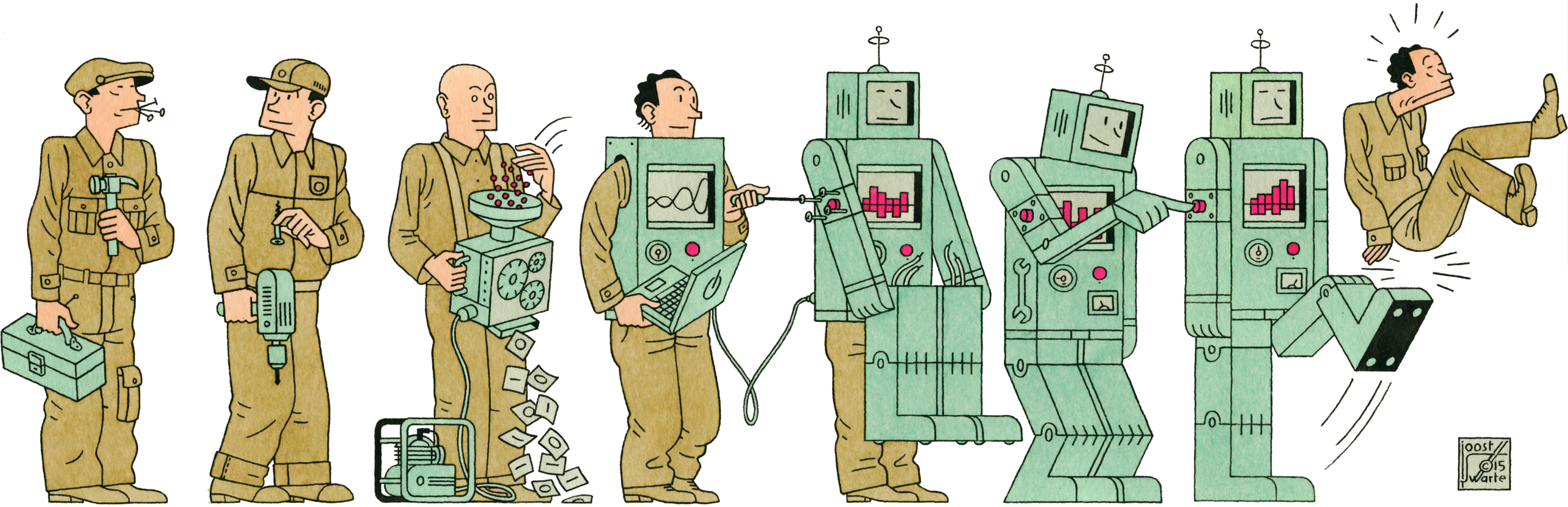
Expertise, Artificial Intelligence, and the Work of the Future



David Autor, Ford Professor of Economics

MIT Economics and Shaping the Future of Work Initiative

ABFER 11th Annual Conference, Singapore. 23 May 2024

The year is 2021…

The year is 2021…

Young woman weaving a rug in India **2021**
© Rang Bandhej Retail Pvt. Ltd.

Cobalt mining, Democratic Republic of Congo, **2021**
© NY Times

“It’s 2034 and Transformative AI enables machines to do virtually all of the tasks humans currently do”

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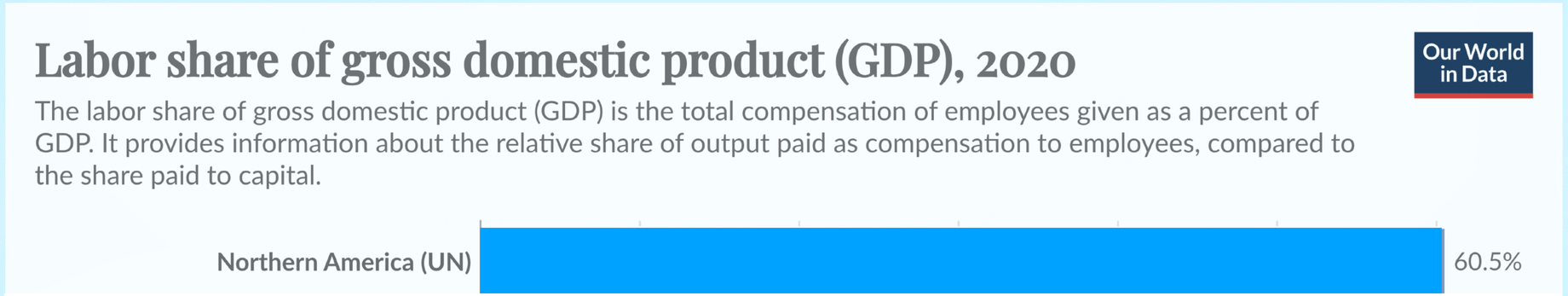
Labor's share of GDP is highest in industrialized countries



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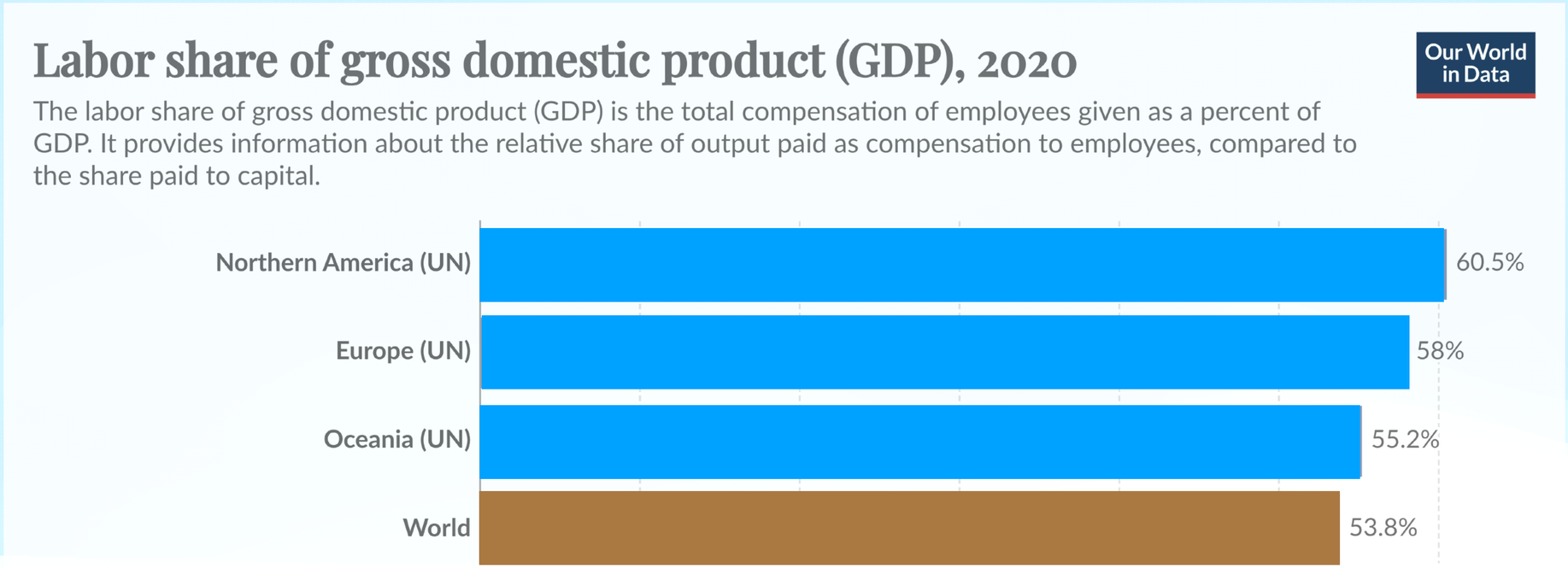

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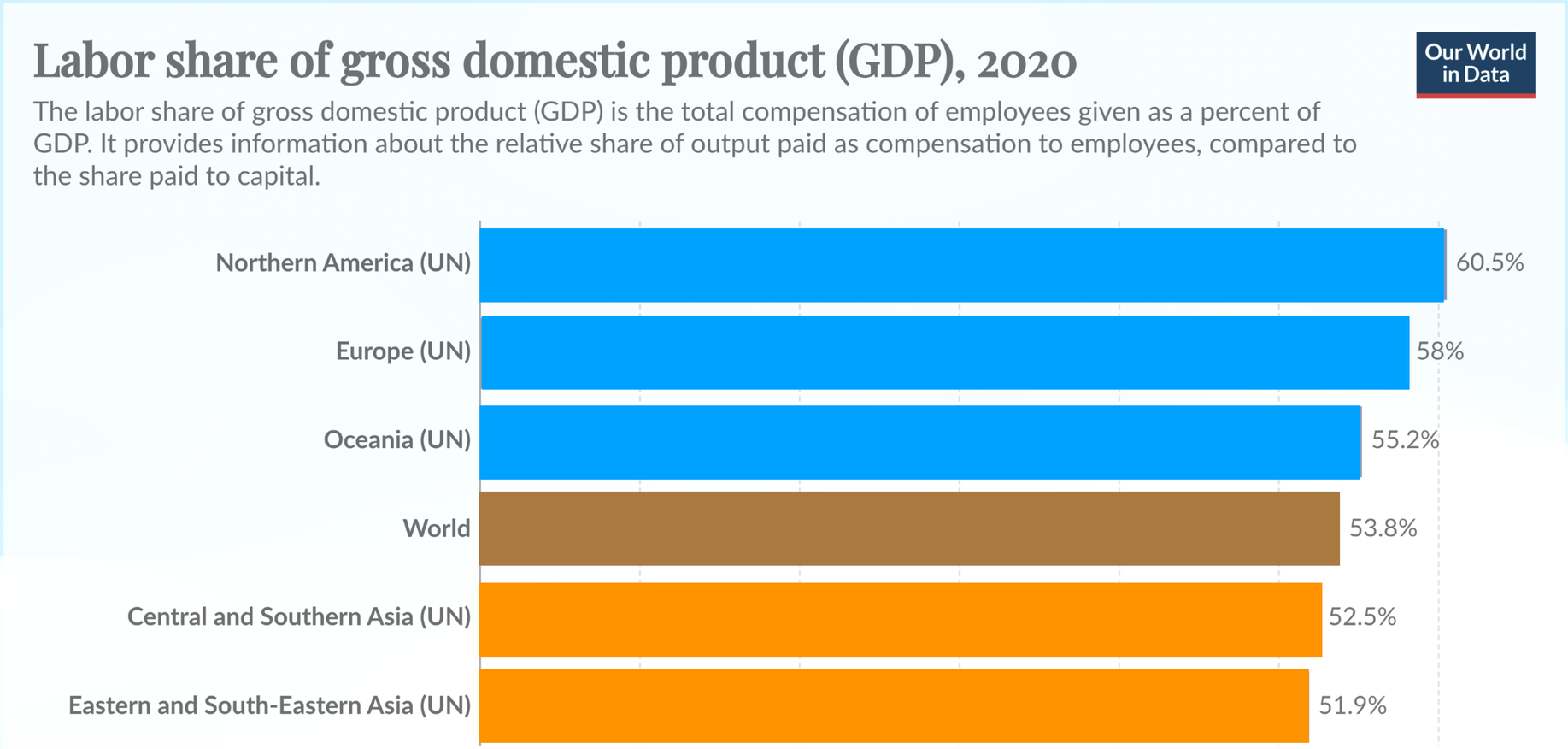
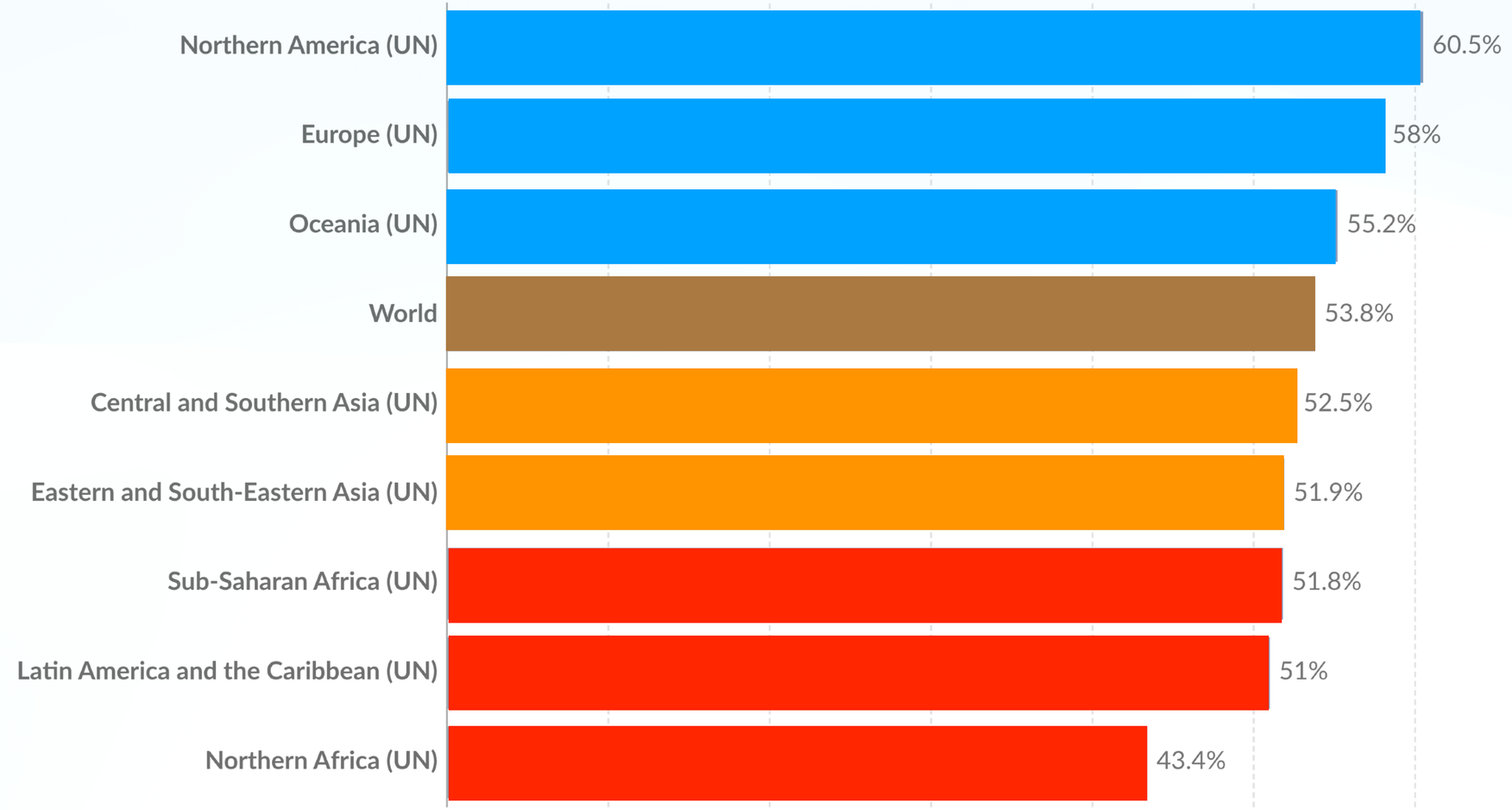


Labor's share of GDP is highest in industrialized countries

Labor share of gross domestic product (GDP), 2020

Our World in Data

The labor share of gross domestic product (GDP) is the total compensation of employees given as a percent of GDP. It provides information about the relative share of output paid as compensation to employees, compared to the share paid to capital.



Data source: UN Statistics Division

OurWorldInData.org/trade-and-globalization | CC BY

Expertise is what makes labor valuable in industrialized economies

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- *Definition*: Expertise is domain-specific knowledge or competency that's needed to accomplish a particular goal

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- For expertise to command a substantial market wage
  i. The goal it enables must have market value
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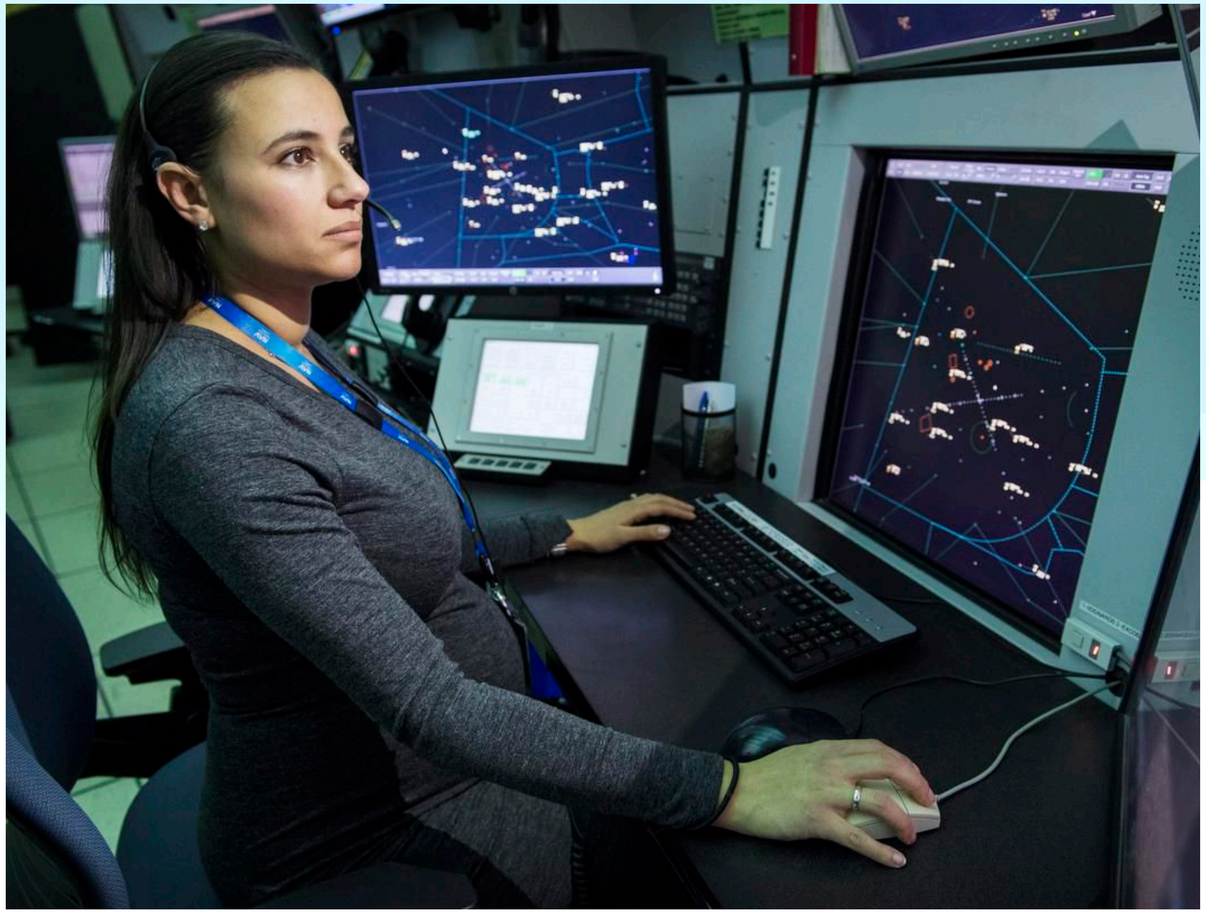
- For expertise to command a substantial market wage
  i. The goal it enables must have market value
  ii. The expertise must be scarce
- Why should we care?

