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# Future of Work and Workers: Potential Roles for Automation and Control

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Singapore,  
15 December 2023

Pramod P. Khargonekar  
UC Irvine

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Artificial intelligence Added

# Generative AI set to affect 300mn jobs across major economies

Technology could boost global GDP by 7% but also risks creating 'significant disruption'

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Premium

# AI and the future of employment: The possibility of AI leading to large-scale loss of jobs is no longer faraway

May 11, 2023 - World

## Survey: Latinos open to AI for minor tasks but fear it will replace them

Marina E. Franco (Noticias Telemundo for Axios)

TheUpshot

# In Reversal Because of A.I., Office Jobs Are Now More at Risk

Technology disruption typically affected blue-collar occupations. Now white-collar workers may feel the brunt of changes.

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China News Society Innovation HK/Macao Cross-Strait Cover Story Photo

Home / China / GBA focus

## How big a threat is AI to the workforce?

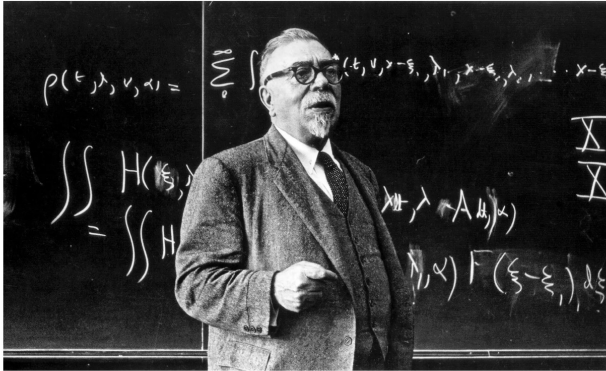
By Zhang Tianyuan | HK EDITION | Updated: 2023-06-12 11:03

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The growing capabilities of artificial intelligence-related tools and services have propelled fears of job losses in various industries. Experts suggest that workers, instead of worrying, collaborate with AI and hone their expertise to face the new normal. Zhang Tianyuan reports from Hong Kong.

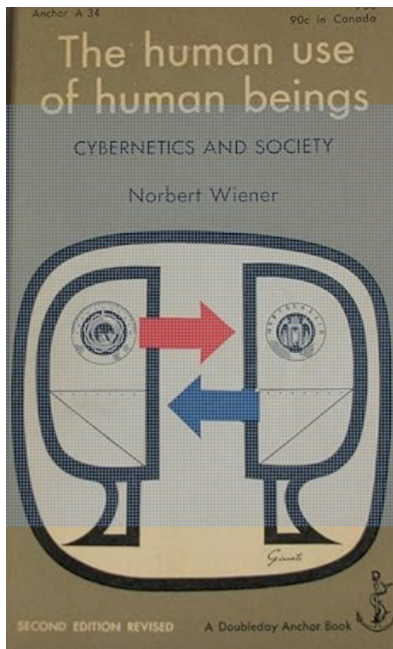
# In 1949, He Imagined an Age of Robots

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Norbert Wiener, the visionary mathematician whose essay "The Machine Age" languished for six decades in the M.I.T. archives. Massachusetts Institute of Technology

Source: [J. Markoff, NY Times, May 20, 2013](#)



1954

“If we combine our machine-potentials of a factory with the valuation of human beings on which our present factory system is based, we are in for an industrial revolution of unmitigated cruelty.” ...

“Finally the machines will do what we ask them to do and not what we ought to ask them to do.”

...

“Moreover, if we move in the direction of making machines which learn and whose behavior is modified by experience, we must face the fact that every degree of independence we give the machine is a degree of possible defiance of our wishes.”

# AI is the Next General-Purpose Technology

General purpose technologies

‘Engines of growth’?

