



Work Organization and Psychosocial Trends Related to Advanced Technology and Robotics

Naomi Swanson, Ph.D.
Senior Science Advisor
Division of Science Integration
NIOSH

January 23, 2020

“4th Industrial Revolution” is Transforming the Workplace

- “Innovative Society”
 - Work characterized by innovation, creativity, research, development
 - Routine knowledge work will be automated
- Organizations will take new forms
 - Increasingly distributed work as technology develops
 - Increased outsourcing, off-shoring, new partnering models, platforms
 - Greater use of consultants and contractors
 - Outsourcing of non-core tasks
 - Renting, not owning, facilities

“4th Industrial Revolution” is Transforming the Workplace

- The rapid pace of change and technological development will result in a “network society”
 - Organizational barriers eroded
 - Flatter, more open and agile organizational structures
 - Uncoupling of paid work from traditional office space
 - Online work
 - Non-routine work
 - Integrating expertise through networking

Old and New Health and Safety Risks

- Increased on-line work in non-office environments can create increased ergonomic and psychosocial risks
 - Isolation, stress, information overload, burnout
 - Blurring of work-life boundaries
 - Tendency toward longer working hours
 - Work intensification
- Risks associated with new human-machine interfaces
- Cybersecurity risks as interconnectedness increases
- Significant changes to work arrangements

New Health and Safety Risks – Work Arrangements

- Growth in non-standard work arrangements
 - Shorter contract duration and less job security
 - Irregular working hours
 - Increased use of third parties such as temporary agencies
 - Various forms of dependent self-employment (subcontracting)
 - Informal work arrangements that purposely exist outside regulatory framework

H&S Effects of Nonstandard Work Arrangements

- Temporary employment is linked to injuries, and poor physical and mental health
- Job insecurity:
 - Increases vulnerability to bullying and harassment which is associated with depression and suicide
 - Linked with adverse mental and physical outcomes
 - Often co-existing low pay encourages excessive hours of work or working multiple jobs
 - Associated with fatigue-related hazards and health problems associated with poor nutrition and accommodation.

Other Concerns

- OSH regulations are based on employer-employee relationships and may not cover some non-standard work arrangements
- Will need new ways of ensuring worker well-being with growing number of freelance and contingent workers
- Social implications of working with AI systems as much as with other human workers
- Aging of the workforce
- Need to support workers across a wide range of “work” settings and geographies/time zones
- Need for continuous reskilling and up-skilling, but educational systems haven’t kept pace with changing nature of work

What Work Skills Are Needed For the Future?

- Sense-Making
- Social Intelligence
- Novel and Adaptive Thinking
- Cross-Cultural Competency
- Computational Thinking
- New-Media Literacy
- Transdisciplinarity
- Design Mindset
- Cognitive Load Management
- Virtual Collaboration

Robots and Automation: Impact on Jobs



Machines and Humans: A Long-Time Partnership

- Humans have used machines for hundreds of years
- The industrial revolution represented a major breakthrough in the use of machines and machinery
- Today's technological landscape involves smart machines and processes
 - Machinery and equipment can be installed anywhere
 - Robots will be human assistants and, eventually, co-workers.



Do Robots/Automation Herald the End of Work?

The Coming Robot Dystopia

All Too Inhuman

Ullah Reza Nourbakhsh

The term “robotics revolution” evokes images of the future: a not-too-distant future, perhaps, but an era surely distinct from the present. In fact, that revolution is already well under way. Today, military robots appear on battlefields, drones fill the skies, driverless cars take to the roads, and “telepresence robots” allow people to manifest themselves halfway around the world from their actual location. But the exciting, even seductive appeal

data fantasies contain a seed of truth: the robotic future will involve dramatic tradeoffs, some so significant that they could lead to a collective identity crisis over what it means to be human.

This is a familiar warning when it comes to technological innovations of all kinds. But there is a crucial distinction between what’s happening now and the last great breakthrough in robotic technology, when manufacturing automations began to appear on factory floors during the late twentieth century. Back then, clear boundaries separated industrial robots from humans: protective fences isolated robot workspaces, ensuring minimal contact between man and machine and humans and robots performed wholly distinct tasks without interaction.

Such barriers have been breached not only in the workplace but also in the wider society: robots now share the formerly human-only commons.

Will Humans Go the Way of Horses?