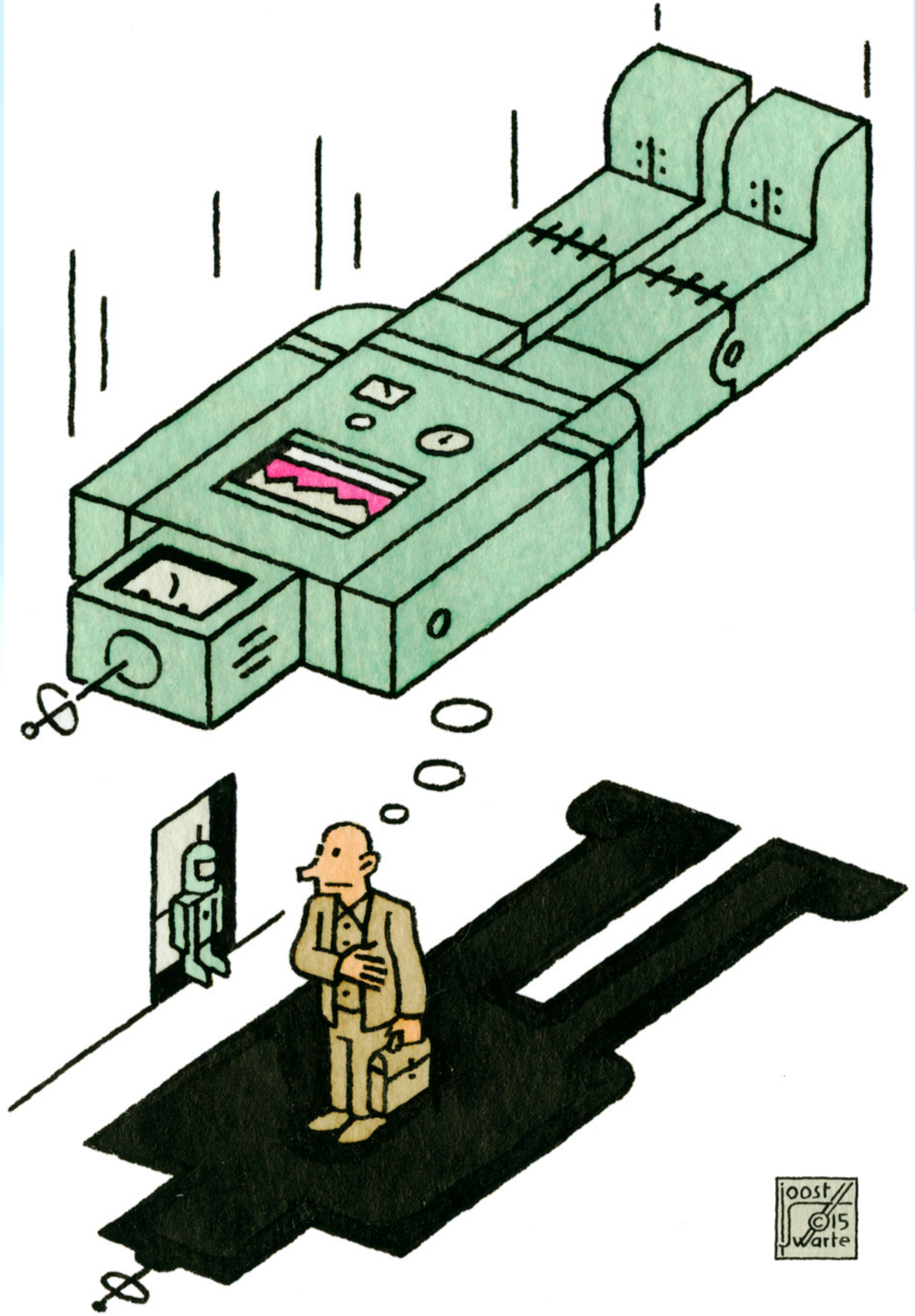
Non-expert work pays poorly

Crossing Guard
Median annual earnings $31,450

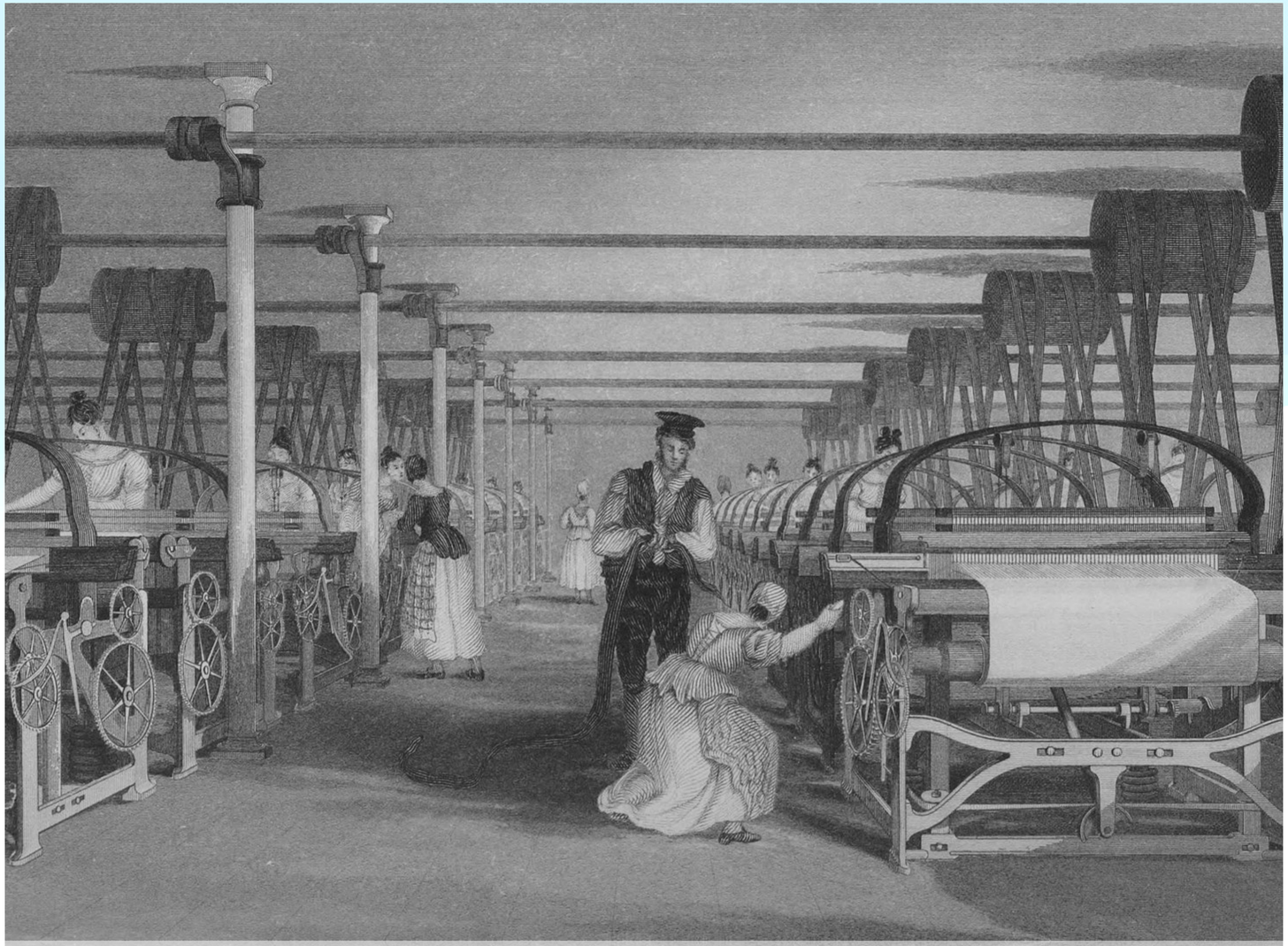


Air Traffic Controller
Median annual earnings $129,750

The Birth of Mass Expertise During the Industrial Revolution



The 1st and 2nd Industrial Revolutions, 1760–1914

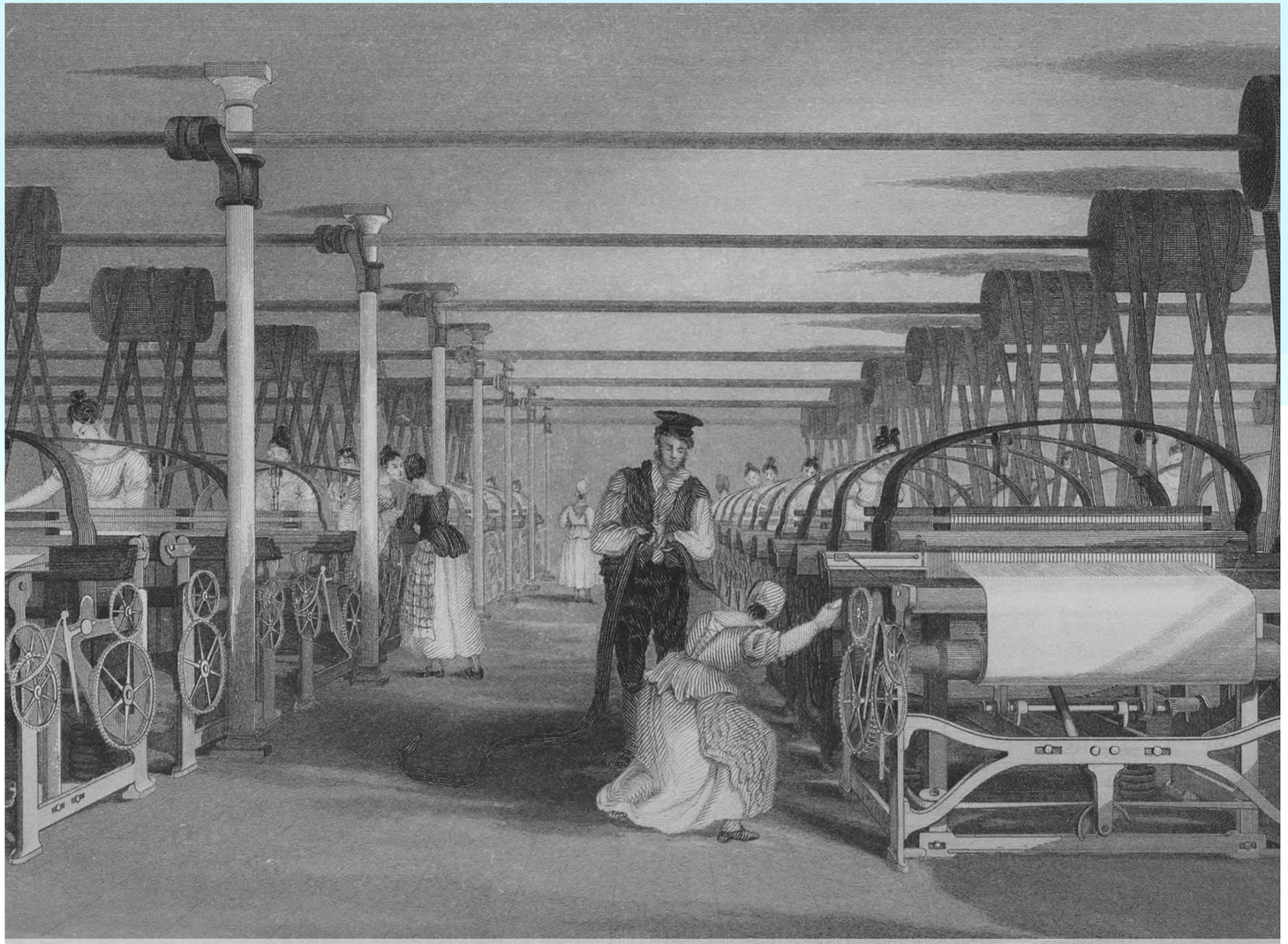


Illustrator T. Allom, Engraver J. Tingle
Public Domain, 1835

The 1st and 2nd Industrial Revolutions, 1760–1914

Advent of mass production

- **Displaced *Artisanal expertise***



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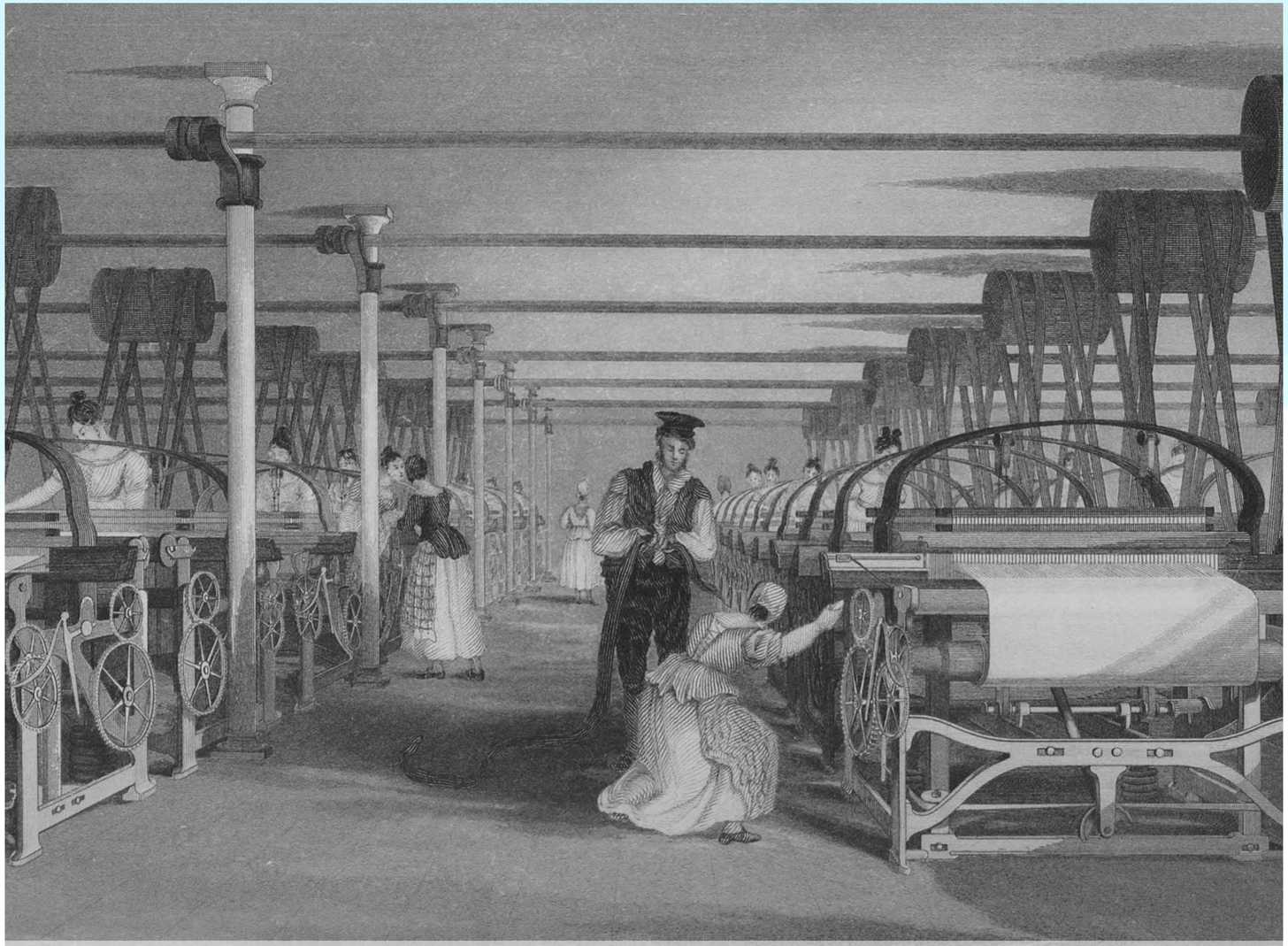

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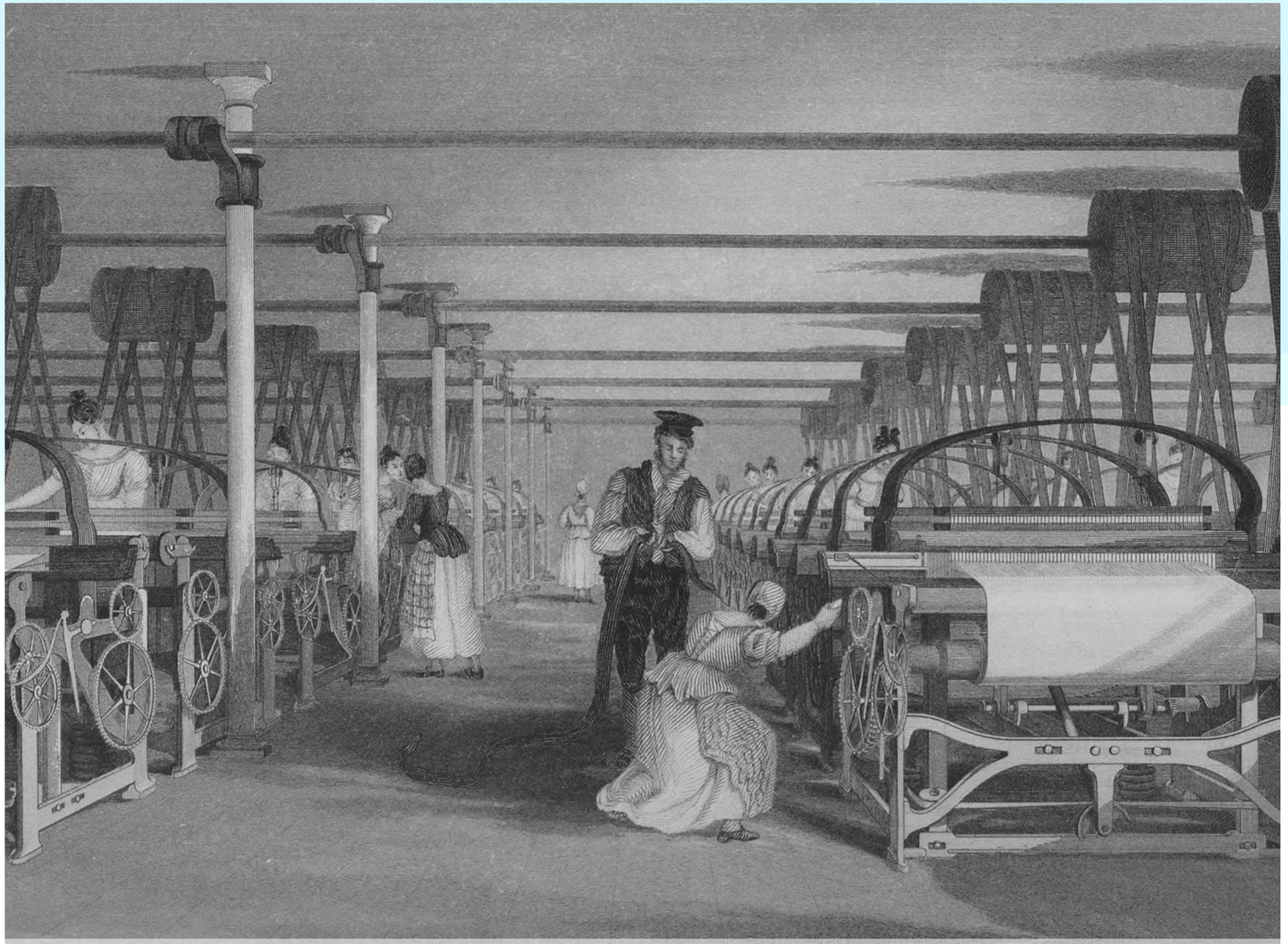
The 1st and 2nd Industrial Revolutions, 1760–1914

Advent of mass production

- **Displaced *Artisanal expertise***
- **Mass production — Machines + managers + untrained low-paid workers**
- **Ultimately, mass production required: Mass expertise — mastering tools, following rules**



Illustrator T. Allom, Engraver J. Tingle
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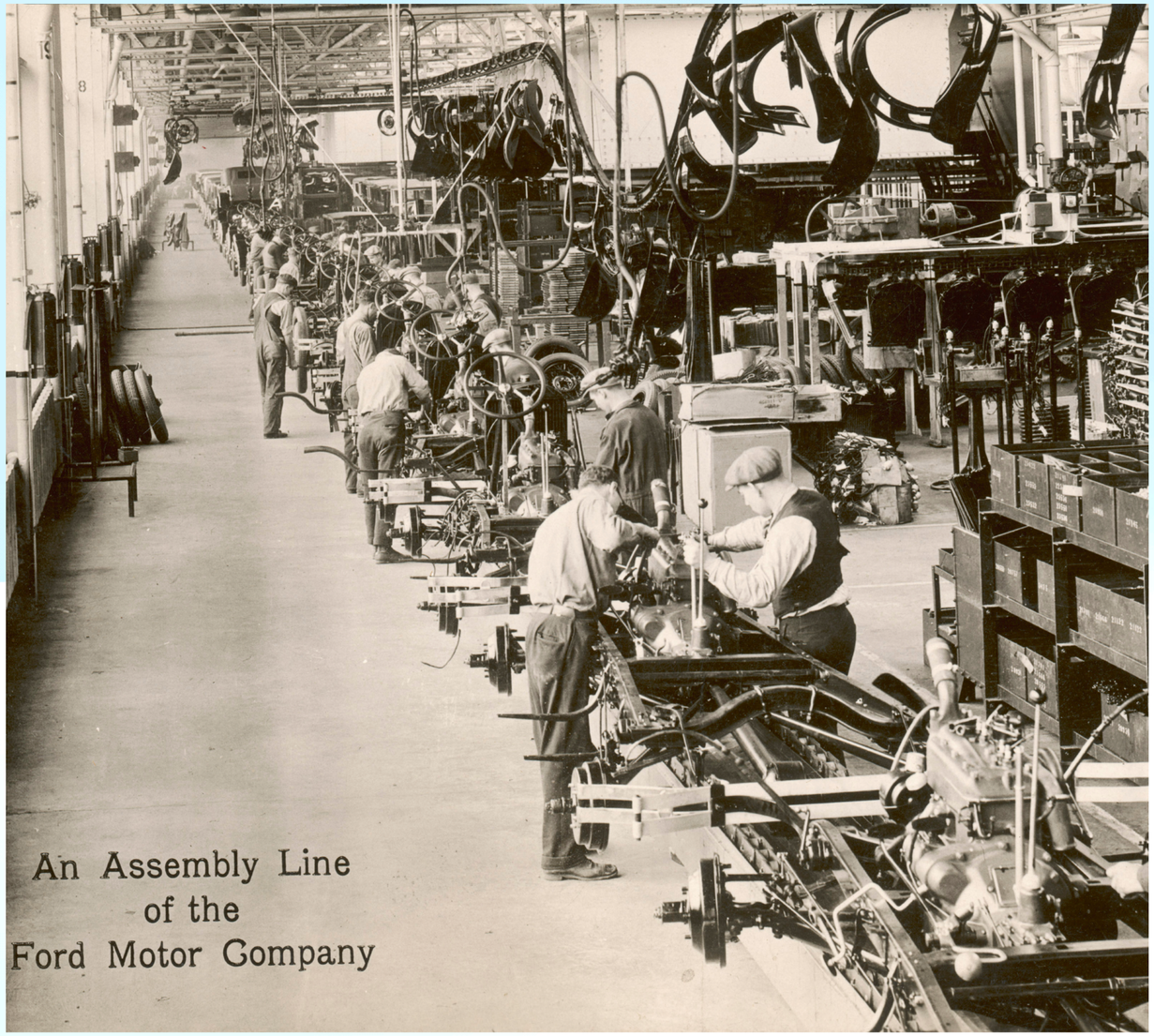
‘Mass Expertise’

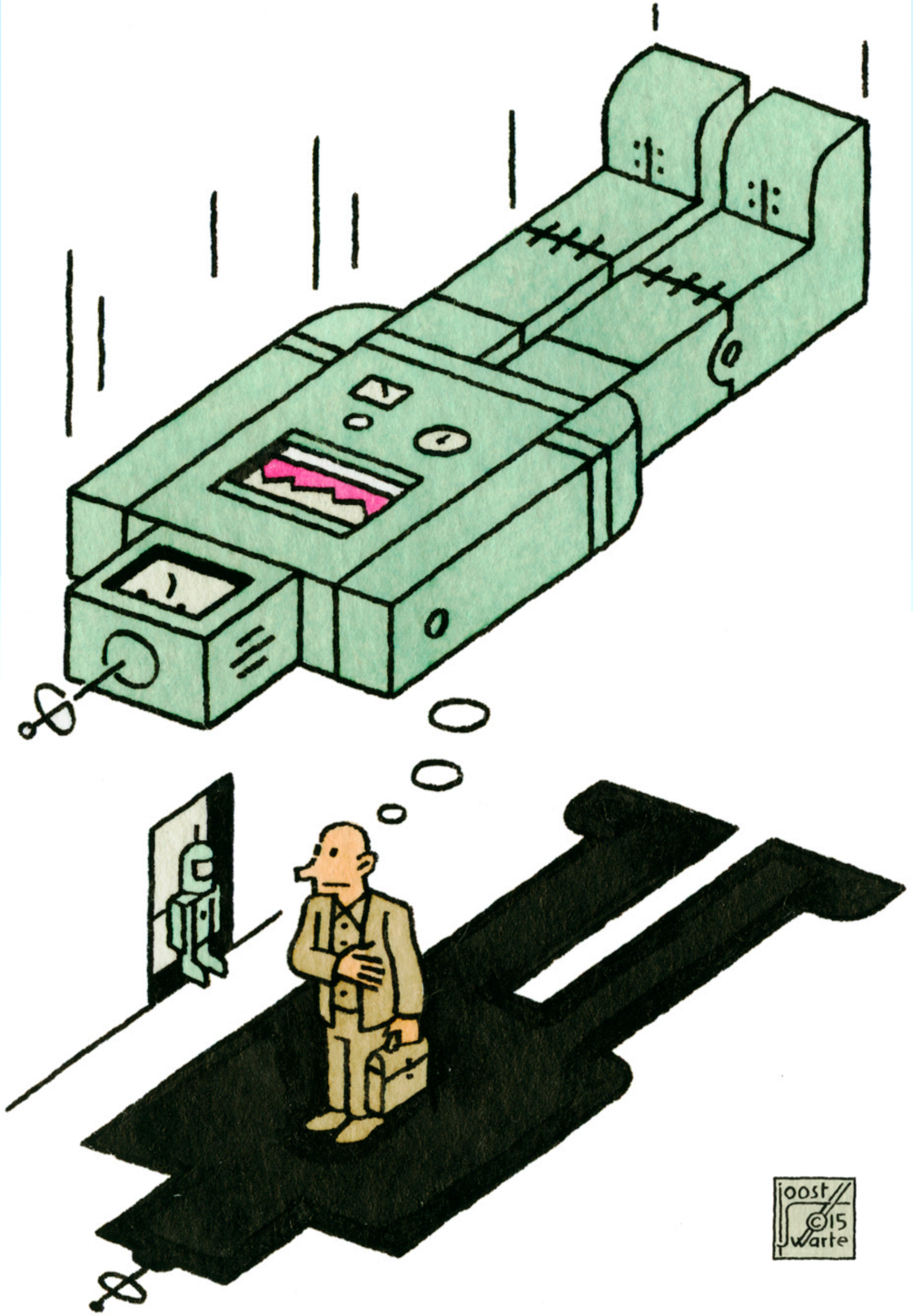


Tool and die workers,
Ford River Rouge plant, 1920s or 1930s
© Adobe Stock (licensed)

Office workers at International Harvester
© Wisconsin Historical Society

The Computer Revolution–

Displacing Mass Expertise



The Computer Revolution — Automating routine tasks

Jacquard loom of 1801
The first industrial computer

The Computer Revolution — Automating routine tasks

What is a computer?