Timothy F. Bresnahan<sup>\*.a.c</sup>, M. Trajtenberg<sup>b.c</sup>

## Characteristics of a General-Purpose Technology

- Widespread applicability
- Continuous improvement
- No close substitutes
- Enabling complementary innovations

## GPTs are GPTs: An Early Look at the Labor Market Impact Potential of Large Language Models

Tyna Eloundou<sup>1</sup>, Sam Manning<sup>1,2</sup>, Pamela Mishkin<sup>\*1</sup>, and Daniel Rock<sup>3</sup>

<sup>1</sup>OpenAI

<sup>2</sup>OpenResearch

<sup>3</sup>University of Pennsylvania

March 20, 2023

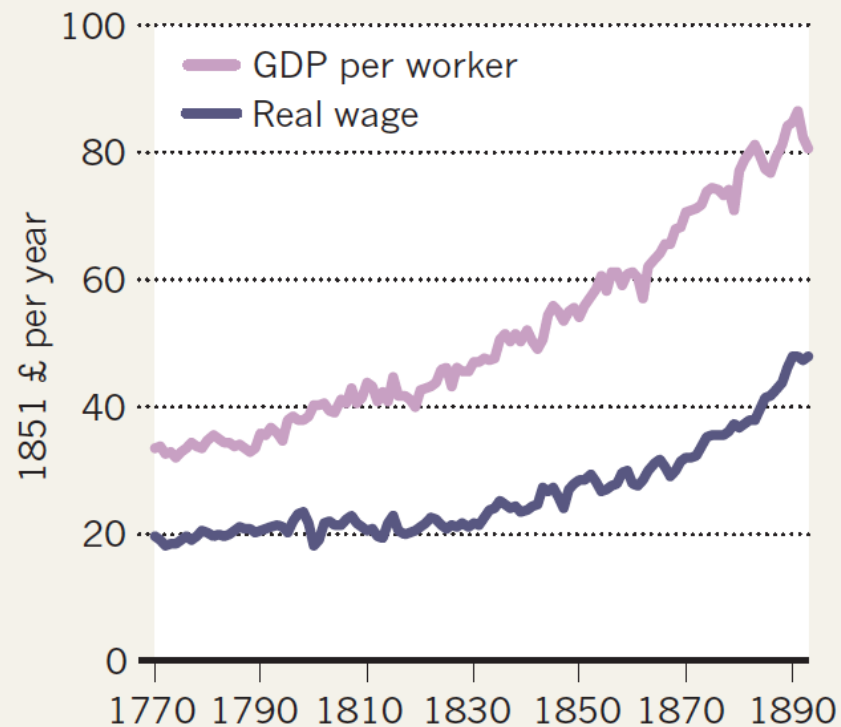
## Examples of General-Purpose Technologies as Epochal Innovations

- Mechanization (steam engine)
- Electricity
- Computers, internet, web (ICT)

