kevin Drum warns recently in *Mother Jones* magazine? And do “smart machines” threaten our children with “long-term misery,” as concludes a recent working paper by economists Jeffrey Sachs and Laurence J. Kotlikoff? Have we reached “the end of labour,” as Noah Smith laments in *The Atlantic*?

While no one can be certain of what robotic marvels lie ahead, one certainty is that public anxiety about the adverse effects of technological change on employment has a venerable history. In the early 19th century, a group of English textile artisans known as Luddites staged a machine-smashing rebellion in which they destroyed automated looms that would, they feared, reduce demand for their skills. The Luddites’ brashness earned them a place in the lexicon: in common parlance, a Luddite is someone who fears or opposes new technology—and the connotation is rarely positive. But the Luddites had legitimate reasons for concern, as we explain below.

Economists as a rule are not Luddites. Indeed, economic commentators have laboured over many decades to allay the fear that technological advances reduce overall employment as machines displace workers. Economists typically refer to this concern as the ‘lump of labour fallacy’—the supposition that an increase in labour productivity inevitably reduces employment. The flaw in this chain of logic is the presumption that there is a finite amount of work to do. While intuitively appealing, this idea is

¹ David Autor is Professor of Economics and Associate Head at MIT, Department of Economics. David Dorn is Associate Professor of Economics at CEMFI Madrid.

demonstrably false. In 1900, for example, 41 per cent of the U.S. workforce was employed in agriculture. After a century of astonishing agricultural productivity growth, that employment share stood at two per cent in 2000. The Green Revolution transformed demands for physical and cognitive skill and the very fabric of American life. But it did not reduce total employment. Rather, 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 trend increase.

Labour saving technological change necessarily displaces workers in accomplishing specific job tasks, which is where the productivity gains come from, but in the long run, these same advances generate new products and services that raise national income and increase overall demand for labour in the economy. It would have been almost inconceivable for a farmer in 1900 to foresee that one century later, healthcare, finance, information technology, consumer electronics, hospitality, leisure, and entertainment would employ far more workers than agriculture. But successive waves of technological change have yielded both job destruction and job creation, with the net effect being greater societal wealth and no shortage of employment. 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 are not a threat to employment, does that mean that workers have nothing to fear from “smart machines?” Actually, no, and that is where the Luddites had a point. As technological advances shift labour demand from old to new activities, some workers win and others lose. For example, many 19th century Britons benefited from the introduction of newer and better automated looms, with unskilled labourers being hired as loom operators, and British consumers were could now afford mass-produced fabrics, but it is unlikely that skilled textile workers were better off in net terms. Quite simply, advances in automation made their specialized skills less scarce and thus less valuable. This is not quite the robotic apocalypse, but it is certainly a real cost.

Fast forward to the present. The multitrillion-fold decline in the cost of computing since the 1970s has created enormous economic incentives for employers to substitute increasingly cheap and capable computers for expensive labour. These rapid advances, which confront us daily as we check in at the airport, order books online, pay bills at our bank’s website, or consult our smartphone for driving directions, have reawakened fears that workers will be displaced by machinery. These fears naturally resonate when unemployment is high and job growth low. Will this time be different?

A starting point for discussion is the observation that although computers are now ubiquitous, they cannot do everything. A computer's ability to quickly and cheaply accomplish a task depends upon a human programmer's ability to write procedures or rules that direct the machine to take the correct steps at each contingency. We refer to the procedural, rule-based activities at which computers currently excel as "routine" tasks. These tasks typically involve organizing, storing, retrieving, and manipulating information, or executing exactly defined physical movements in production processes. Measures of job task content uniformly find that routine tasks are most pervasive in middle-skill jobs such as bookkeeping, clerical work, and repetitive production and monitoring jobs.

Logically, computerization has reduced the demand for workers in routine task-intensive jobs. But, as per the Green Revolution example, this does not imply that overall demand for labour has declined. As computers have taken over our routine tasks, they have boosted demand for workers who perform "non-routine" tasks that are complementary to the automated activities. What are these "non-routine" tasks? They can be roughly divided into two major categories that happen to lie on opposite ends of the occupational skill distribution.