- **Symbolic processor** — Accesses, analyzes, and acts upon information

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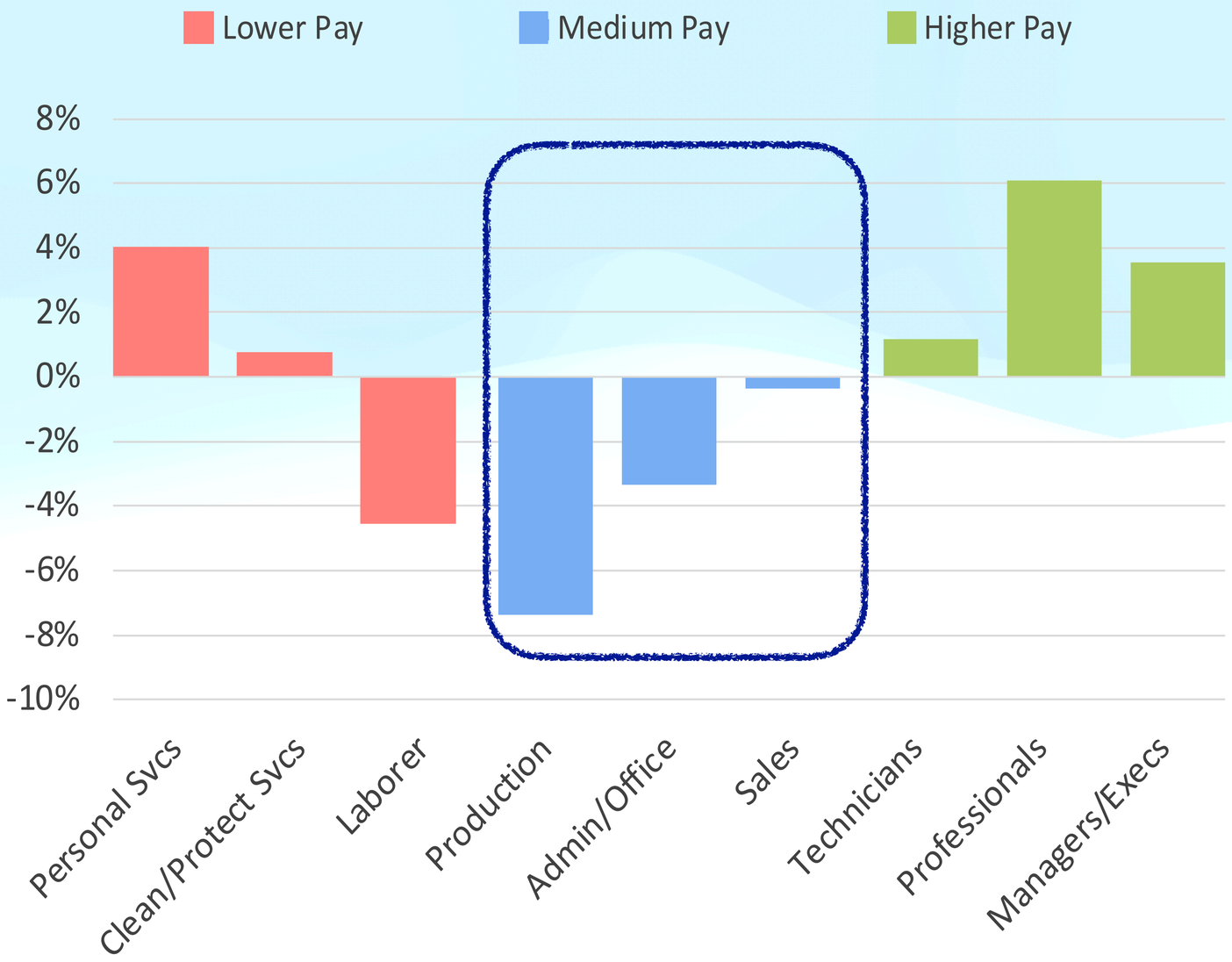
The Computer Revolution — Automating routine tasks

What is a computer?

- **Symbolic processor** — Accesses, analyzes, and acts upon information
- **Follows rules** — Carries out codifiable, 'routine' tasks, specified in programs

Jacquard loom of 1801
The first industrial computer

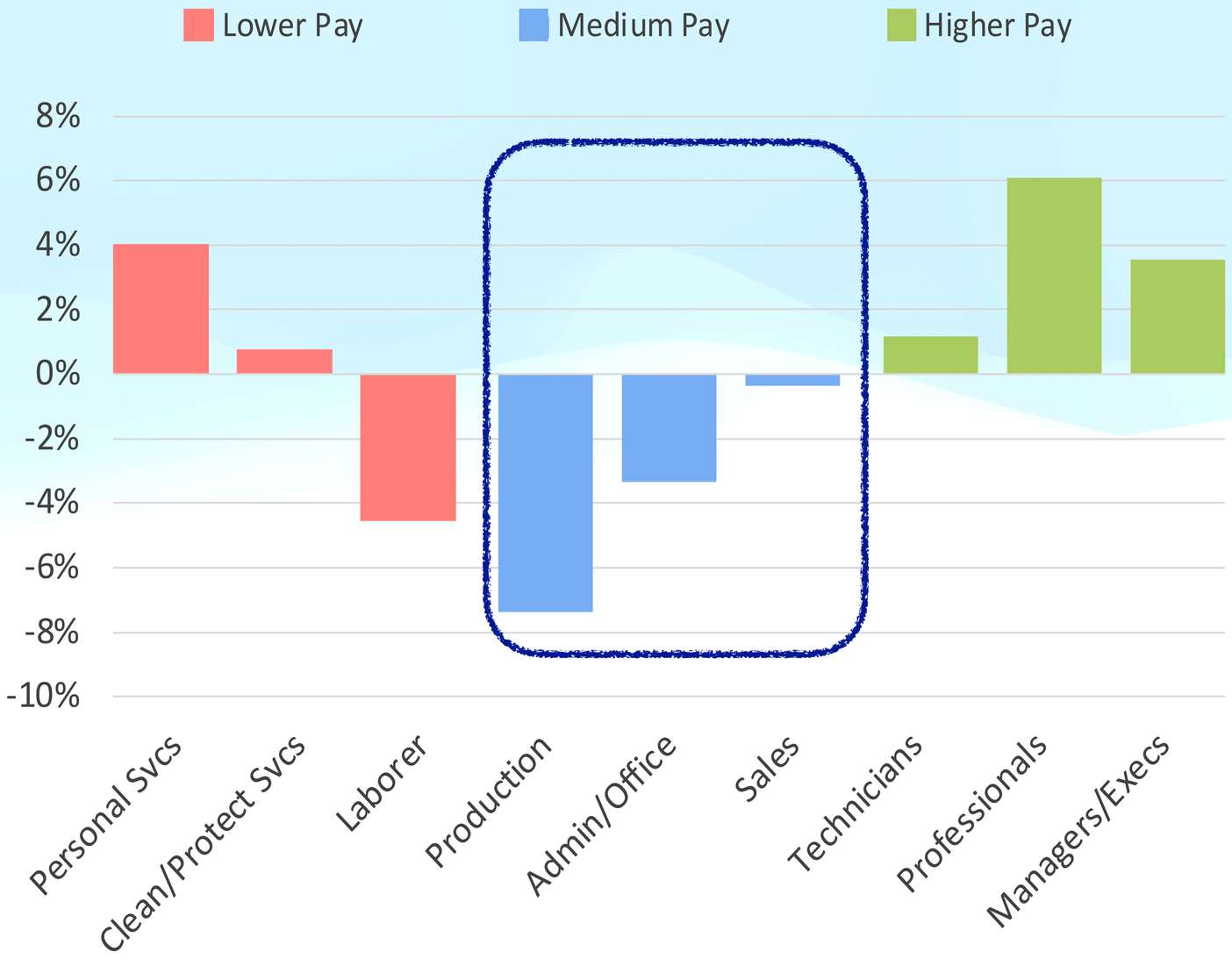
The barbell of occupational polarization, 1980 — 2015



Autor, Mindell, Reynolds, 2020

The barbell of occupational polarization, 1980 — 2015

- **At least a *trillion-fold* decline in the cost of computing since 1950!**



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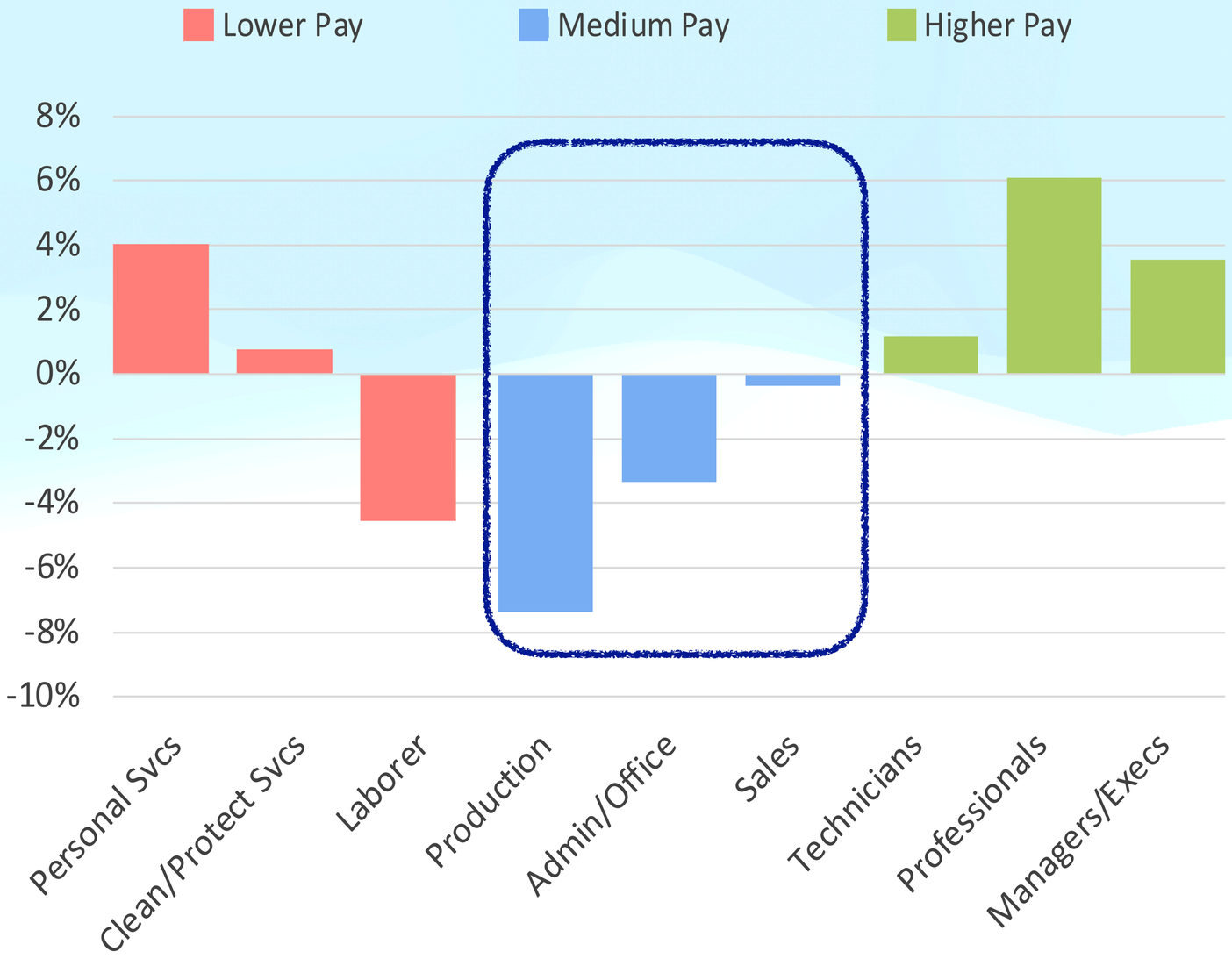
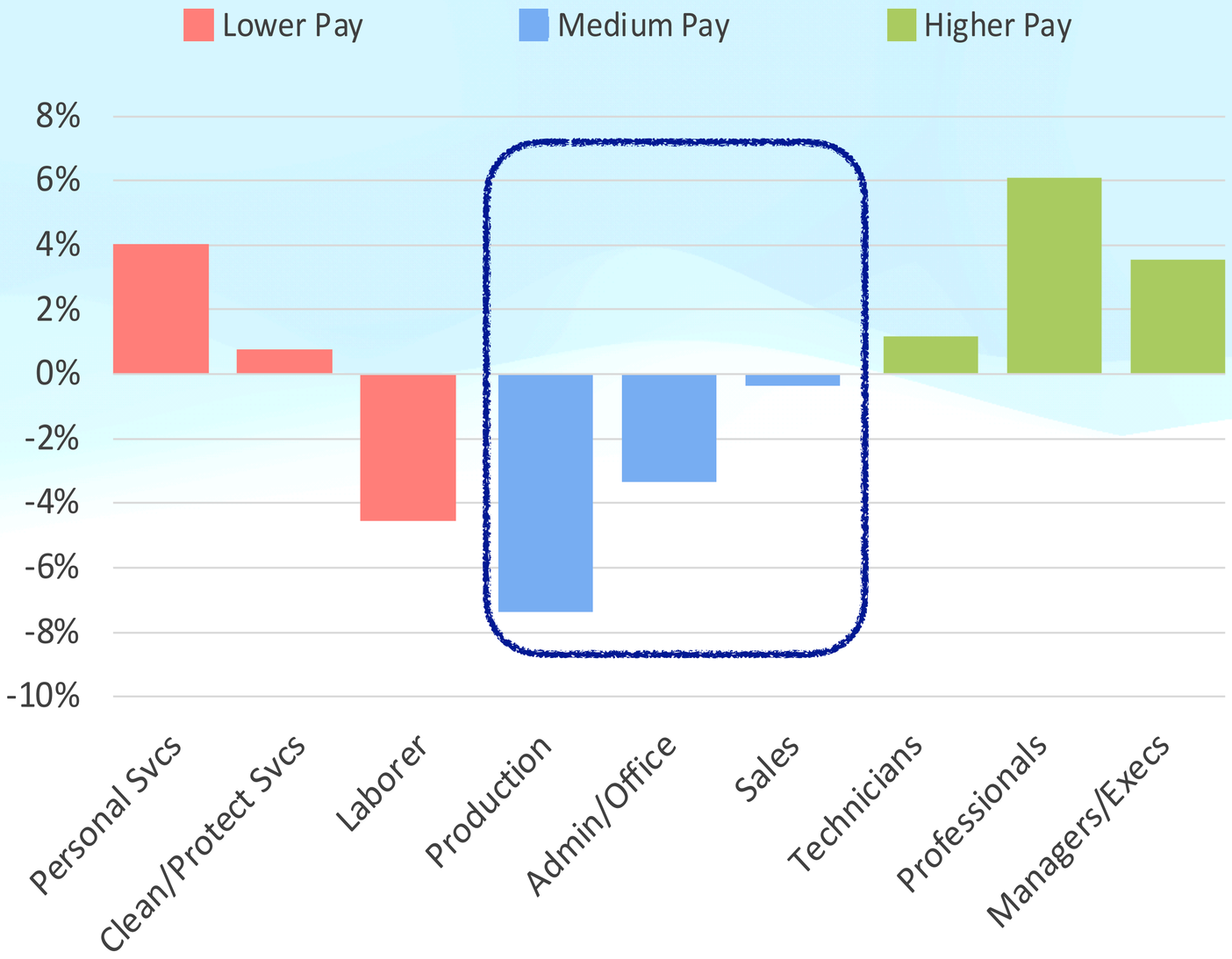


Autor, Mindell, Reynolds, 2020

The barbell of occupational polarization, 1980 — 2015

- **At least a *trillion-fold* decline in the cost of computing since 1950!**
- **Computerization *automated* a large share of *mass expertise***
- **Replaced — Production workers, Office, clerical, and admin workers**



Autor, Mindell, Reynolds, 2020

Polanyi's Paradox – Rules vs. tacit knowledge

Michael Polanyi (1891 - 1976)

Polanyi's Paradox – Rules vs. tacit knowledge

"We know more than we can tell…"

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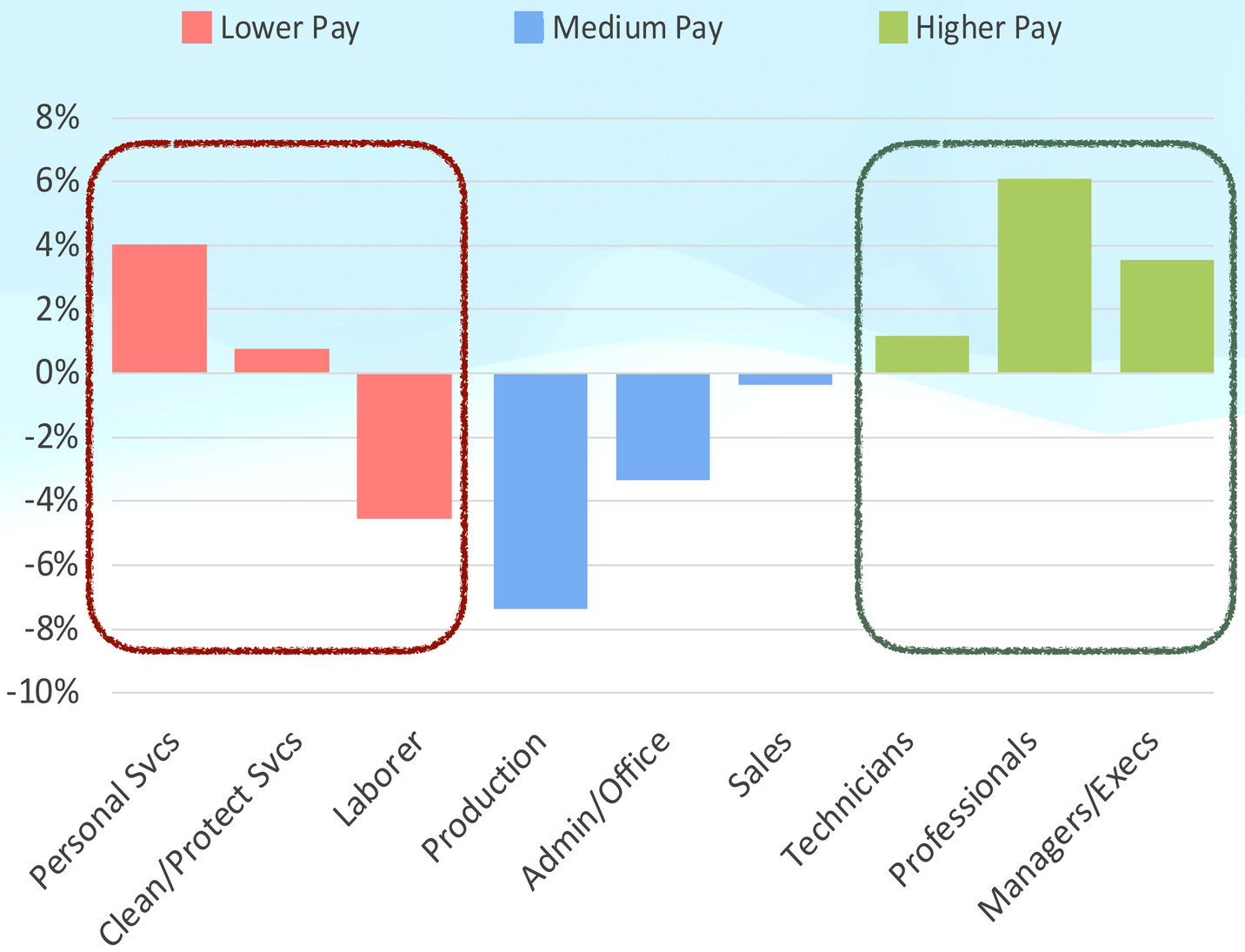
Polanyi's Paradox – Rules vs. tacit knowledge

"We know more than we can tell…"

Implication — we cannot 'computerize' tasks that we don't explicitly understand

Michael Polanyi (1891 - 1976)

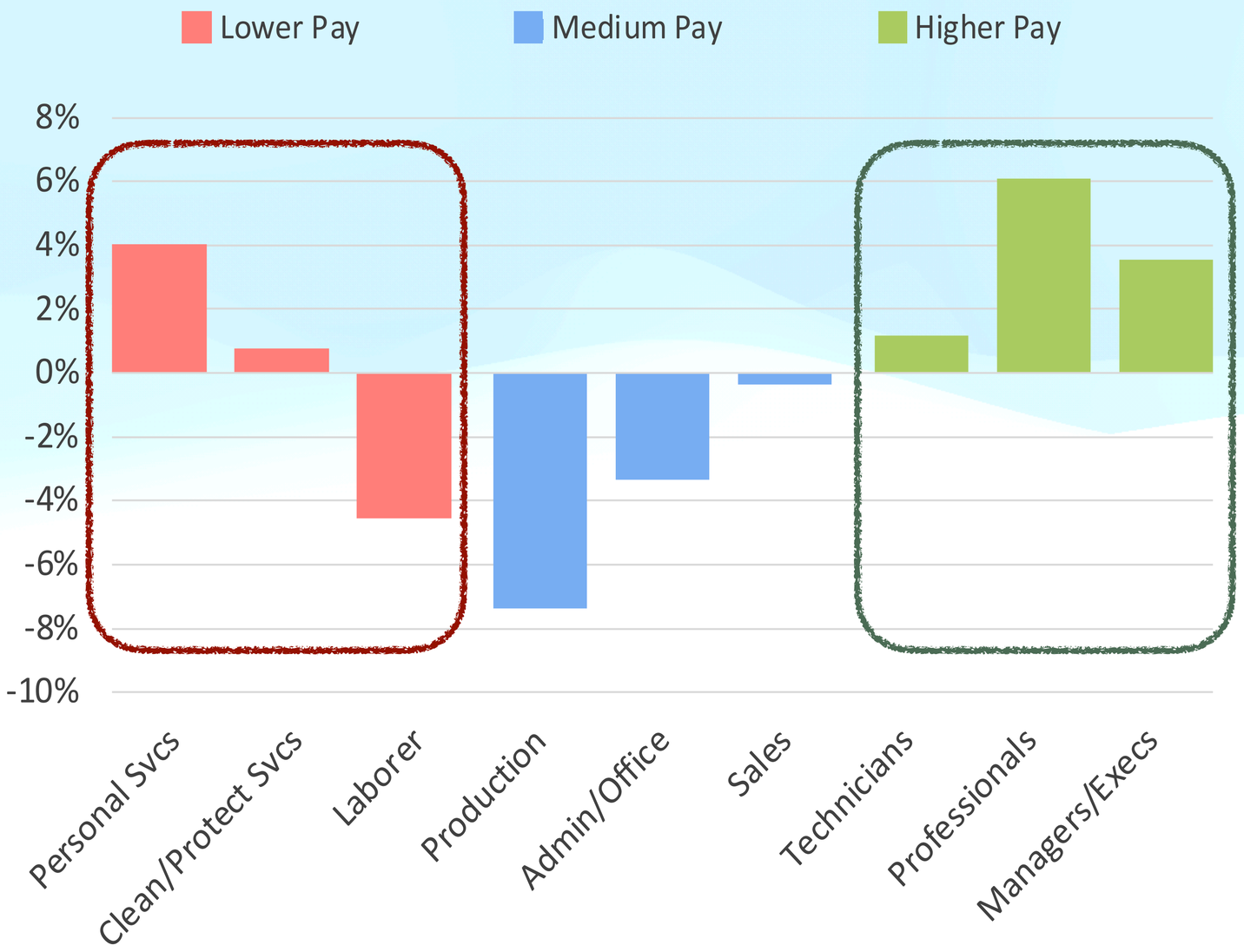
The barbell of occupational polarization, 1980 — 2015