# Mechanization Spawned the Industrial Revolution

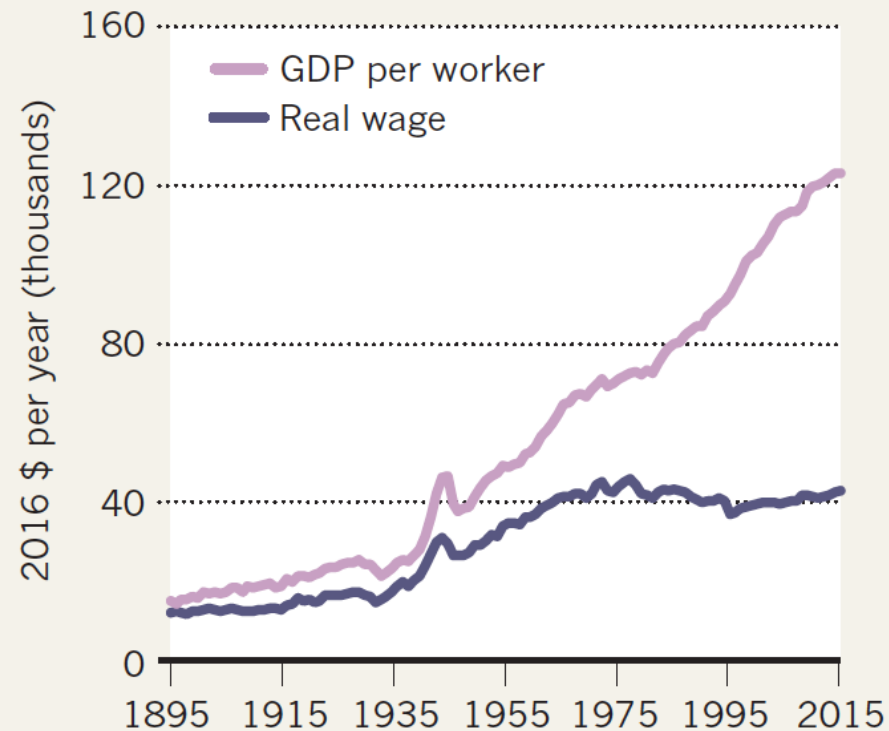
## *Wages in Britain 1770–1893*

At the start of the Industrial Revolution, productivity grew, but wages did not; after 1830, as mechanization gathered pace, wages and output moved in lockstep.



## *Wages in the United States 1895–2015*

At the beginning of the twentieth century, wages rose with increasing productivity; since the 1970s, they have stagnated as output per worker has continued to rise.