On one side are so-called "abstract" tasks, which require problem-solving, intuition, persuasion, and creativity. These tasks are characteristic of professional, managerial, technical and creative occupations, such as law, medicine, science, engineering, marketing and design. Workers who are most adept in these tasks 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 side of the occupational skill spectrum are so-called "manual" tasks, which require situational adaptability, visual and language recognition, and in-person interaction. Tasks like preparing a meal, balancing a serving tray through a crowd of moving people, or cleaning a hotel room present mind-bogglingly complex challenges for software engineering. But from the human perspective, these manual tasks are straightforward, requiring primarily innate abilities like dexterity, keen eyesight, language recognition and perhaps a modest amount of training. The good news for workers is that people can do these tasks while robots cannot, and probably not for many years to come. The bad news is that the skills required to accomplish these tasks are not scarce, meaning that manual task-intensive jobs usually pay low wages. Over the last thirty years, rapid computerization has fostered a polarization of employment, with job growth concentrated in both the

highest and lowest paid occupations—those that specialize in either “abstract” or “manual” tasks—while middle-wage “routine” occupations have declined. Job polarization is observed both at the national level in the U.S., in most countries of Western Europe, and at the regional level within the U.S. Our research shows that U.S. cities like Dallas, San Francisco and Chicago, which historically specialized in industries that strongly relied on routine occupations, computerized more rapidly over the last three decades and simultaneously experienced stronger employment polarization than regions with little routine employment such as Pittsburgh, San Antonio and Palm Beach. Rapidly polarizing regions experienced particularly large declines in middle-wage clerical and production occupations. Yet surprisingly, overall employment rates in these regions have been largely unaffected. Rising employment in high-wage managerial, professional and technical occupations and in low-wage in-person service occupations has compensated for the loss of routine jobs.

So computerization is not reducing the quantity of jobs, but it is 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 labour market—where the routine task-intensive jobs lie—is sagging. Workers without college education therefore concentrate in manual task-intensive jobs—like food service, cleaning, and security—which are numerous but offer low wages. This bifurcation of job opportunities contributes to a historic rise in earnings inequality. The good fortune of highly educated workers contrast with the experience of middle-skill workers, whose primary job tasks can increasingly be substituted by ever-cheaper computer hardware. Akin to the 19th century weavers who fought to halt the wave of technological change overtaking their industry, contemporary workers who previously worked in routine task-intensive jobs may face diminished employment security, earnings growth, and upward mobility.

How can we assist workers to ride the wave of technological change rather than being swamped by it? One facile policy recommendation that economists like to offer is that citizens should invest in higher 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, college education has perhaps never been a better investment. Yet, college education is far from a comprehensive solution to our labour market problems. Not all U.S. high school graduates, let alone displaced mid-career workers, are academically or temperamentally prepared to pursue a four-year college degree. Only 40 per cent of Americans enrol in a four-year college after graduating from high school, and more than 30 per cent of those who enrol 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, at least as we read the evidence. While many middle-skill jobs are susceptible to automation, others demand a mixture of tasks that puts humans at an advantage over machines. To take one prominent example, medical paraprofessional positions, radiology technicians, phlebotomists, nurse technicians, are a numerically significant and rapidly growing category of relatively well-paid, middle-skill occupations. While paraprofessionals do not typically require a four-year college degree, they do demand one to two years of post-secondary vocational training.

These middle-skill jobs will persist, and potentially grow, because they involve tasks that cannot readily be unbundled, with machines performing the routine tasks and workers performing the residual, without a substantial drop in quality. Consider, for example, the commonplace frustration of calling a software firm for technical support only to discover that the support technician knows nothing more than the standard answers shown on his or her computer screen, that is, the technician is a mouthpiece, not a problem-solver. This example captures one feasible division of labour: machines performing routine technical tasks, such as looking up known issues in a support database, and workers performing the non-routine task of making polite conversation while reading aloud from a script. But this is not generally a productive form of work organization because it fails to harness the complementarities between technical and interpersonal skills. Stated in positive terms, routine and non-routine tasks will generally coexist within an occupation to the degree that they are complements, that is, the quality of the service improves when the worker combines technical expertise and human flexibility.

This reasoning suggests that many of the middle-skill jobs that persist in the future will combine routine technical tasks with the set of abstract and manual tasks in which workers hold comparative advantage: interpersonal interaction, flexibility, adaptability and problem-solving. Medical paraprofessionals are one example of this virtuous combination, but this broad description also fits numerous skilled trade and repair occupations: plumbers, builders, electricians, HVAC installers, automotive technicians, marketing occupations, and even modern clerical occupations that provide coordination and decision-making functions rather than simply typing and filing. Indeed, even as some formerly middle-skill occupations are being “deskilled,” or stripped of their routine technical tasks, for example, stockbrokers, other formerly high-end technical occupations are made accessible to workers with less esoteric

technical mastery, for example, the nurse practitioner occupation that increasingly performs diagnostic and prescribing tasks instead of physicians. Lawrence Katz of Harvard University memorably titles these workers who fruitfully combine the foundational skills of a high school education with specific vocational skills as the “new artisans.”

In a nutshell, the outlook for workers who have not 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 a myriad of personal training and assistance occupations such as physical therapists, personal trainers, coaches and guides. These workers will adeptly combine technical skills, often gained in postsecondary vocational training, with interpersonal interaction, flexibility and adaptability to offer services that are uniquely human.