Autor, Mindell, Reynolds, 2020

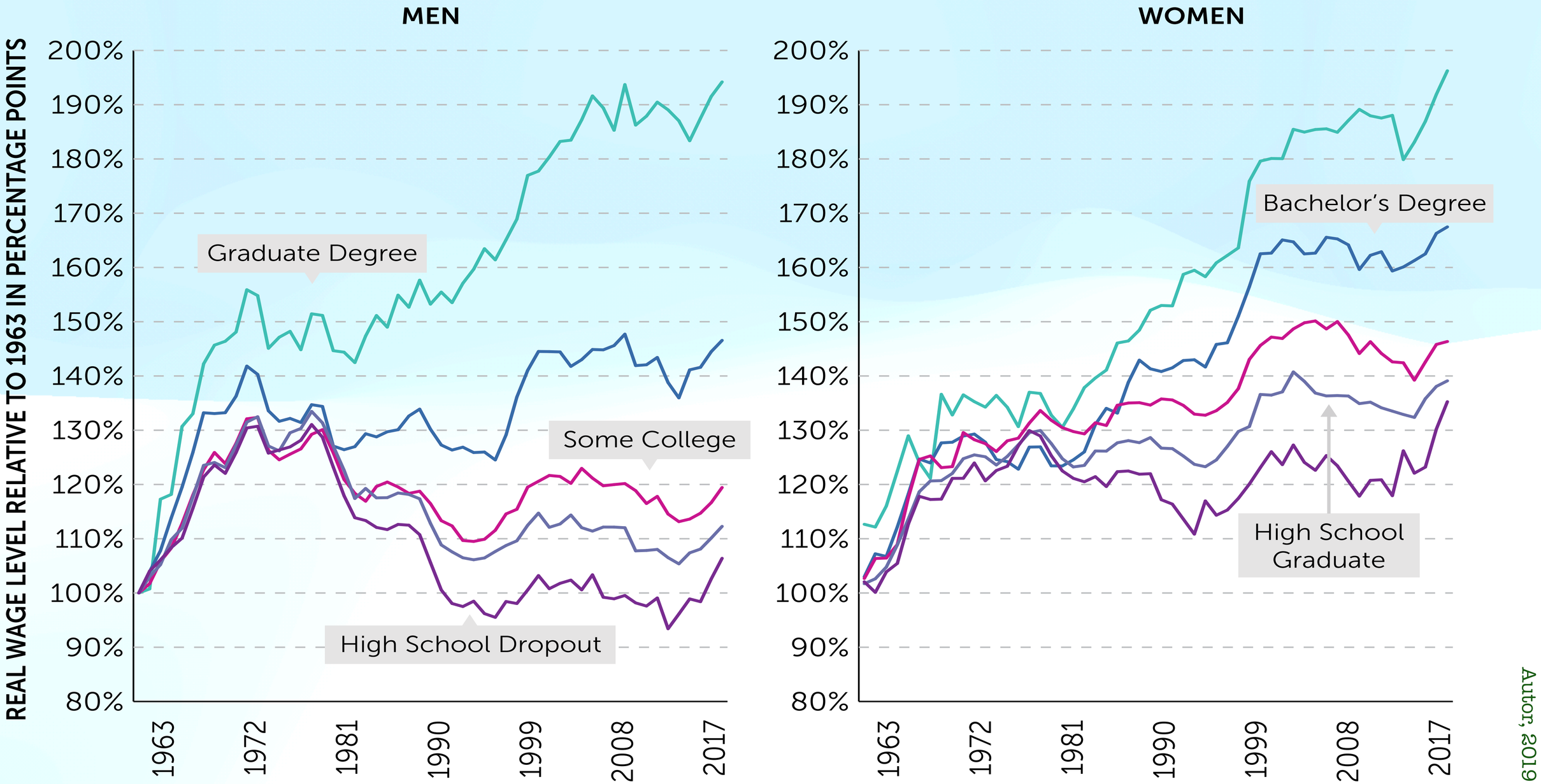
The barbell of occupational polarization, 1980 — 2015

- **Enhancing the value of elite expertise** — Doctors, lawyers, managers, engineers, researchers
- **Pushing workers in middle-skill jobs downward into non-expert work** — Food service, cleaning, security



Autor, Mindell, Reynolds, 2020

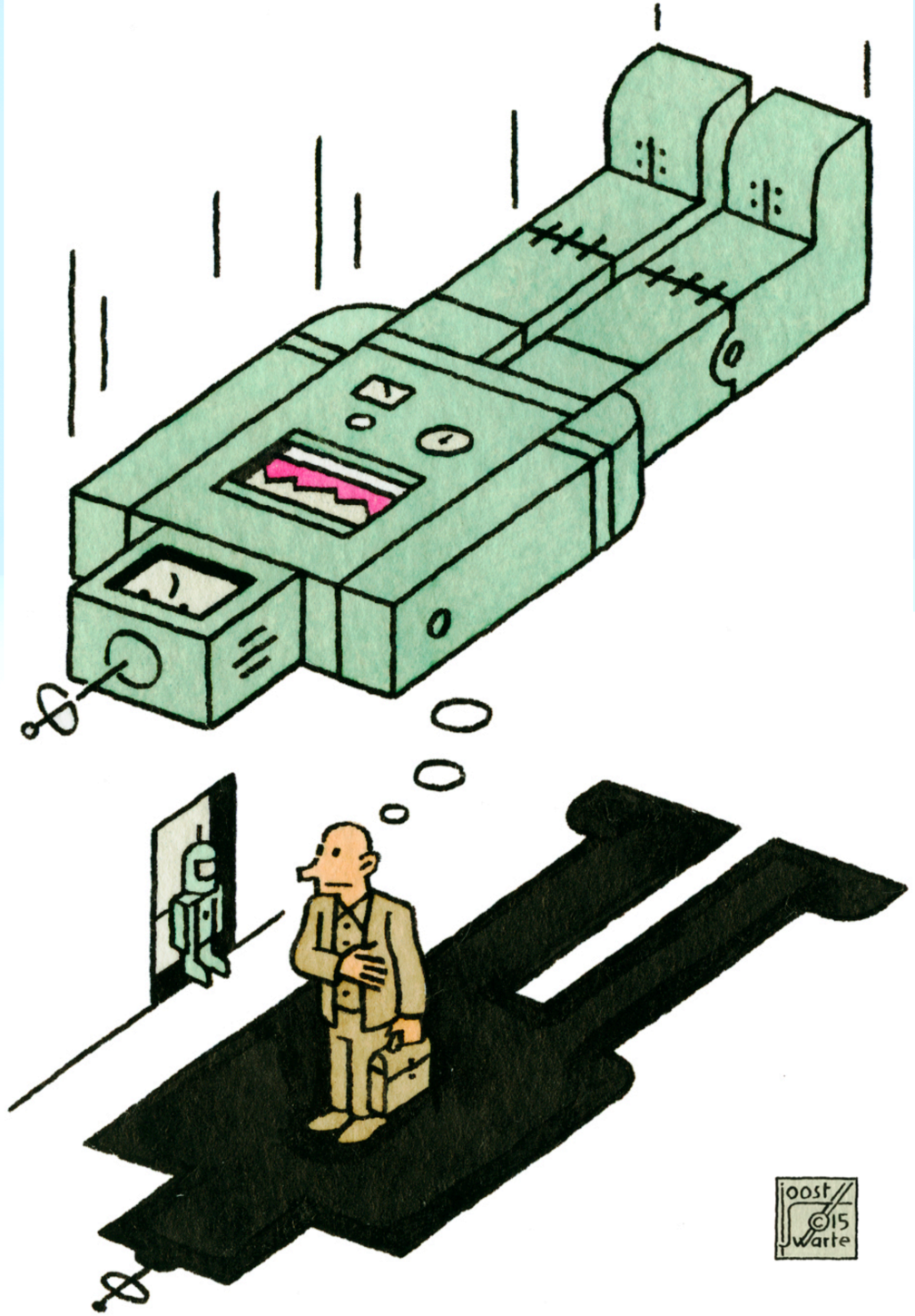
Computerization fostered wage polarization



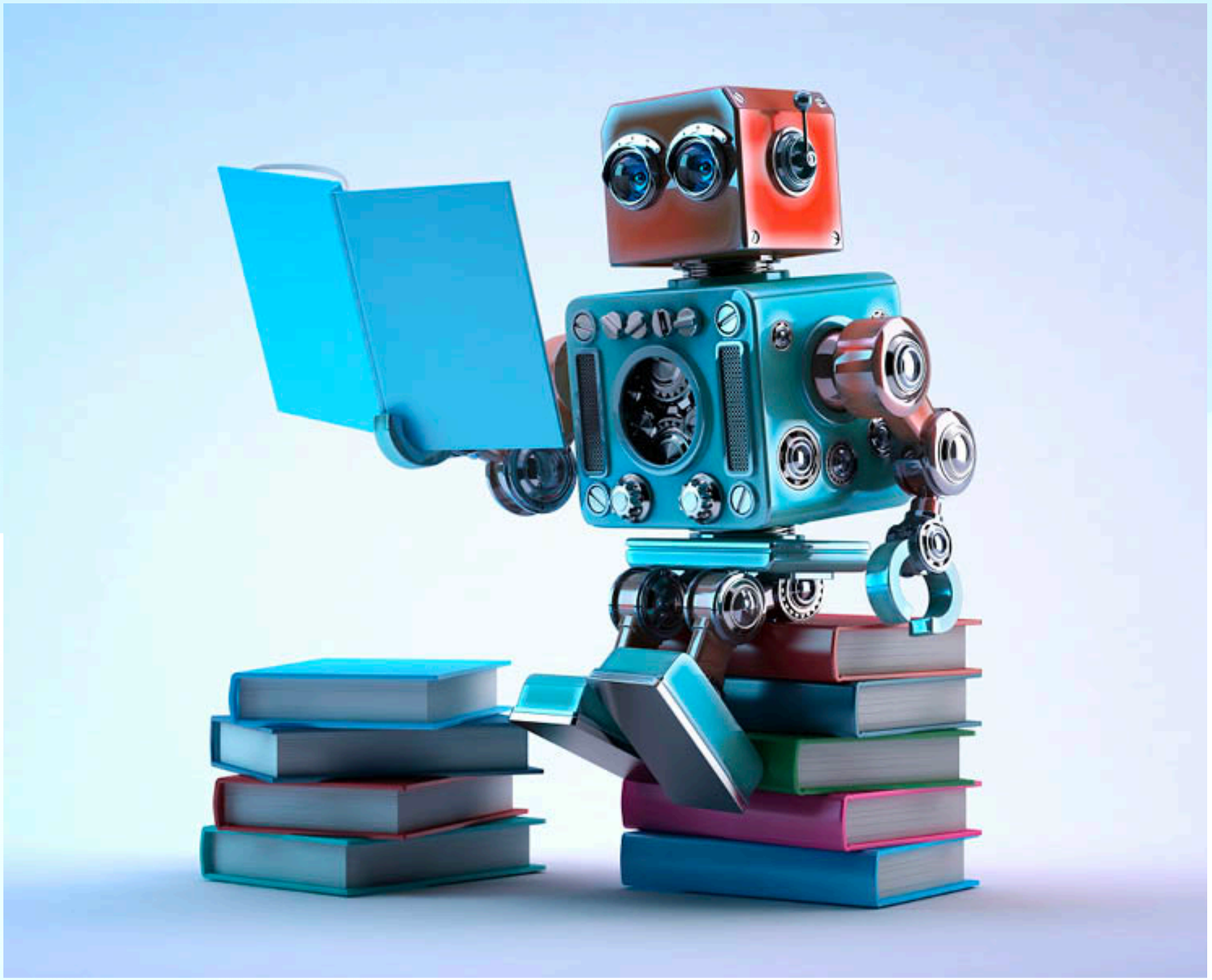
Autor, 2019

The Artificial Intelligence era —

Augmenting Expertise or Displacing Experts?



Autonomous learning



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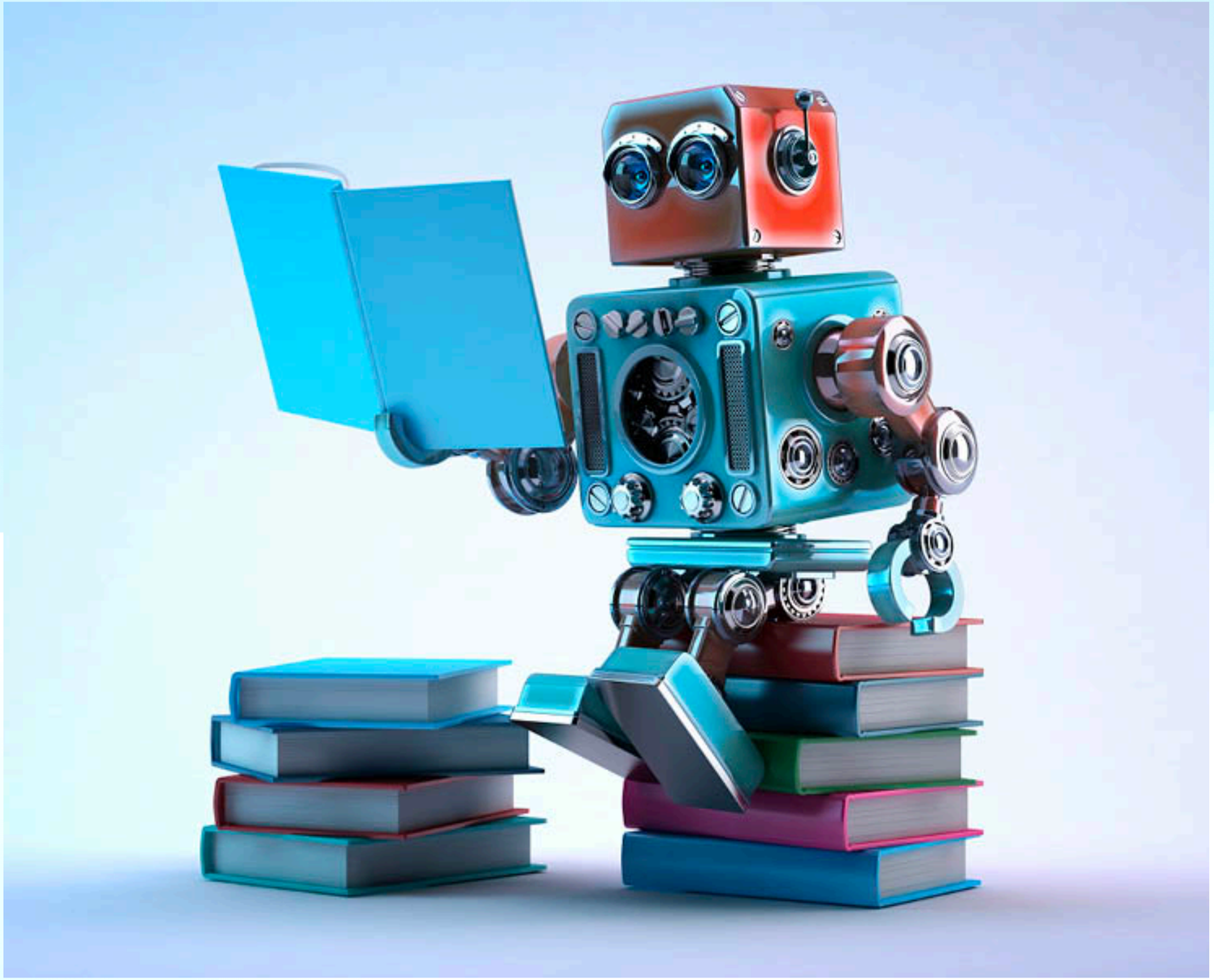
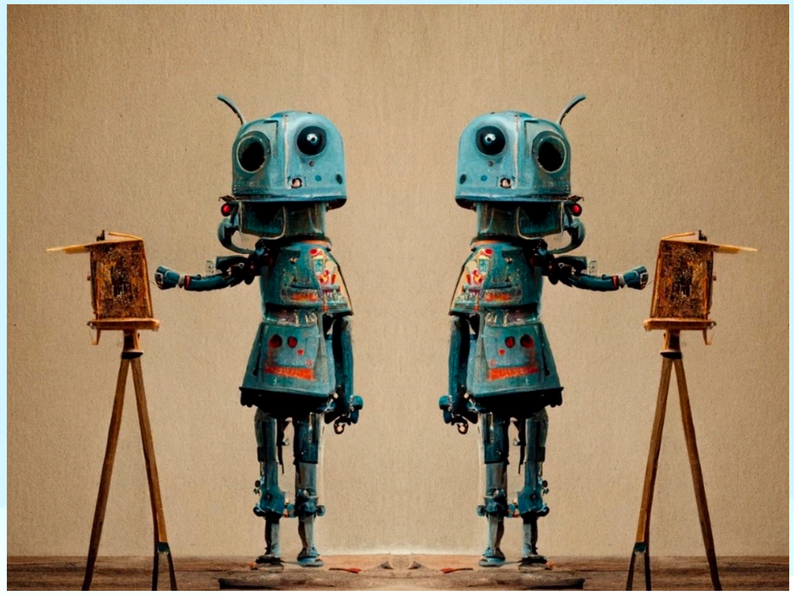


Creative tasks



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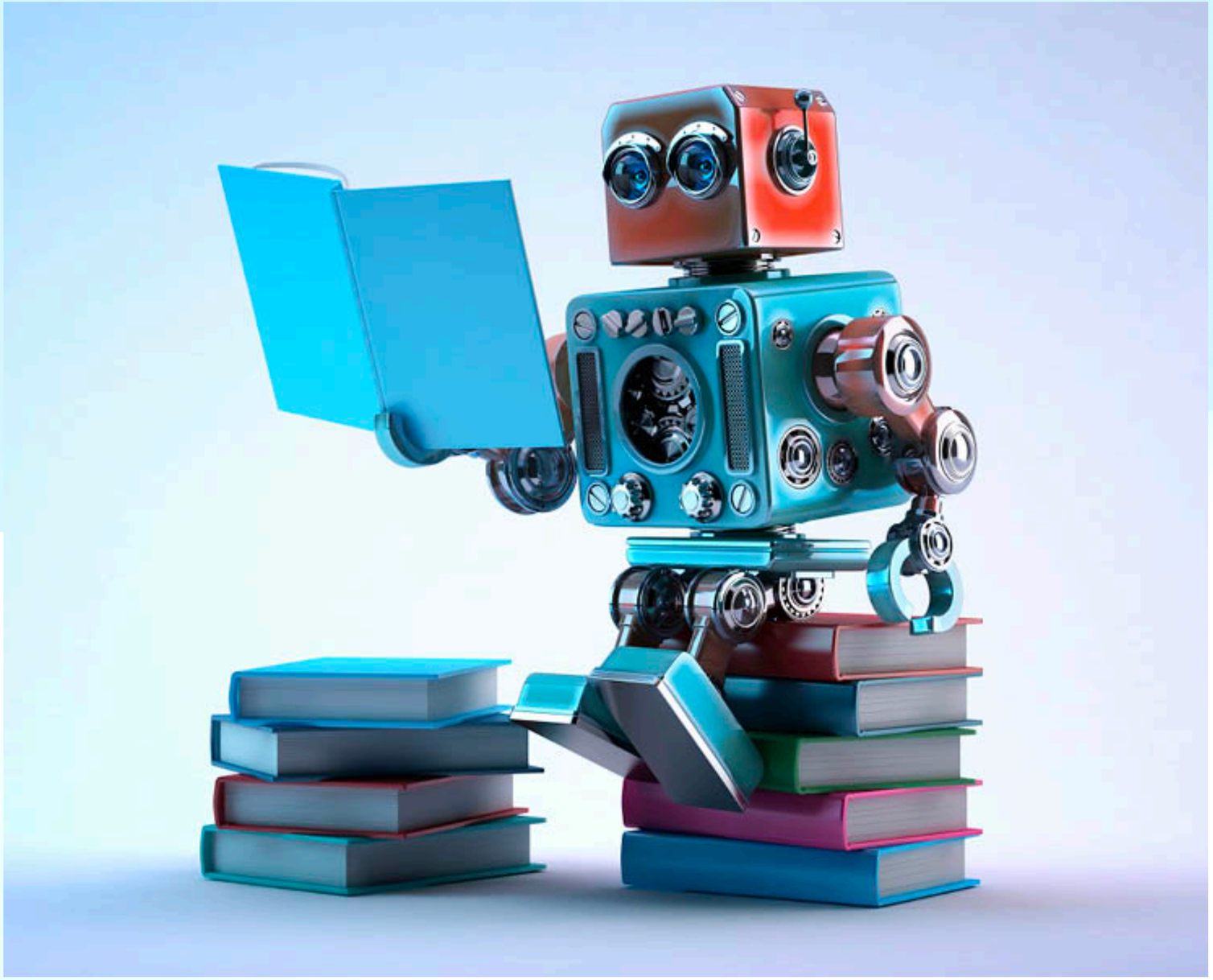

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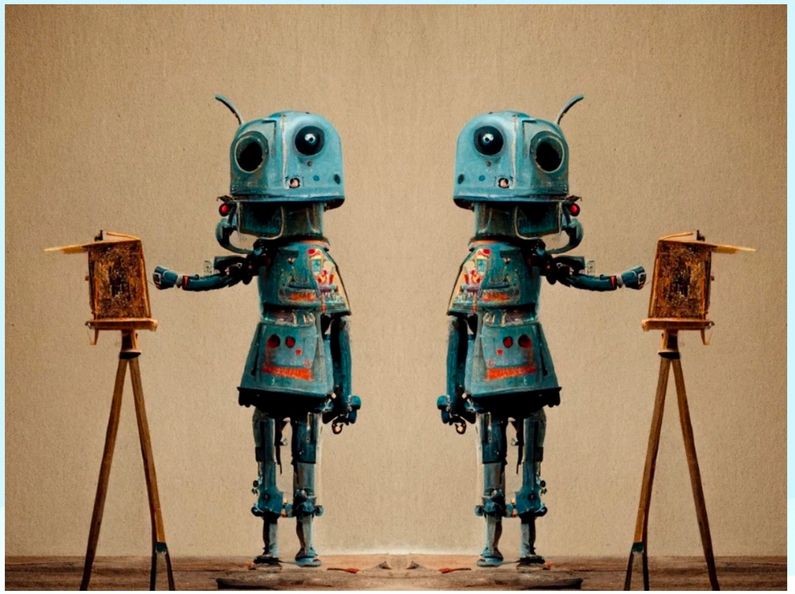
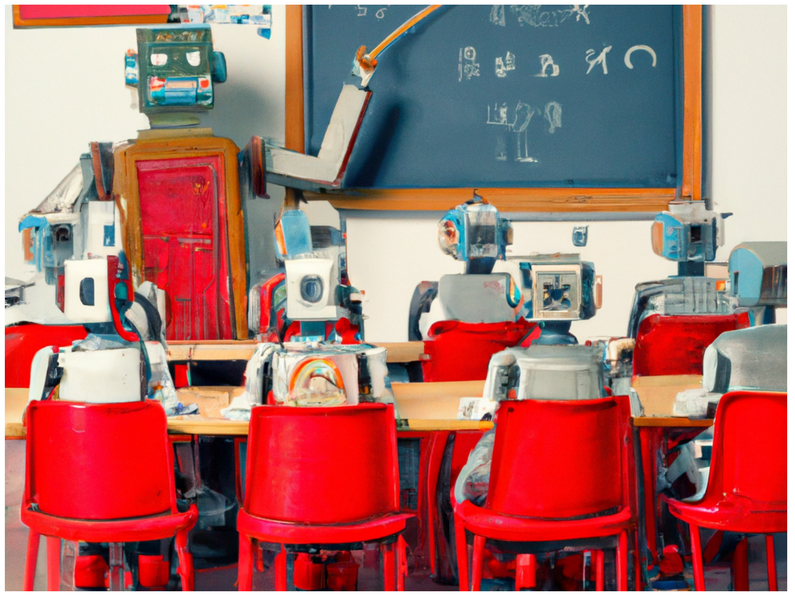
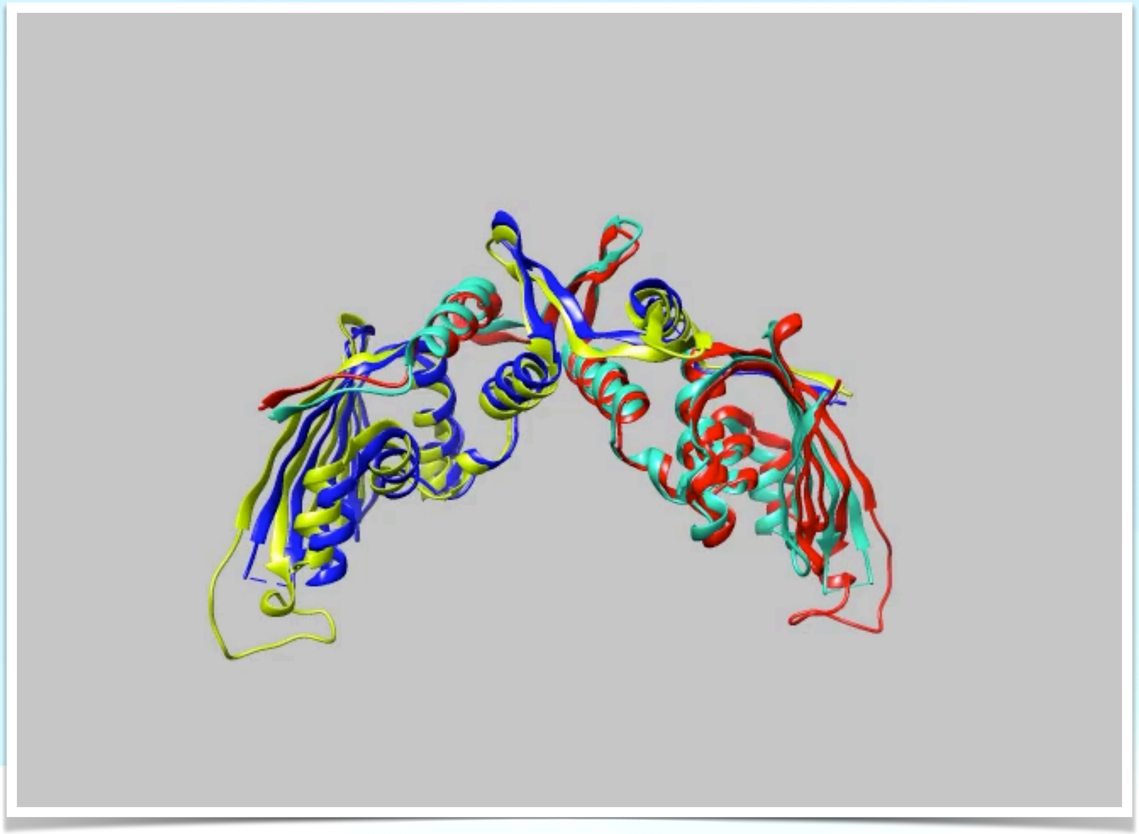
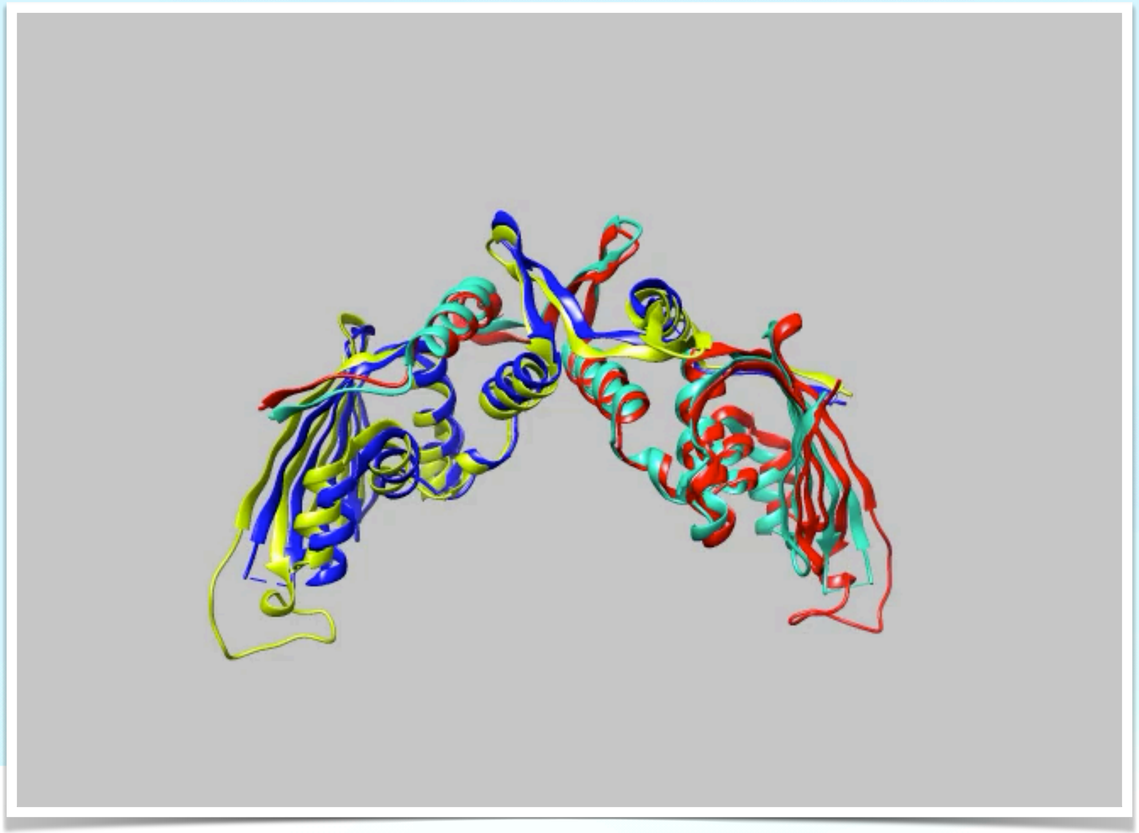