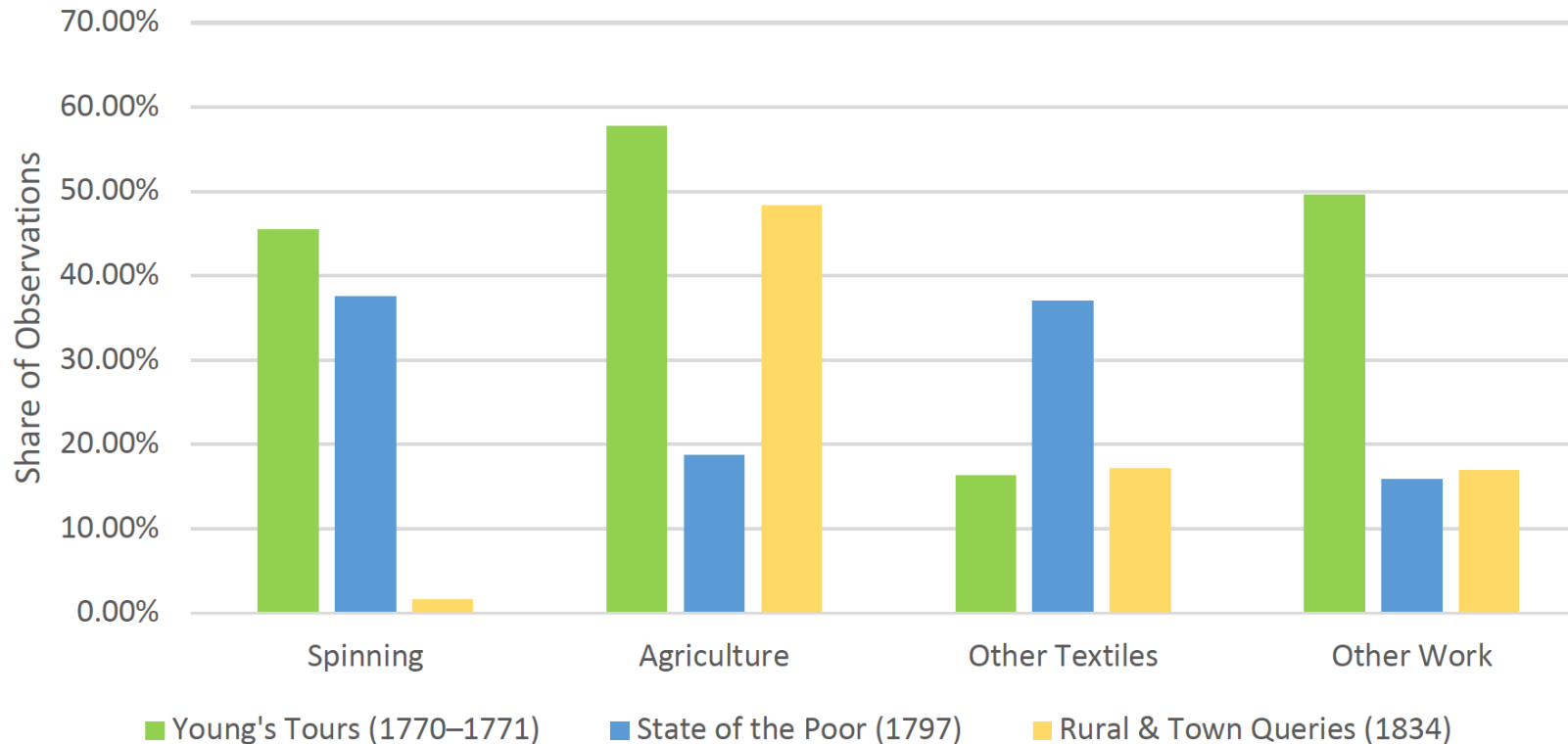


“The new normal in the West was productivity and wages advancing together, as the Industrial Revolution spread across Europe and North America. ...

By the 1830s, technological progress in the West meant a bleak future of work elsewhere.”

# Disruptive Impact on Workers and Work in the UK

Figure 7: Types of Work for Women in England & Wales, 1770–1834



“Within a little more than 50 years, innovations eliminated an occupation that had employed nearly one in five women and children. This is one of the earliest examples of mass technological unemployment, and the largest instance yet documented.”

# Automation and Work

- Displacement of jobs
- Changes in the composition of tasks
- New tasks, jobs, work, economic sectors
- Worker productivity
- Economy and society