Labor in the Second Machine Age

Erik Brynjolfsson and Andrew McAfee

The debate over what technology does to work, jobs, and wages is as old as the industrial era itself. In the second decade of the nineteenth century, a group of English textile workers called the Luddites

necessary feature of capitalism. In 1930, after electrification and the internal combustion engine had taken off, John Maynard Keynes predicted that such innovations would lead to an increase in material prosperity but also to widespread “technological unemployment.” At the dawn of the computer era, in 1964, a group of scientists and social theorists sent an open letter to U.S. President Lyndon Johnson warning that cybernation “results in a system of almost unlimited productive capacity, which requires progressively less human labor.” Recently, we and others have argued that as digital technologies race ahead, they have the potential to leave many workers behind.

On the other side are those who say that workers will be just fine. They have history on their side: real wages and the

What Impact Will Automation Have on Jobs?

- Differing estimates of the impact of automation on jobs
 - 9% to 50% of jobs replaced by automation
- Three potential types of impact:
 - Humans will be replaced in a large number of jobs
 - Automation will shift the types of jobs done by humans or transform jobs, but won't replace many jobs
 - A net increase in jobs because of the increased productivity and innovation from technological change.

Projected Impact of Technology on Jobs

- Frey and Osborne (2013)
 - Focused on potential for technological substitution and automation by occupation
 - Used task descriptions from O*NET and reviews of potential for automating different tasks from panel of experts
 - For over 700 detailed U.S. occupations
 - Conclude that 47% of U.S. jobs at high risk of automation within 10-20 years
 - Low wage occupations and occupations requiring less education are particularly at risk

Projected Impact of Technology on Jobs

- Arntz, Gregory, and Zierahn (2016)
 - Focus on worker reports of tasks perform in their jobs
 - Estimate that 9% of U.S. jobs at risk of automation
- McKinsey Institute (2017, 2018)
 - Focus on complexity of tasks within occupations (7 tasks groups)
 - Three tasks groups have high potential for automation
 - Predictable physical work (81% risk)
 - Data processing (69% risk)
 - Data collection (64% risk)

Projected Impact of Technology on Jobs

- McKinsey Institute (cont.)
 - Four tasks groups have much lower automation potential
 - Unpredictable physical work (26% risk)
 - Personal interactions (20% risk)
 - Decision making, planning, creative tasks (18% risk)
 - Managing and developing people (7% risk)

Projected Impact of Technology on Jobs

- U.S. Bureau of Labor Statistics (2017)
 - Projections of future labor force participation by occupation between 2016 and 2026
 - Few occupations with job loss
 - Overall employment growth of 11.5 million jobs
 - Technological change and employment growth are not incompatible

Other Factors Affecting Automation

- Economic factors
 - Automation typically reduces prices of products/services
 - May increase demand and need for labor
 - May create shift to alternative goods and services and need for labor
 - Automation of routine tasks may free up workers to focus on non-routine, creative aspects of jobs

Other Factors Affecting Automation

- Costs of technology
 - Low wage jobs at greatest risk of automation
 - But, low wages may slow speed of automation
 - Cost of labor compared with cost of technology
- Labor market
 - New technologies require a skilled workforce
 - Skill gaps and shortages can slow adoption of automation
- Regulatory and social acceptability
- Demographic changes

Automation Benefits for Workers

- Robots and other technologies can
 - Create opportunities for entirely new tasks (e.g., piloting drones)
 - Do tasks and activities that cannot be done by humans
 - Analyzing “big data”
 - Can perform in unhealthy or dangerous environments or perform dangerous manual tasks



Automation Benefits for Workers

- Enhance human capabilities
 - Exoskeletons
 - Assistive devices for people with disabilities



techcrunch.com

AI-enabled assistant robot returning to the Space Station with improved emotional intelligence

Darrell Etherington

@etherington / 8 hours ago



Concluding Thoughts

- Automation is occurring at an increasing pace and will impact nearly all occupations
- The risk of job replacement is greatest for jobs that are highly routine and amenable to automation
- Automation will cause jobs to change
 - Higher demand for more educated workers
 - Creative, decision-making, and interpersonal skills will be emphasized
 - New specialist roles (e.g., big data, AI, and machine learning specialists, robotics engineers)
- There will be a need for “lifelong learning,” reskilling and upskilling

Addendum: Impact of Robots on Workers and Wages

- Impact of robots between 2009 and 2017
- Little evidence that growth in robots leading to widespread job displacement – but differing regional and industry impacts
- Greatest number of robots in manufacturing industries in Midwest
- Overall robot impact on employment and wages
 - Employment and wage increases for certain employees and no impact on others
- Robot impact in Midwest in manufacturing
 - Sizeable decrease in employment and wages for certain employees
 - Strong economy masked effects of robots on employment

Thank You! Questions?

Contact Information:

Naomi Swanson

513-533-8165

nswanson@cdc.gov

For more information, contact CDC
1-800-CDC-INFO (232-4636)
TTY: 1-888-232-6348 www.cdc.gov

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