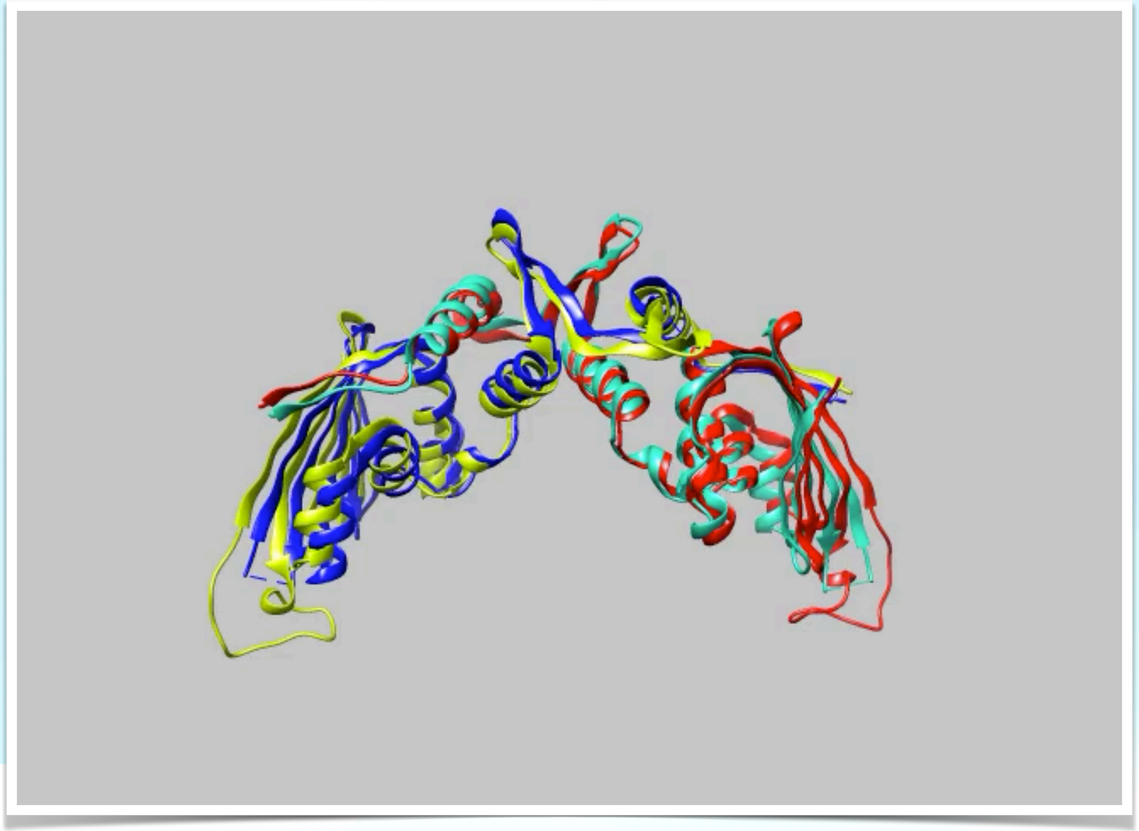
Discovery and invention





Critical Assessment of Protein Structure Prediction (CASP) Competition

- Competition has run annually since 1994
- 215 teams entered in 2020



IN DEPTH

Science December 2020

STRUCTURAL BIOLOGY

‘The game has changed.’ AI triumphs at protein folding

In milestone, software predictions finally match structures calculated from experimental data

“Artificial intelligence (AI) has solved one of biology’s grand challenges”

— Science, December 2020

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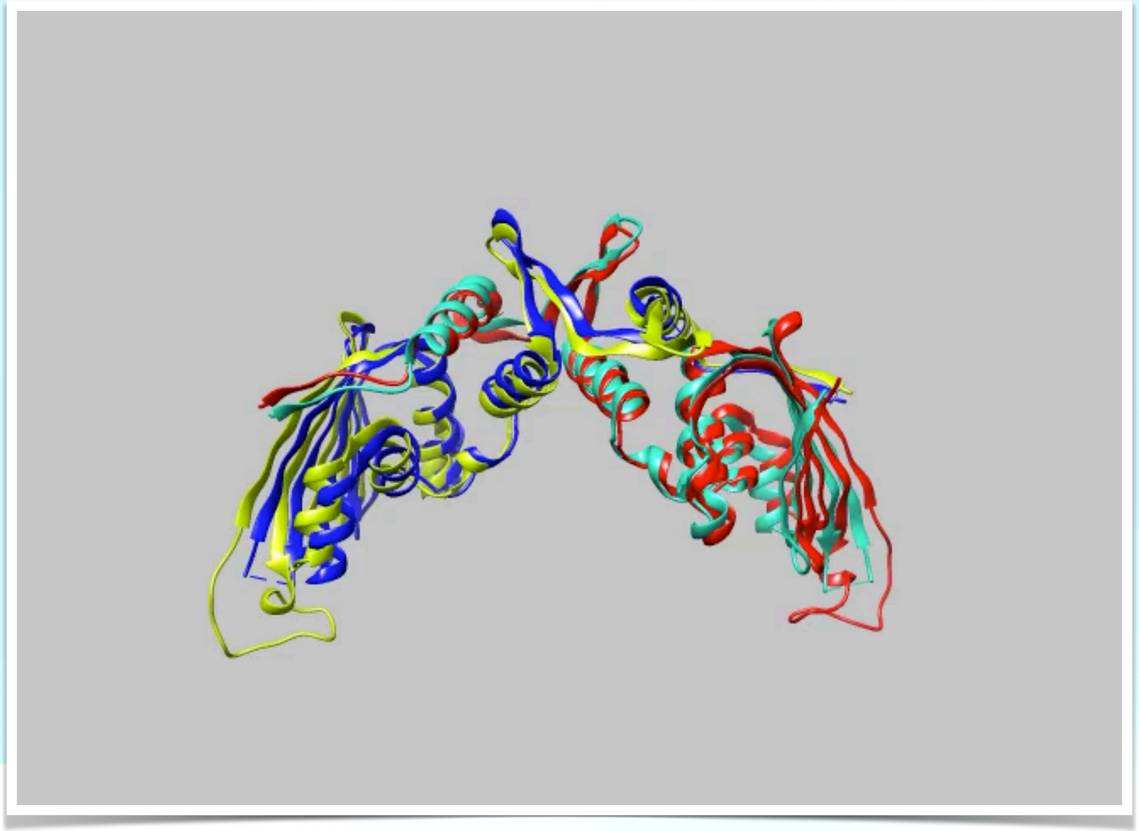

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“This is a 50-year-old problem…I never thought I’d see this in my lifetime.”

— John Moult, co-founder of the CASP

AI is a tool

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- **Many tools** augment the value of human expertise, e.g., pneumatic hammer, stethoscope
- **The potential** — AI could enable workers with complementary skills to perform more expert tasks

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- **The potential** — AI could enable workers with complementary skills to perform more expert tasks
- **But not all tools** — London taxi drivers vs. Waze
- **The peril** — AI could commodify ('*strand*') expertise

AI is already woven into daily life

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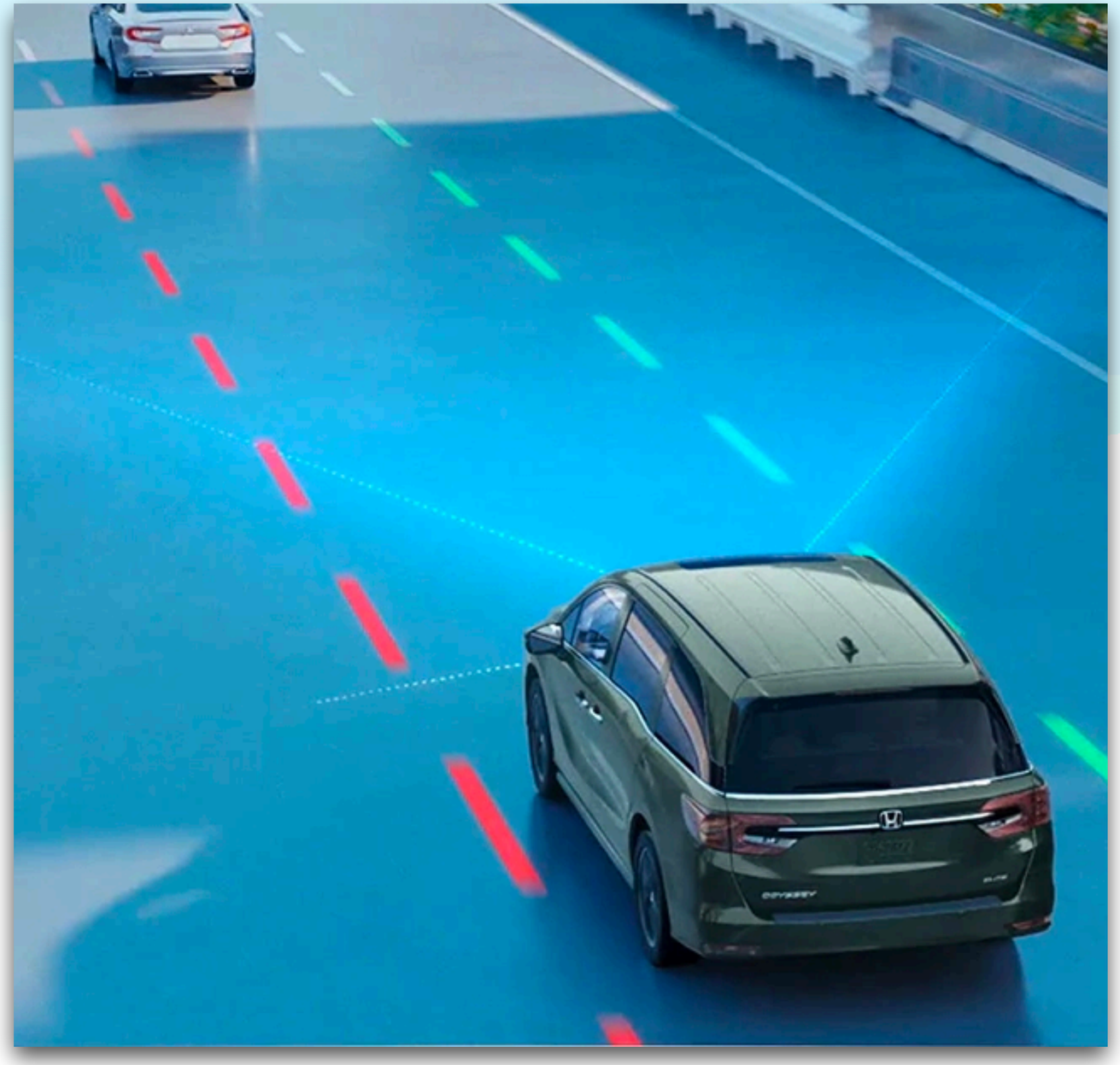
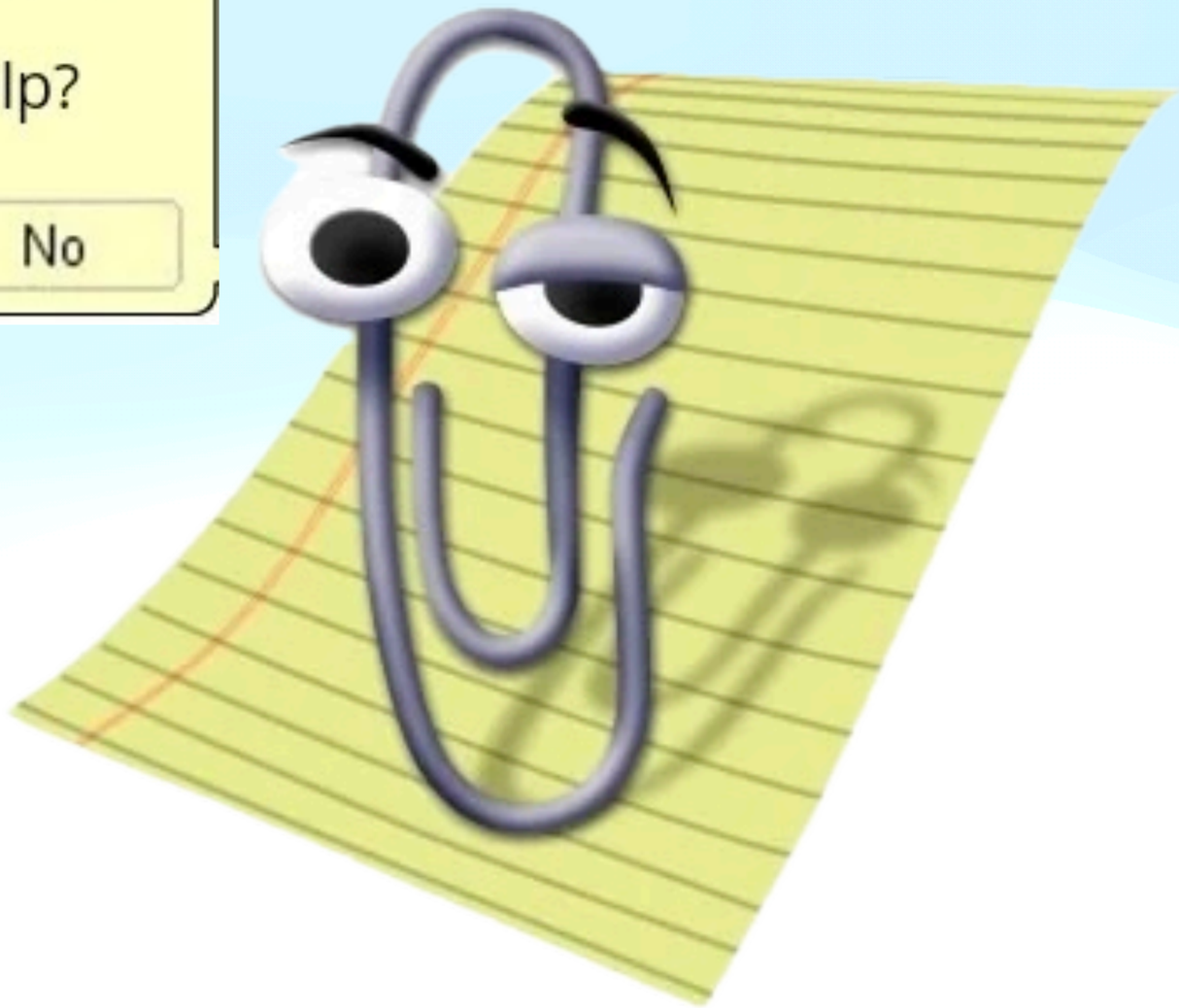


It looks like you're writing a suicide note.

Would you like help?

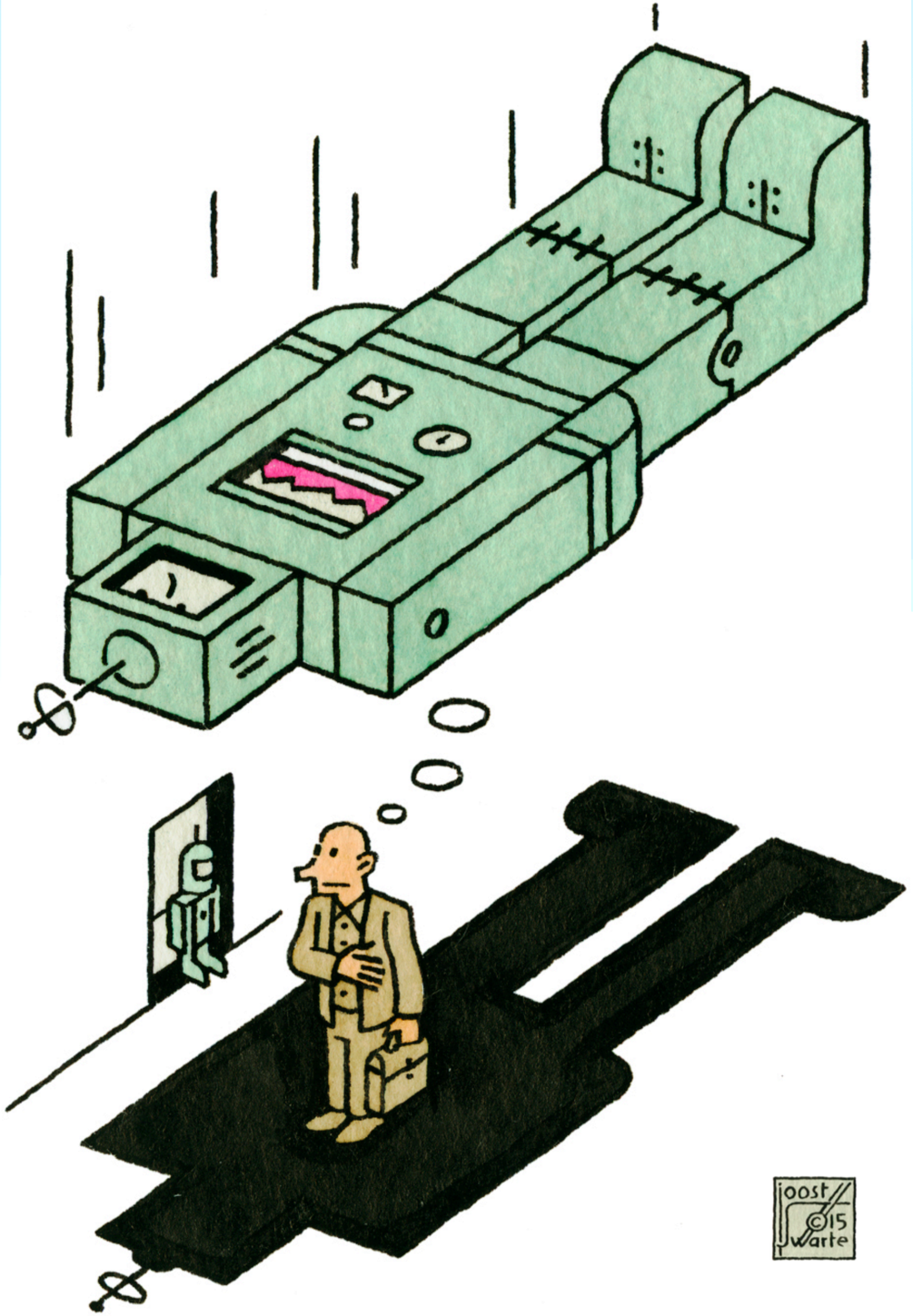
Yes

No



The Peril —

Undermining Human Expertise



Expertise delegation and expertise denigration

Air France flight #447 tail fin recovery, 2009

Expertise delegation and expertise denigration

- June 1, 2009: Pitot tubes (speed sensors) on Air France flight #447 iced over at 35K feet