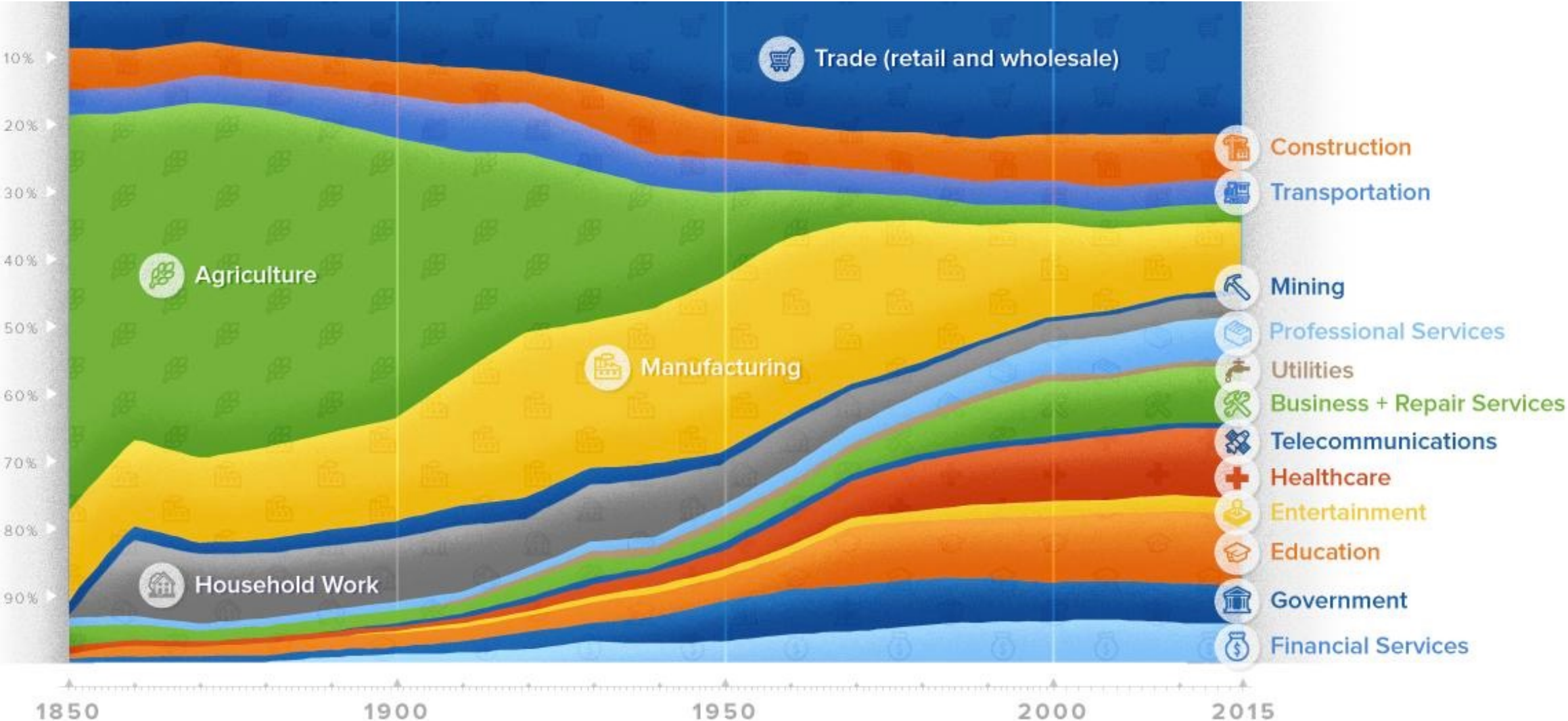
# Automation and Workers

David Autor  
Anna Salomons

“Indeed, one of the central stylized facts of modern macroeconomics, immortalized by Kaldor (1961), is that during a century of unprecedented technological advancement in transportation, production, and communication, labor’s share of national income remained roughly constant (Jones and Romer, 2010). This empirical regularity, which Keynes (1939) deemed “a bit of a miracle,” has provided economists—though not the lay public—with grounds for optimism that, despite seemingly limitless possibilities for labor-saving technological progress, automation need not displace labor as a factor of production.”



# How will This Pattern Evolve in the Next Decades?



Source: World Economic Forum, [Visual Capitalist](#), McKinsey Global Institute, 2019

# Automation and Work

## Automation and New Tasks: How Technology Displaces and Reinstates Labor

Daron Acemoglu and Pascual Restrepo

“The reason why we have had rapid wage growth and stable labor shares in the past is a consequence of other technological changes that generated new tasks for labor and counterbalanced the effects of automation on the task content of production. Some technologies displaced labor from automated tasks while others reinstated labor into new tasks. On net, labor retained a key role in production. By the same token, our framework suggests that the future of work depends on the mixture of new technologies and how these change the task content of production.”

# Levels of Analysis and Action

- Individual
- Firm
- Community and Region
- Government
- Civil society
- Global community

# Generative AI and the future of work in America

July 2023

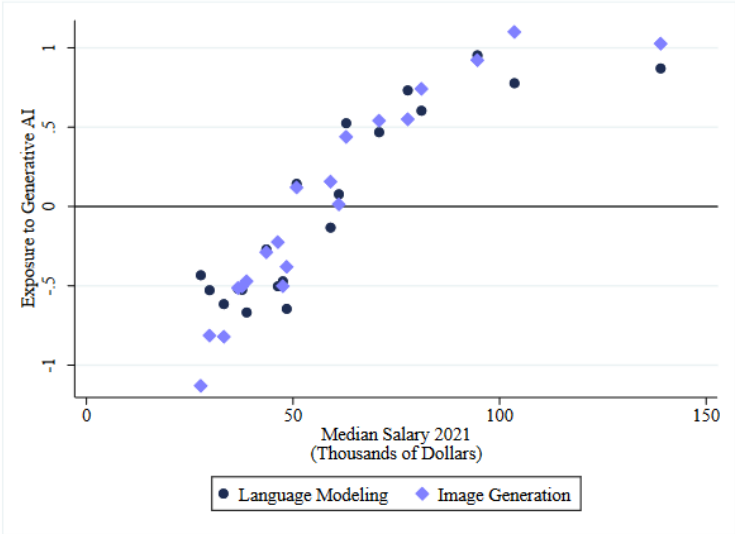
## With generative AI added to the picture, 30 percent of hours worked today could be automated by 2030.