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- Auto-pilot partly disengaged automatically, plane rolled
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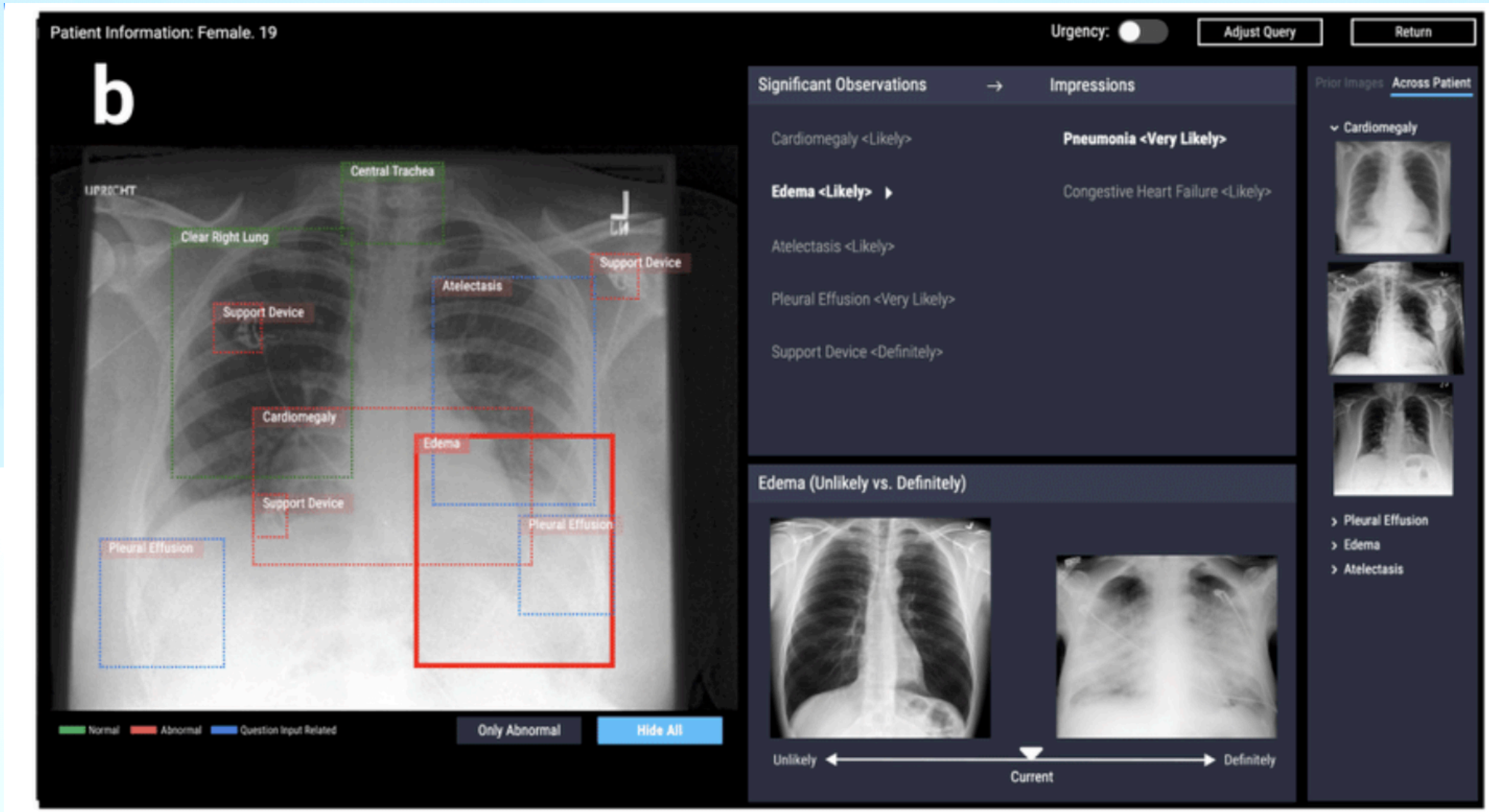
- During the 3.5 minutes between auto-pilot off and water collision, crew did not understand that the plane was stalling
- Cause: "Crew lacked experience on the characteristics of high-altitude manual flying"

Air France flight #447 tail fin recovery, 2009

Radiologists using AI — The case of CheXpert

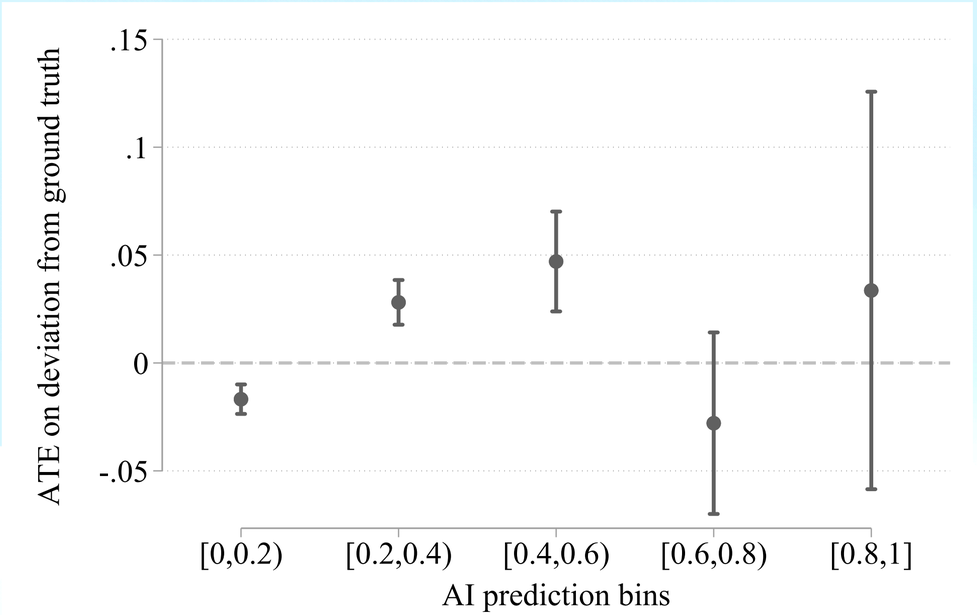


High-fi prototyping. (a) CheXpert: AI radiologist without explanations. (b) CheXplain: The high-fidelity prototype with 8 key features.

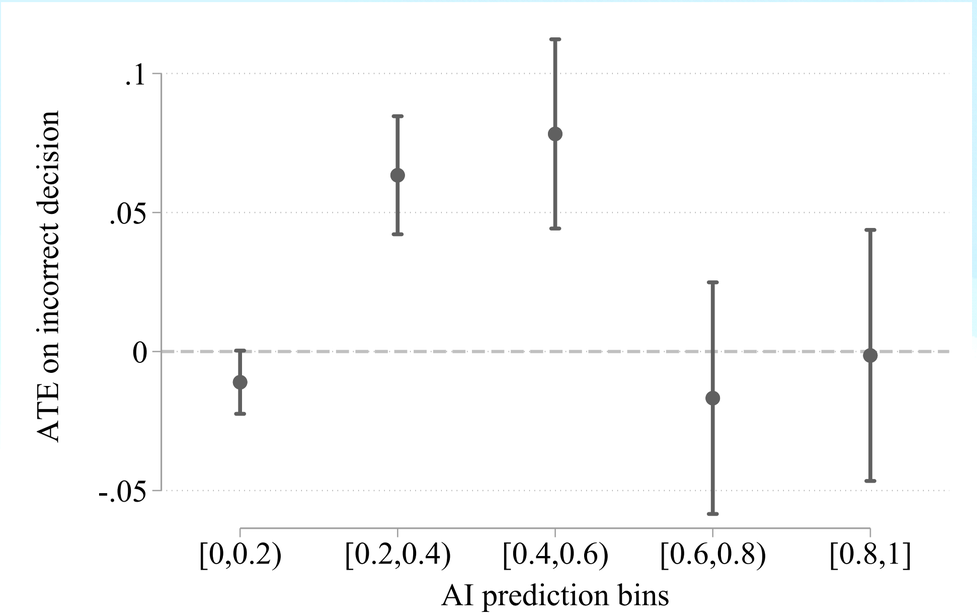
Radiologists using AI — The case of CheXpert

Figure 3: Conditional treatment effect given AI prediction

(a) Deviation from Ground Truth



(b) Incorrect Decision

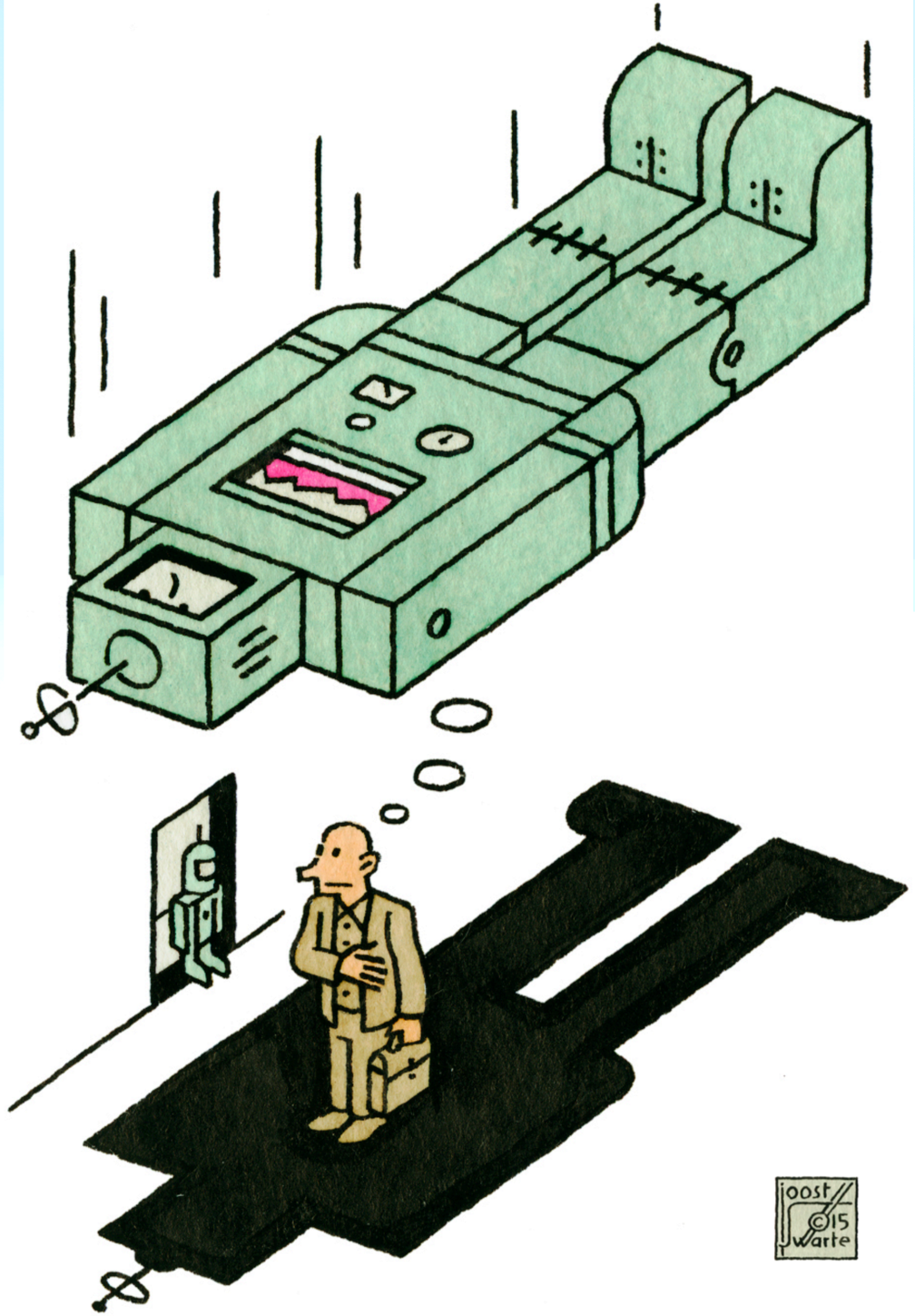


Note: Panel (a) shows the conditional average treatment effect of providing AI information on the absolute value of difference between the radiologist probability and the ground truth. Panel (b) shows analogous treatment effects on incorrect diagnosis, where a correct diagnosis is defined as the treatment recommendation matching the ground truth. Both these treatment effects are conditional on the ranges of AI prediction. Standard errors are two-way clustered at the radiologist and patient-case level. The error bars depict 95% confidence intervals. Robustness to experimental design is in appendix C.4.1 and C.4.2.

Agarwal, Moehring, Rajpurkar, and Salz 2023

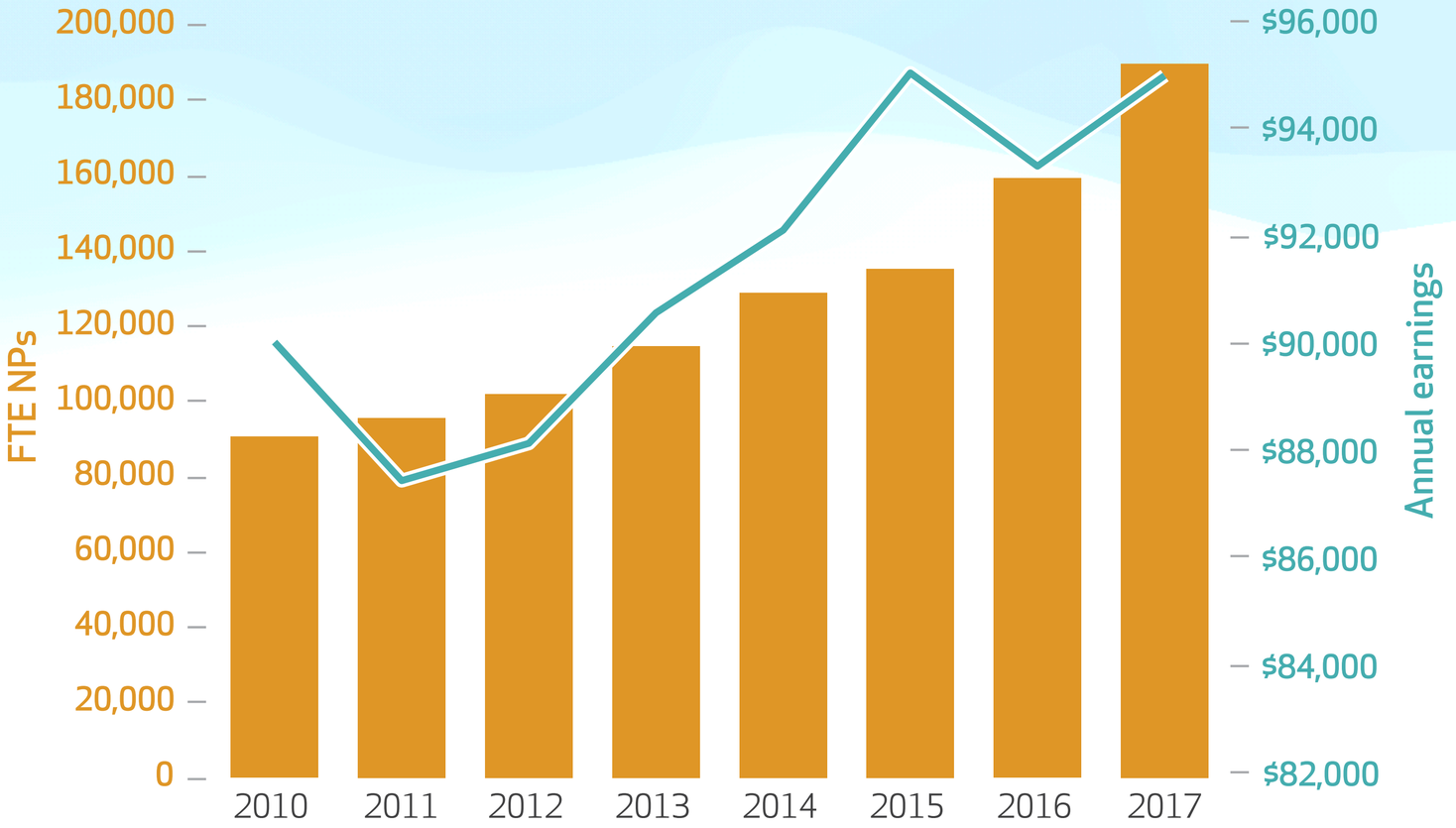
The Potential —

Augmenting Human Expertise



Nurse Practitioners (NP) Employment doubled between 2010 and 2017

Number and average annual earnings of full-time-equivalent (FTE) nurse practitioners (NPs) in the US, 2010–17



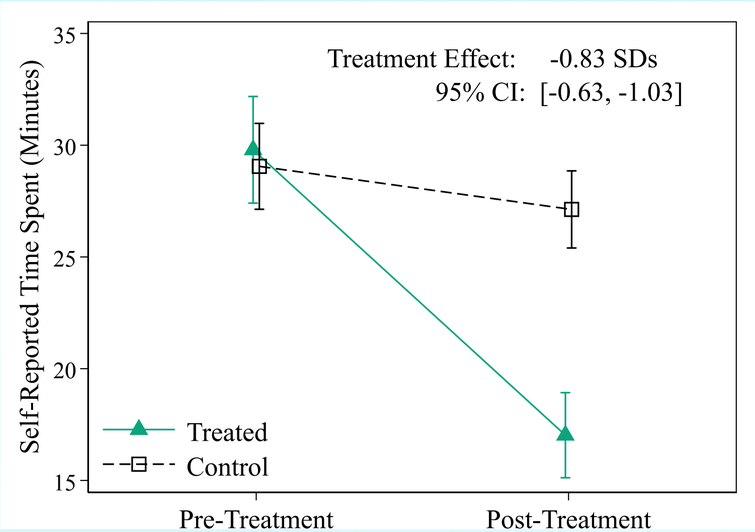
Auerbach et al. 2020

Experimental evidence: ChatGPT for professional writing

Shakked Noy and Whitney Zhang 2023

Experimental evidence: ChatGPT for professional writing

(a) Time Taken Decreases



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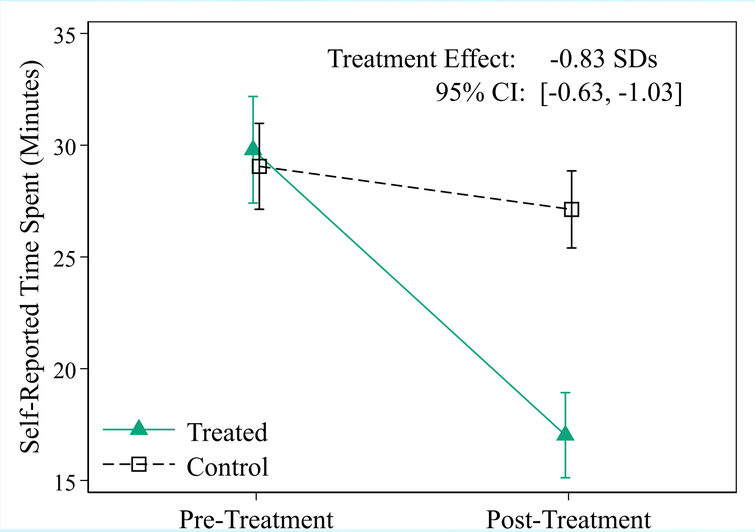
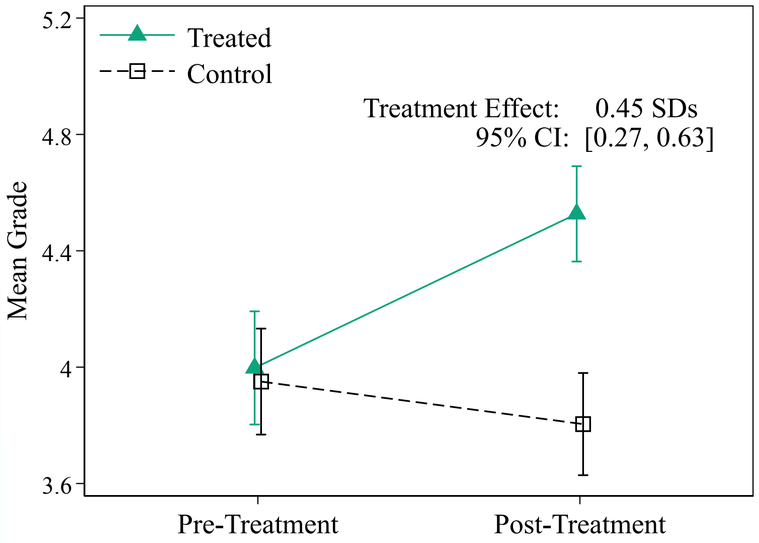


(b) Average Grades Increase



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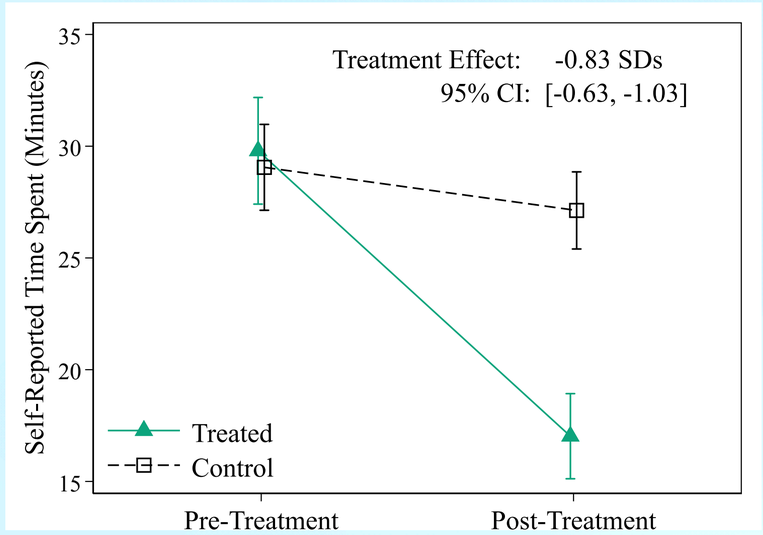

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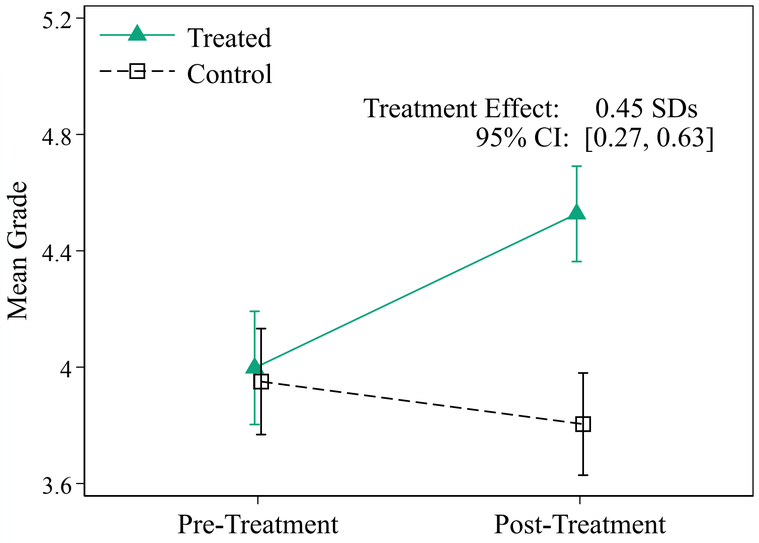

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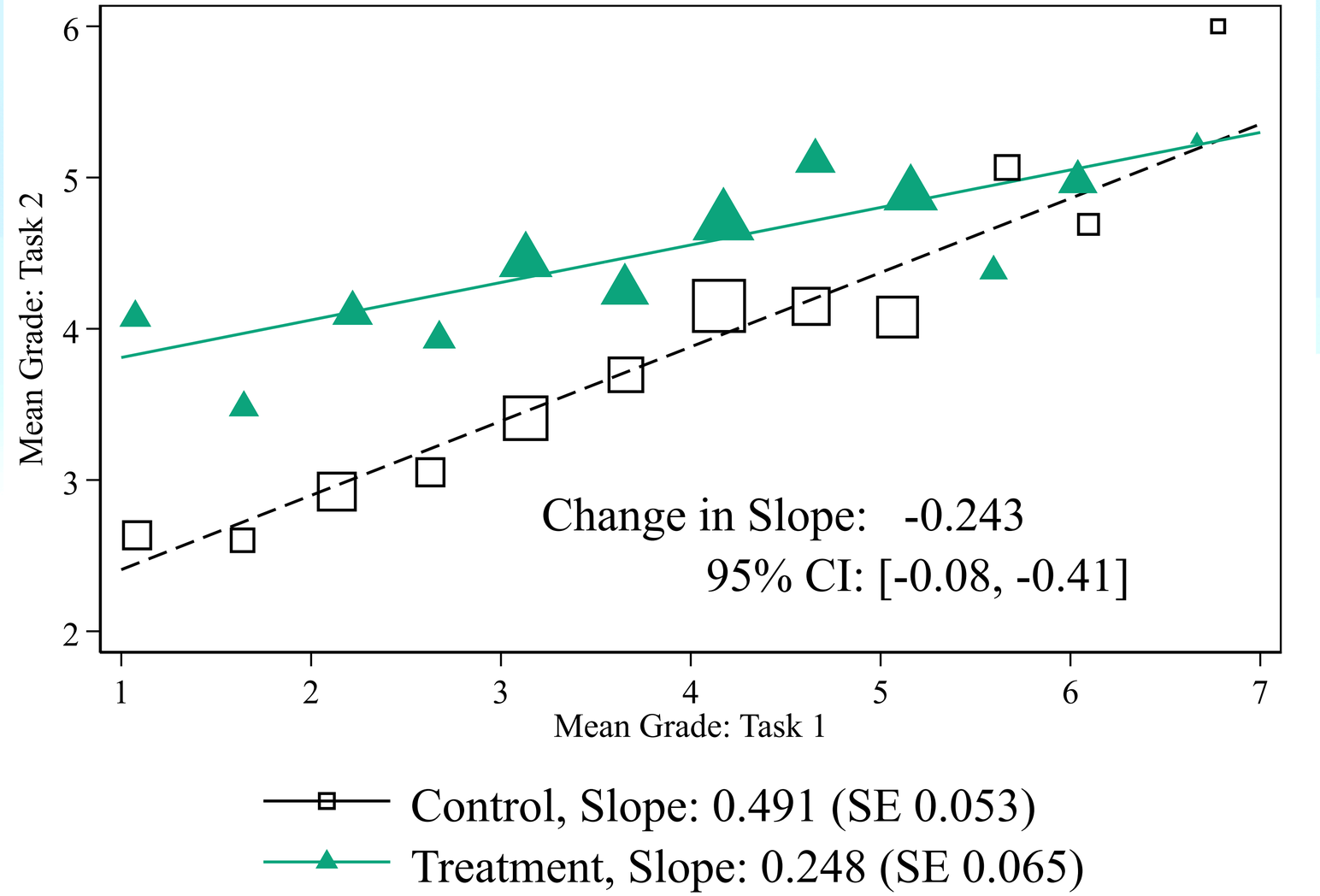