Midpoint automation adoption<sup>1</sup> by 2030 as a share of time spent on work activities, US, %

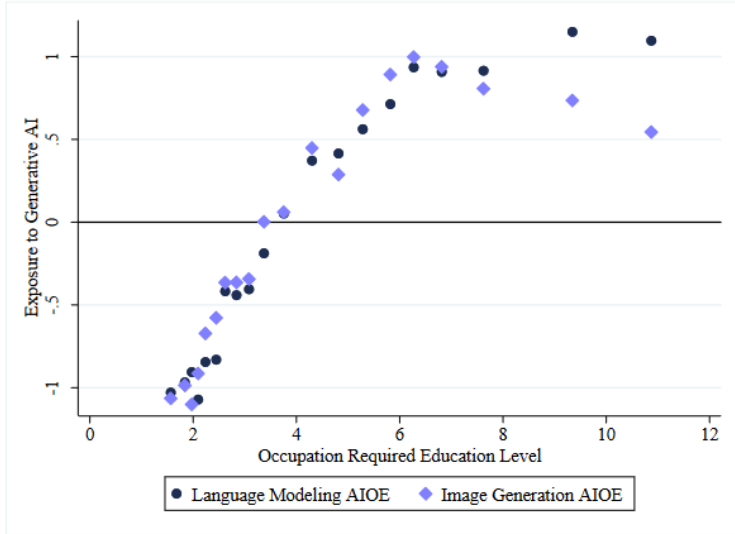


# Generative AI Exposure is Greater for More Educated and Higher Income People

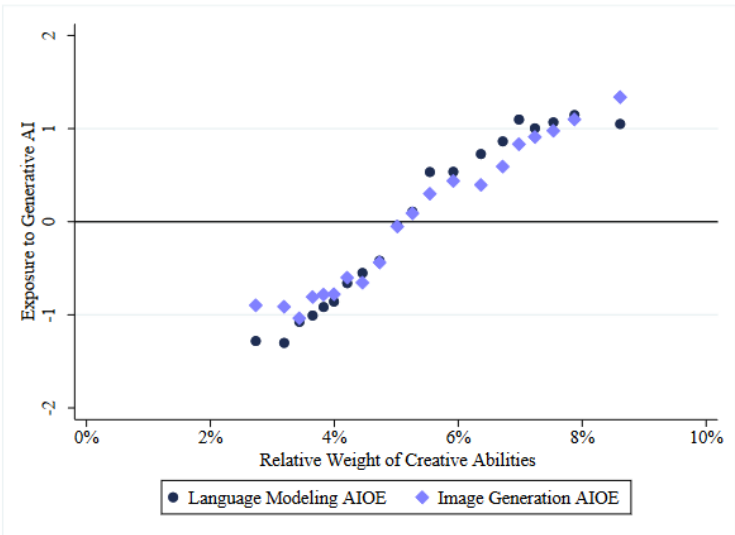
Panel A. Exposure to Generative AI and Median Salary.



Panel B. Exposure to Generative AI and Required Level of Education.



Panel C. Exposure to Generative AI and Presence of Creative Abilities.