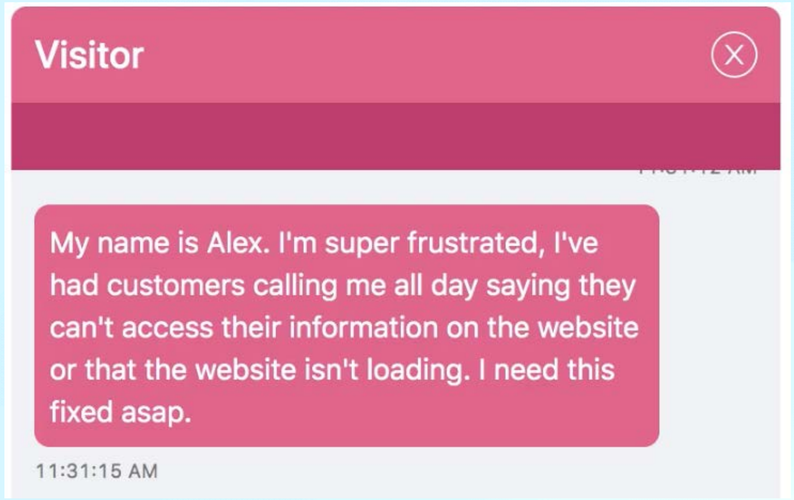
Shakked Noy and Whitney Zhang 2023

Using a LLM to support call-center work — Evidence from a commercial rollout

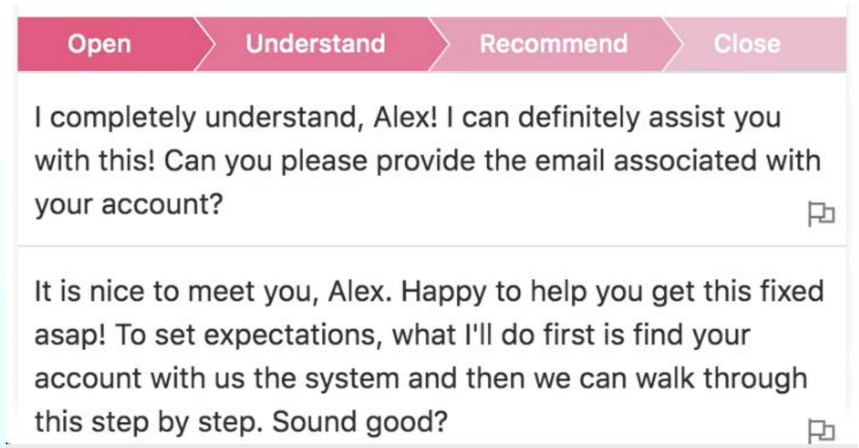
Brynjolfsson, Li, and Raymond 2023

Using a LLM to support call-center work — Evidence from a commercial rollout

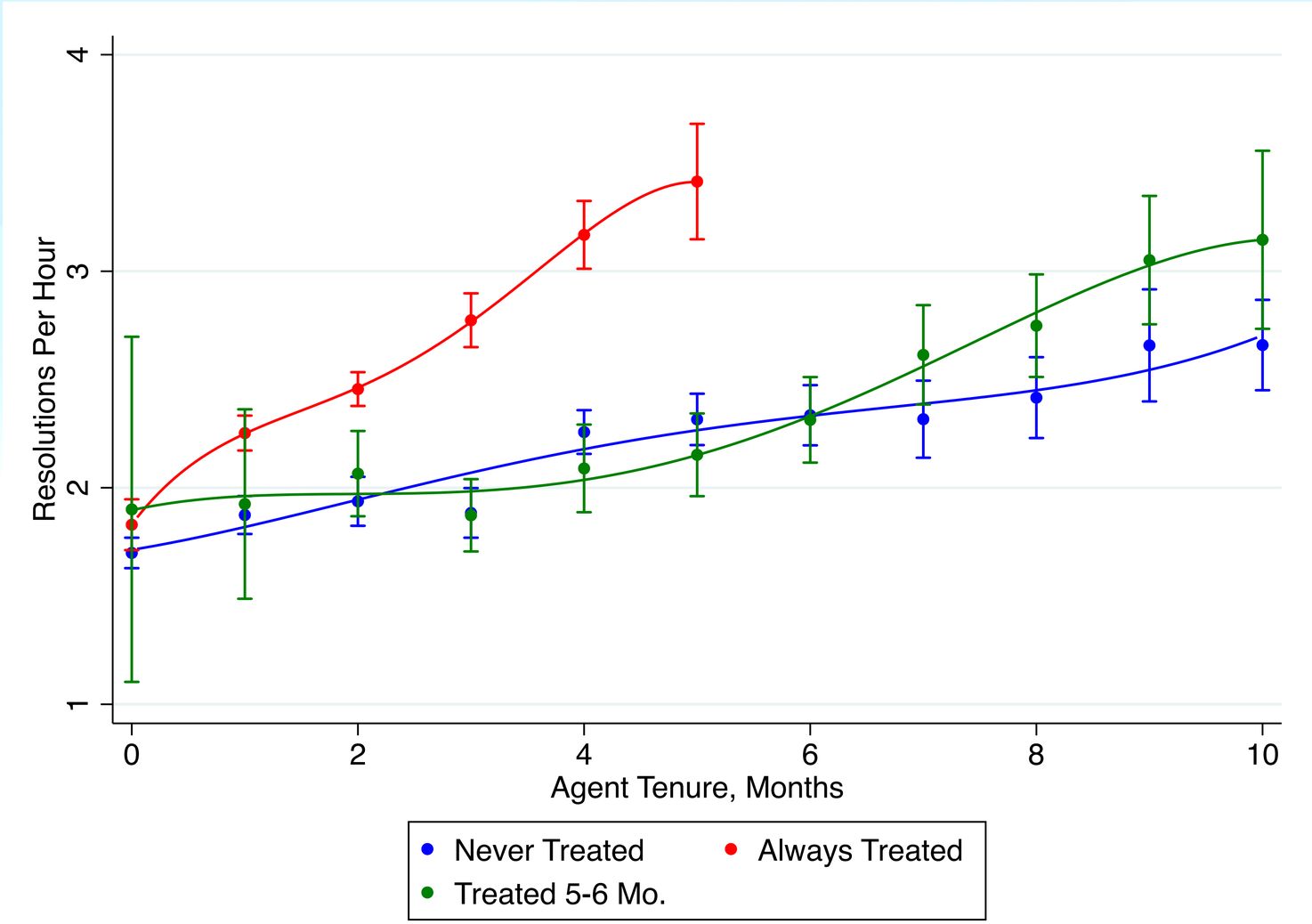
A. Sample Customer Issue



B. Sample AI-generated Suggested Response

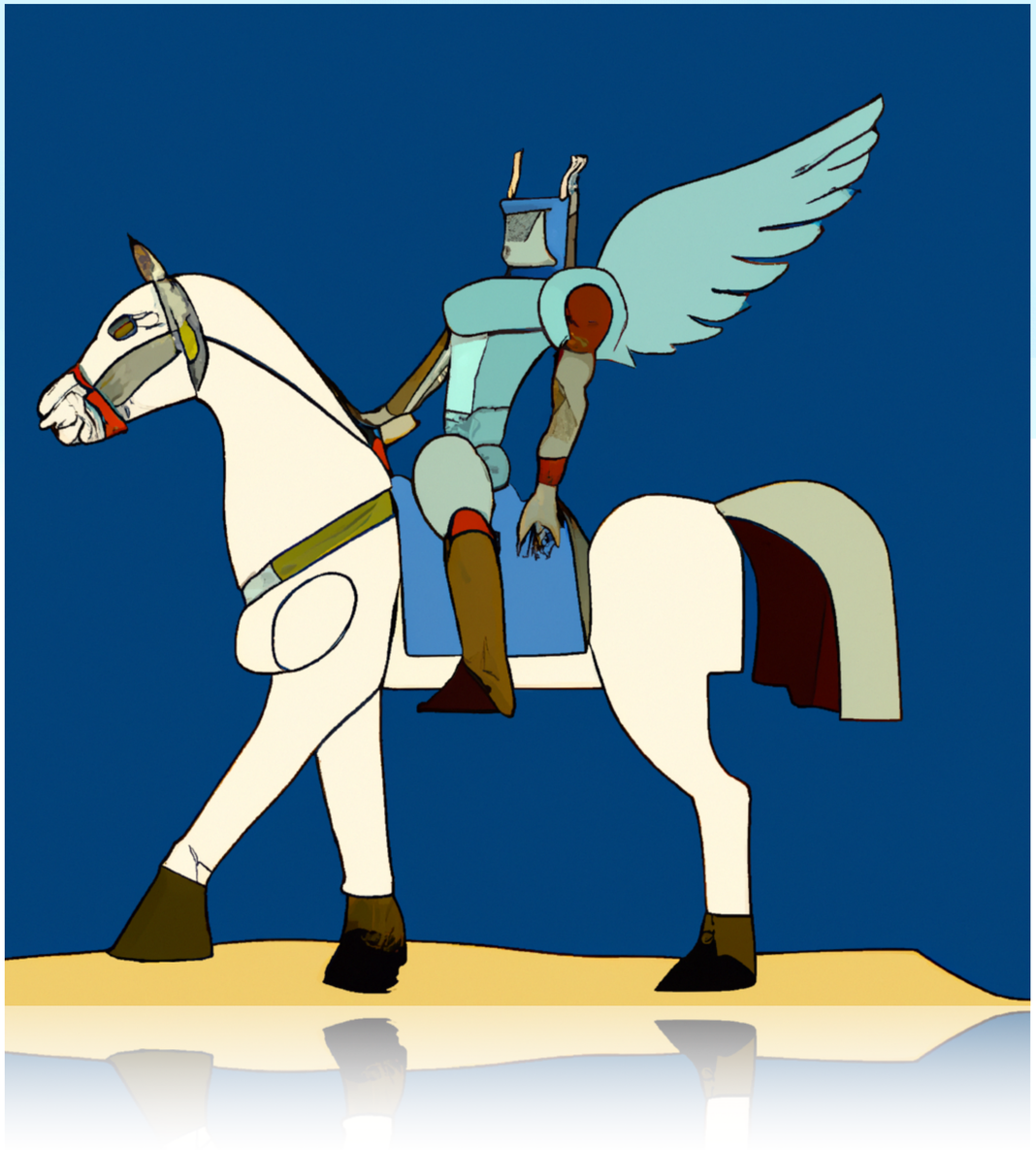


Resolutions Per Hour, by Agent Tenure



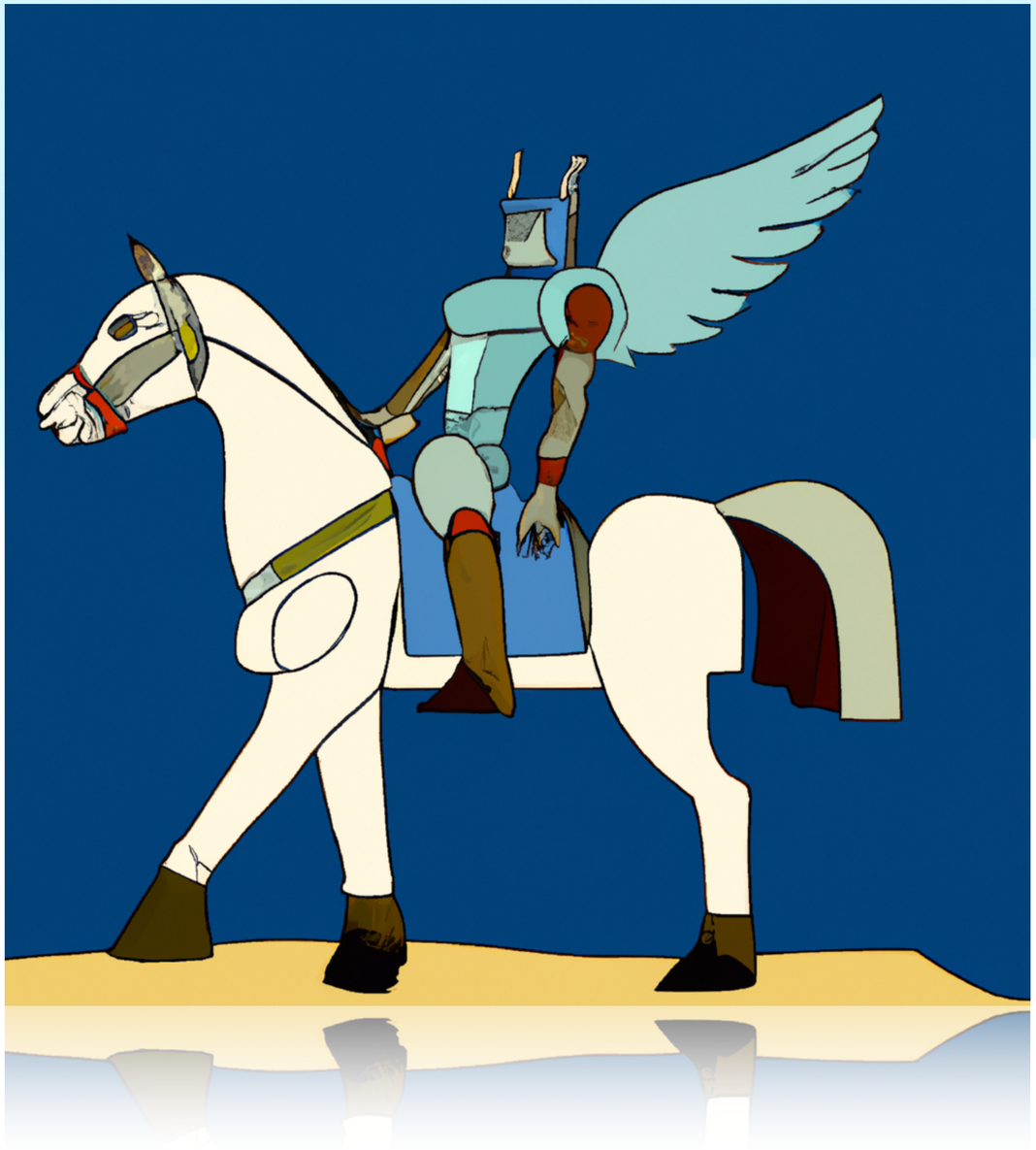
Brynjolfsson, Li, and Raymond 2023

‘Leveling up’ expertise at scale — Some critical questions



‘Leveling up’ expertise at scale — Some critical questions

1. Who is complemented — Does AI reduce the inequality of productivity?



‘Leveling up’ expertise at scale — Some critical questions

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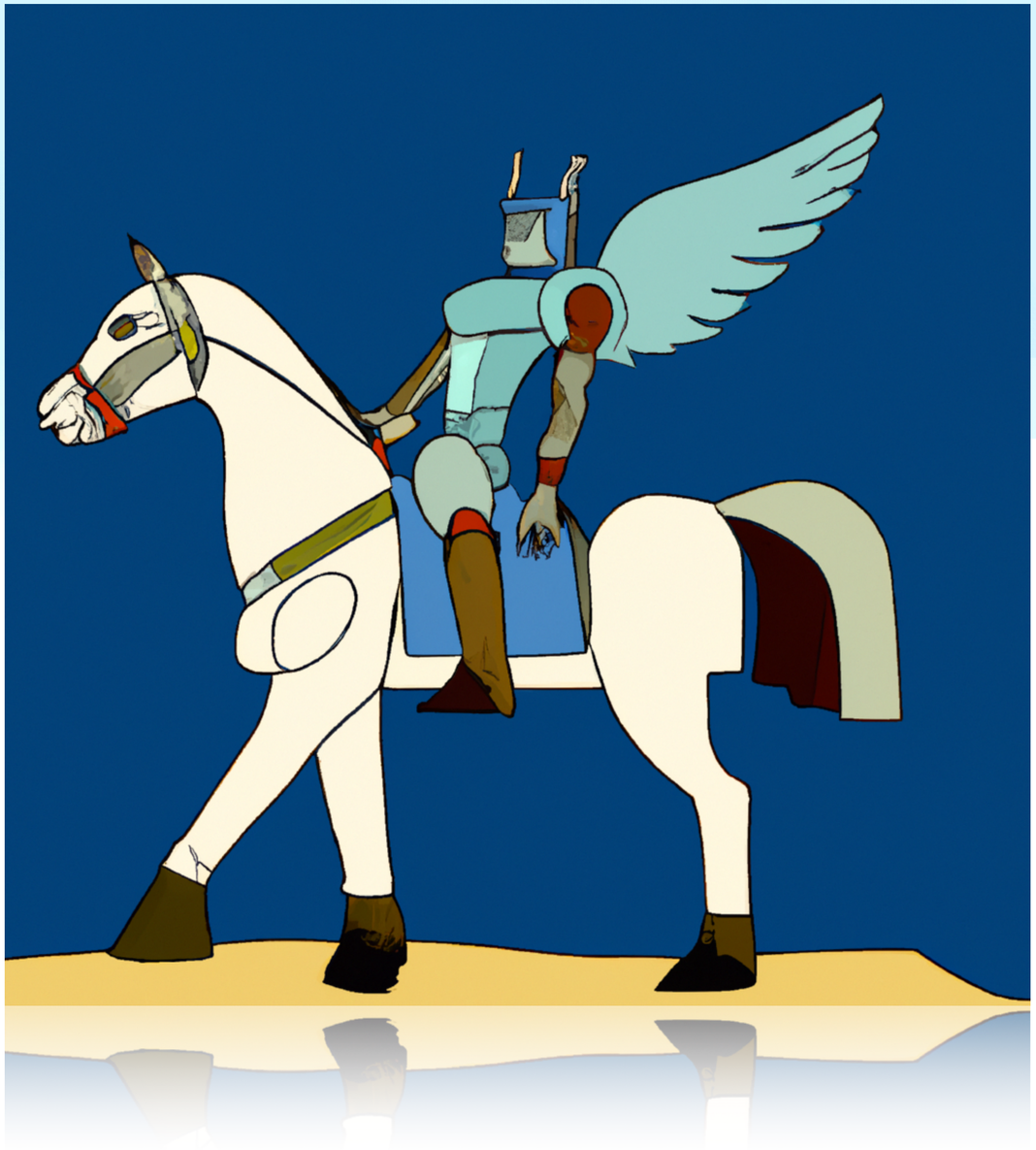

‘Leveling up’ expertise at scale — Some critical questions

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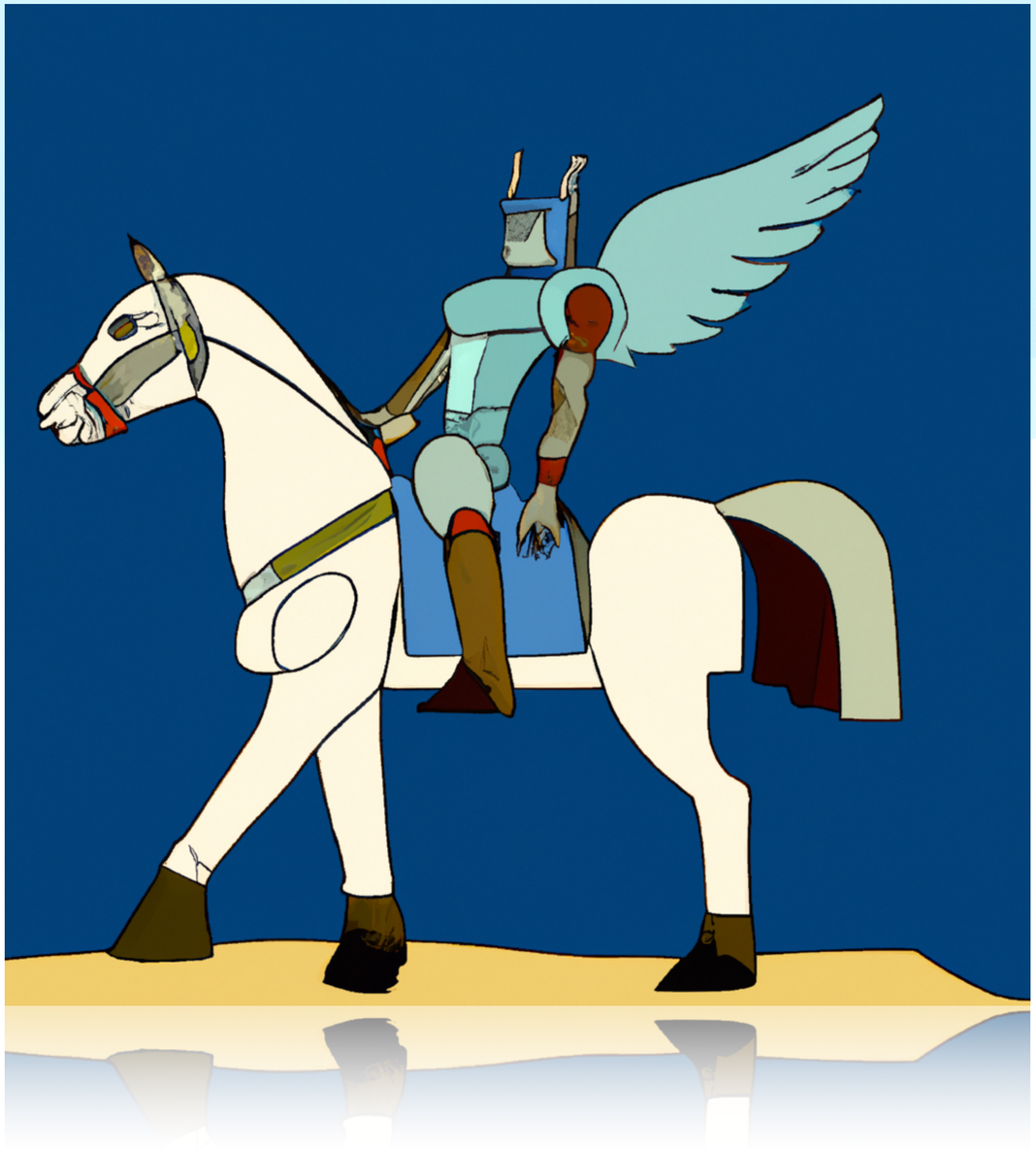
2. Who is substituted — Non-users, elite experts?
3. Will ‘leveling up’ make expertise more valuable—or ‘too cheap to meter’?



Will AI augment expertise or displace experts?

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Will AI augment expertise or displace experts?

- *"The future is not a forecasting exercise; it's a design problem"*
  — Josh Cohen, Apple University

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- **The jobs we get depend on how we *choose* to build and apply the technology**

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Artificial Intelligence — The ‘Great Firewall’ of China

Artificial Intelligence — The ‘Great Firewall’ of China

- The world’s most effective automated censorship system
- The world’s most compre-hensive surveillance state

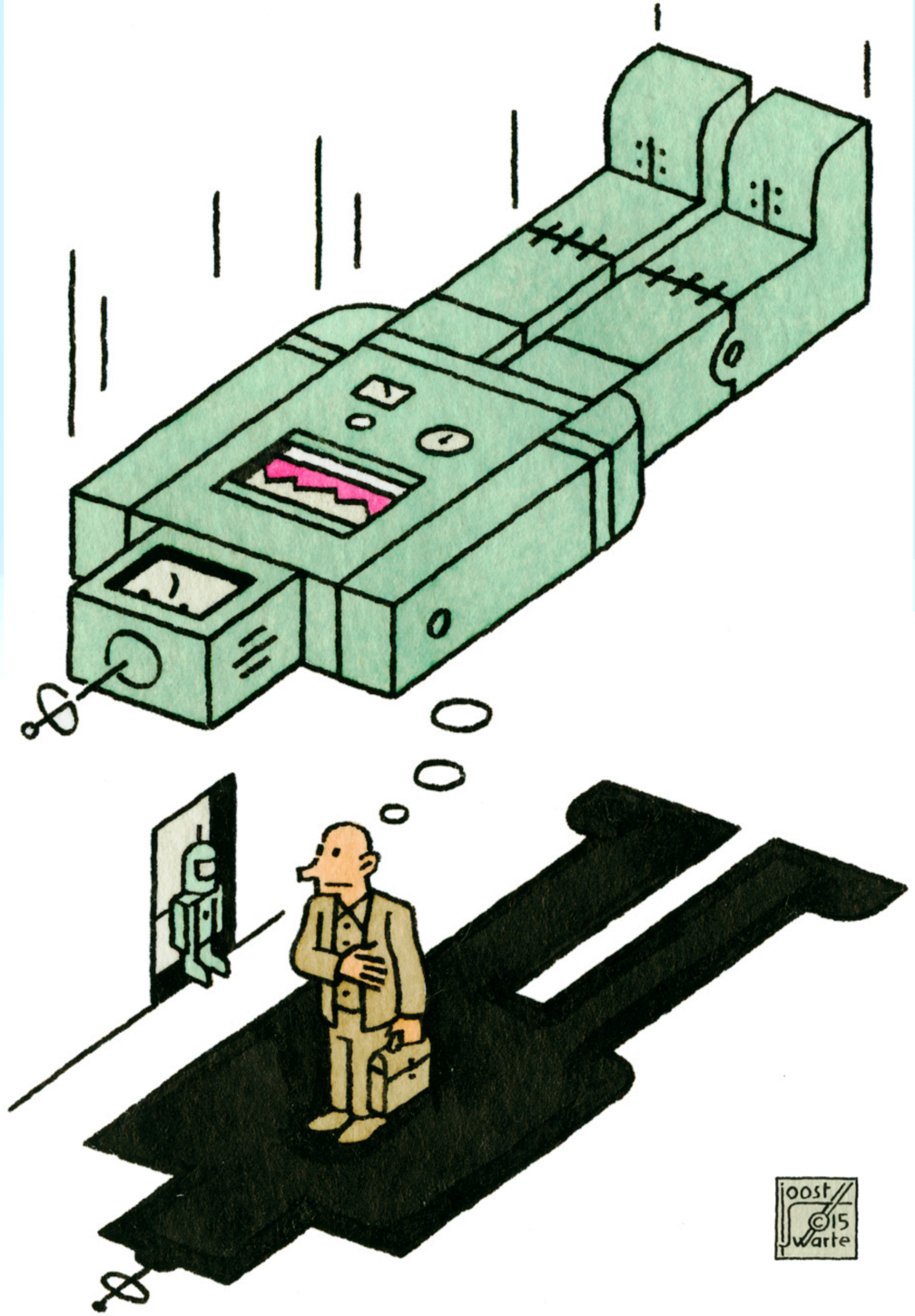
Artificial Intelligence — Augmenting human capacities

Artificial Intelligence — Augmenting human capacities

- **Assisting with elder care**, telepresent ('robotic') surgery, mobile medicine
- **Providing real-time info** for workers doing construction, diagnosis, maintenance, repair (e.g., Google Glass)
- **Enabling immersive learning** through augmented and virtual reality — cheap, convenient, fun

What About —

‘The End of Work’?



“There will come a point where no job is needed.” – Elon Musk, 2023

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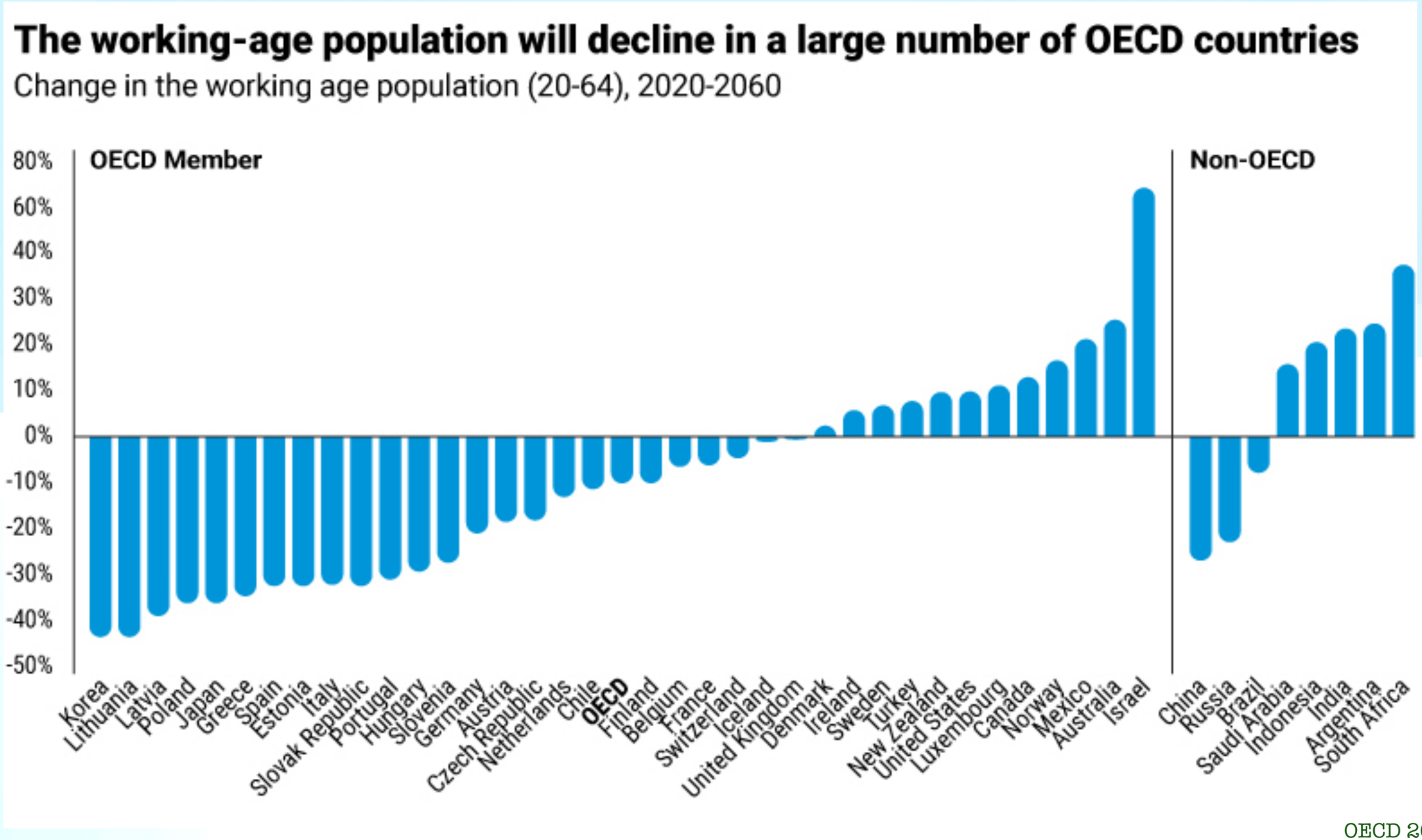
“Get a job as a plumber.” – Geoffrey Hinton, 2023

Working-age pop falling in Europe and Asia, 2020–2060



OECD 2020

Most innovations do not automate work

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Otto Lilienthal, Gliding experiment
1894 (2 years before death)

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Otto Lilienthal, Gliding experiment
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Scanning Electron Microscope, mid-1970s
Dr Graham Beards, https://commons.wikimedia.org/w/index.php?curid=81768453

What is new work? New job titles captured by U.S. Census, 1940–2018

1940

1950

1960

1970

1980

1990

2000

2010

2018

Autor, Chin, Salomons, Seegmiller 2022

What is new work? New job titles captured by U.S. Census, 1940–2018

1940	Automatic welding machine operator
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1960	Textile chemist
1970	Engineer computer application
1980	Controller, remotely-piloted vehicle
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2018	Cybersecurity analyst

Autor, Chin, Salomons, Seegmiller 2022

What is new work? New job titles captured by U.S. Census, 1940–2018

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1950	Airplane designer	Tattooer
1960	Textile chemist	Pageants director
1970	Engineer computer application	Mental-health counselor
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1990	Circuit layout designer	Conference planner
2000	Artificial intelligence specialist	Amusement park worker
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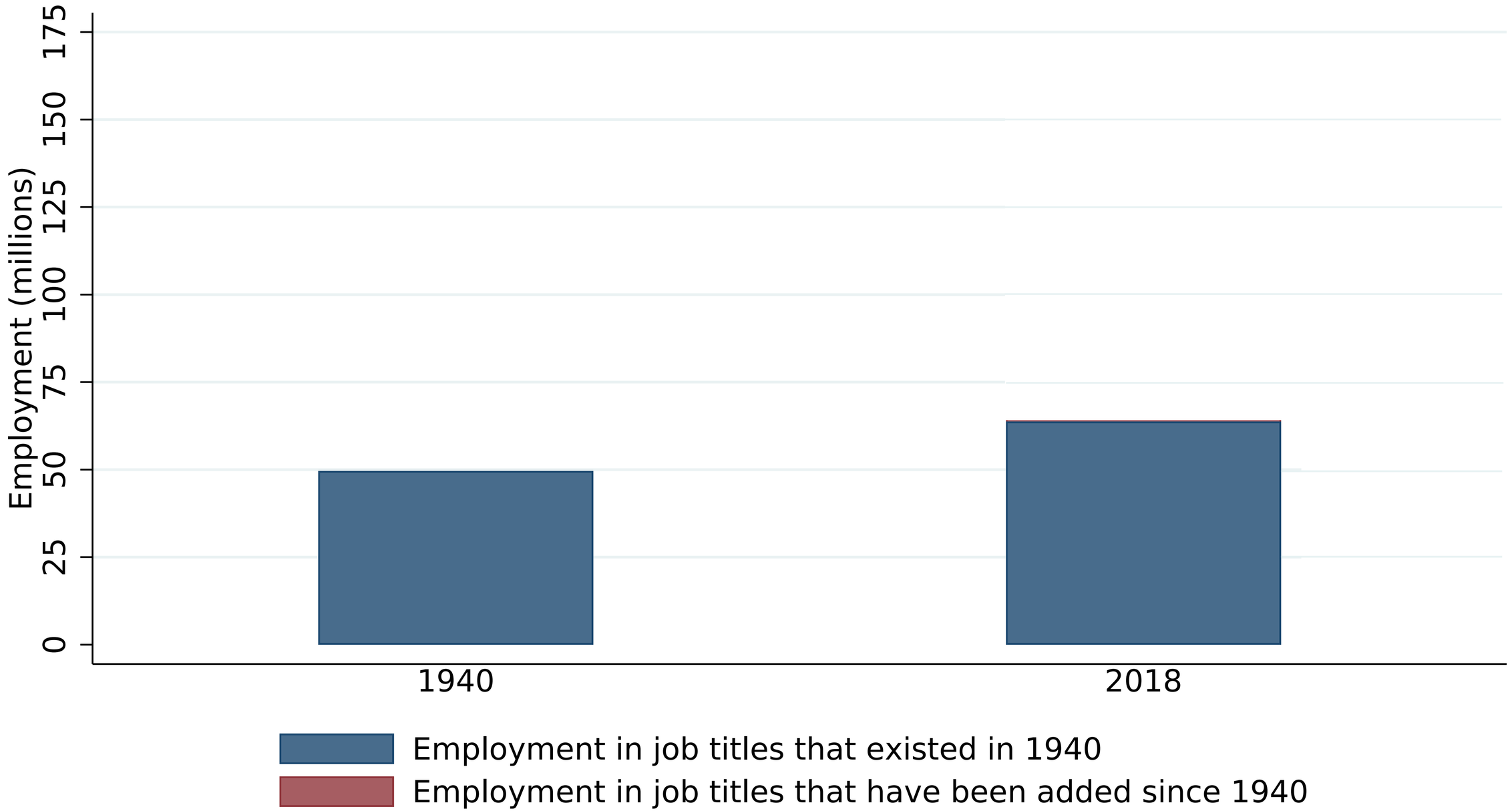
Autor, Chin, Salomons, Seegmiller 2022

How much new work is there?



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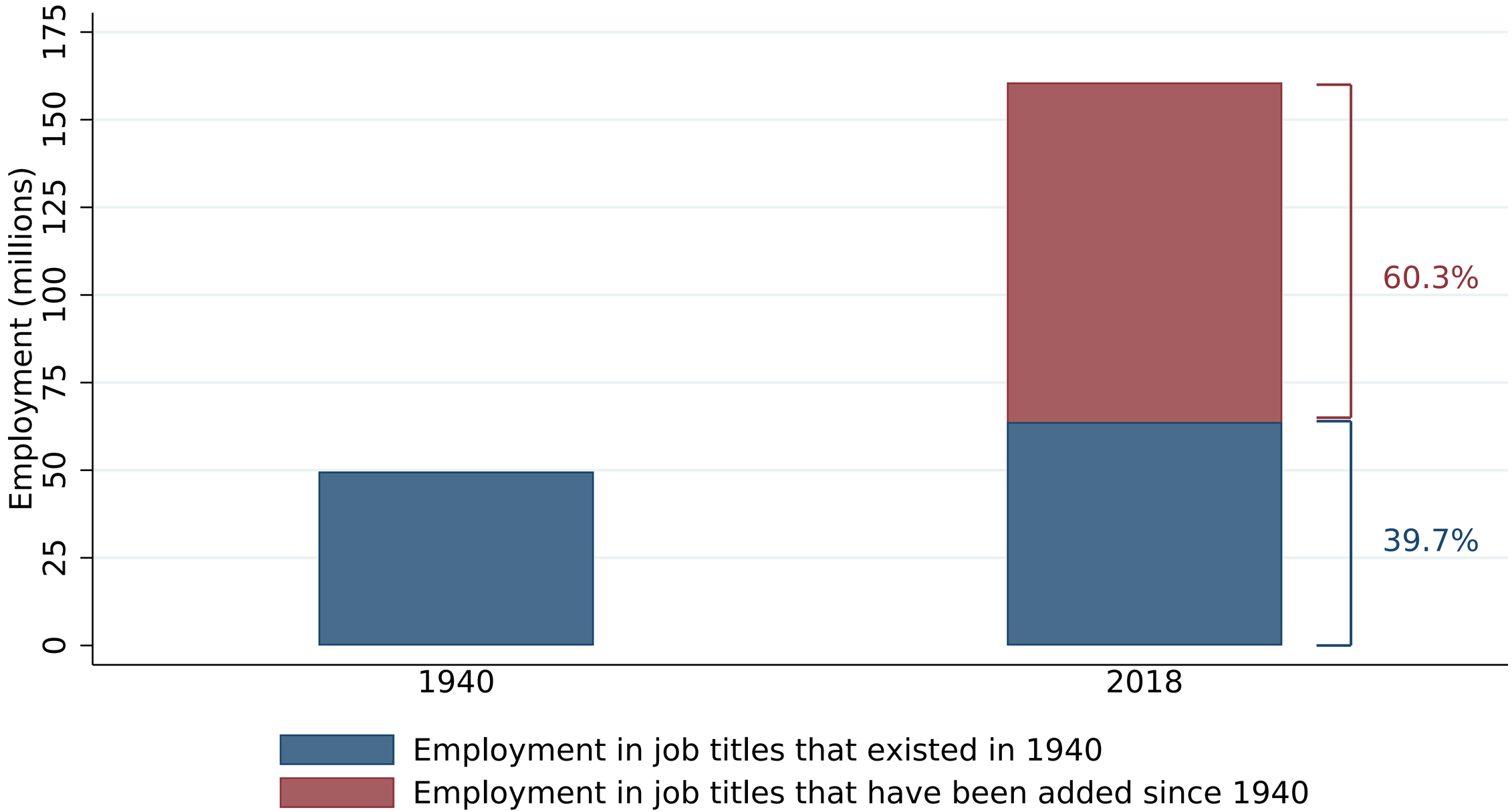

Autor, Chin, Salomons, Seegmiller 2022

The questions we should be asking

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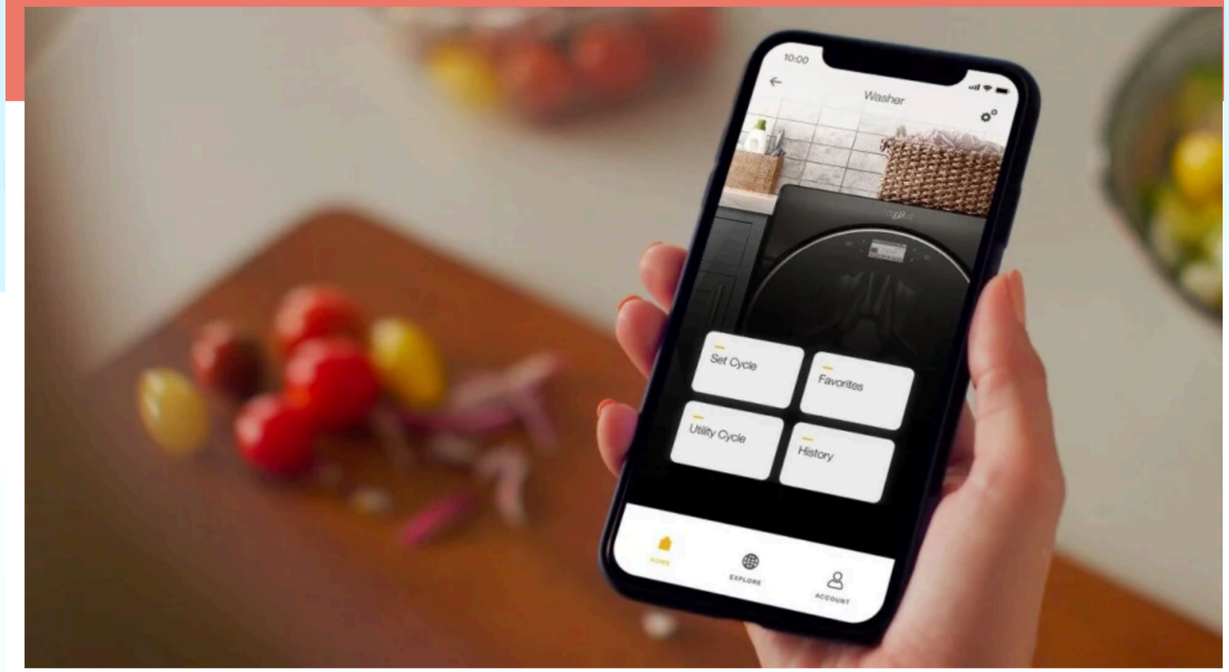
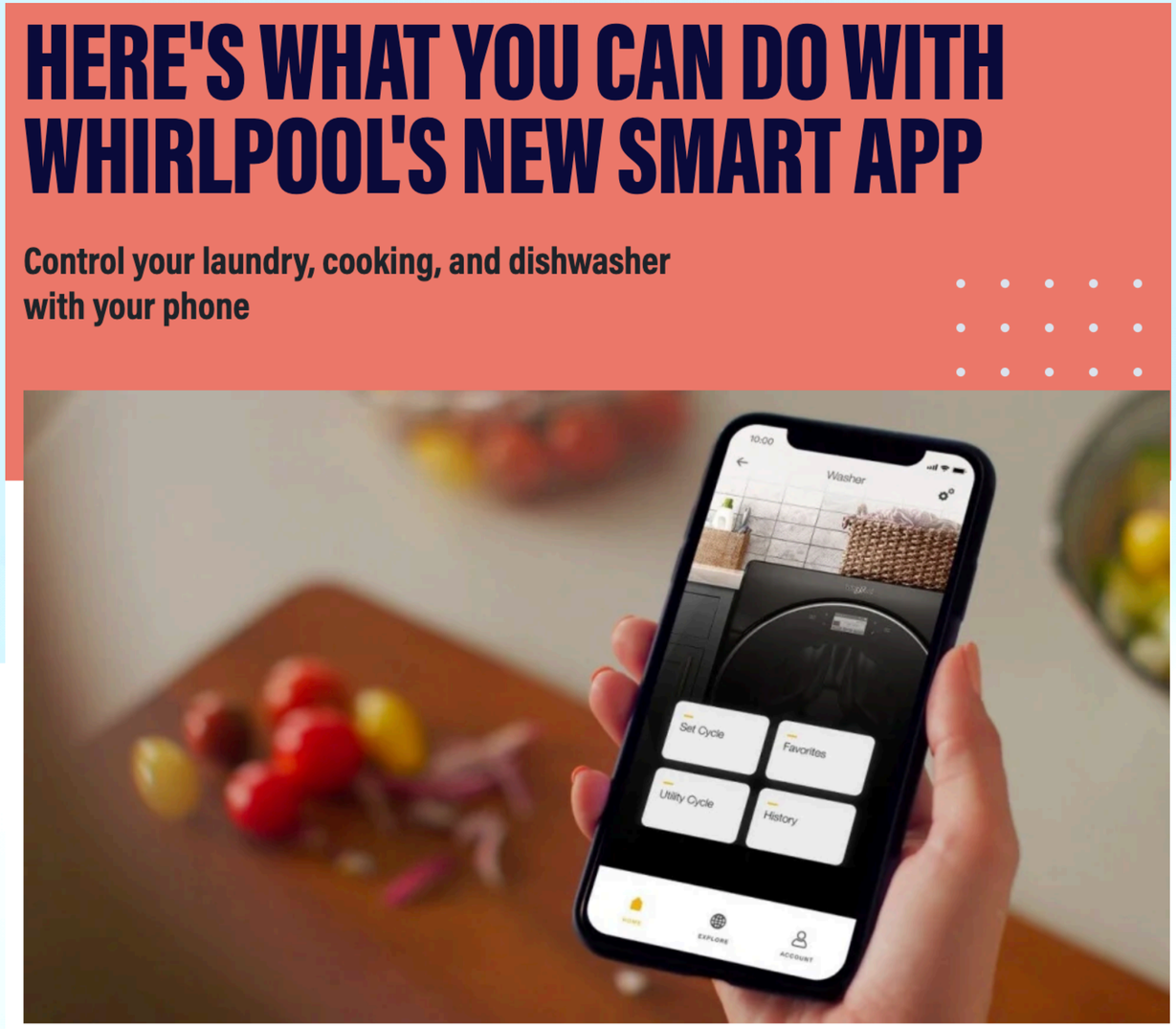
3. How can industry, government, universities, trade unions shape the work of the future?

HERE'S WHAT YOU CAN DO WITH WHIRLPOOL'S NEW SMART APP

Control your laundry, cooking, and dishwasher with your phone



Whirlpool washing machine smart app, 2023



Whirlpool washing machine smart app, 2023

The Apollo Guidance Computer (AGC), 1966

Beyond replicating human capabilities, we should be looking for moonshots

Thank You