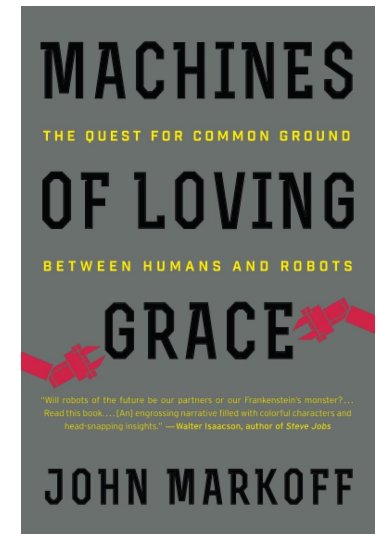
## Occupational Heterogeneity in Exposure to Generative AI

By Ed Felten (Princeton), Manav Raj (University of Pennsylvania), Robert Seamans (New York University)<sup>1</sup>

Source: [Felten, Raj, and Seamans, 2023](#)

# AI or IA

“As a result, AI has been transformed from an academic curiosity into a force that is altering countless aspects of the modern world. This has created an increasingly clear choice for designers — a choice that has become philosophical and ethical, rather than simply technical: will we design humans into or out of the systems that transport us, that grow our food, manufacture our goods, and provide our entertainment?”



Source: [J. Markoff, Machines of Loving Grace, 2015](#)

# Brynjolfsson: Turing Trap

The Turing Trap: The Promise & Peril of Human-Like Artificial Intelligence

*Erik Brynjolfsson*

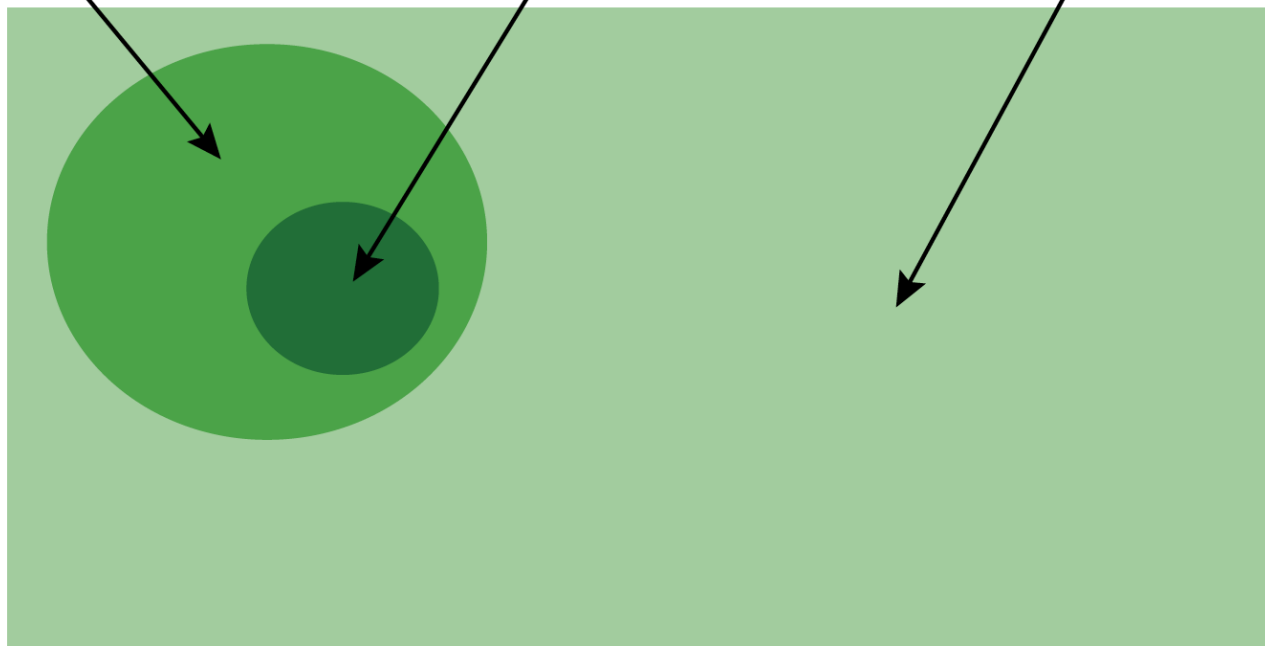
*Figure 1*

Opportunities for Augmenting Humans Are Far Greater than Opportunities to Automate Existing Tasks

Tasks That Humans Can Do

Human Tasks That Machines Could Automate

New Tasks That Humans Can Do with the Help of Machines



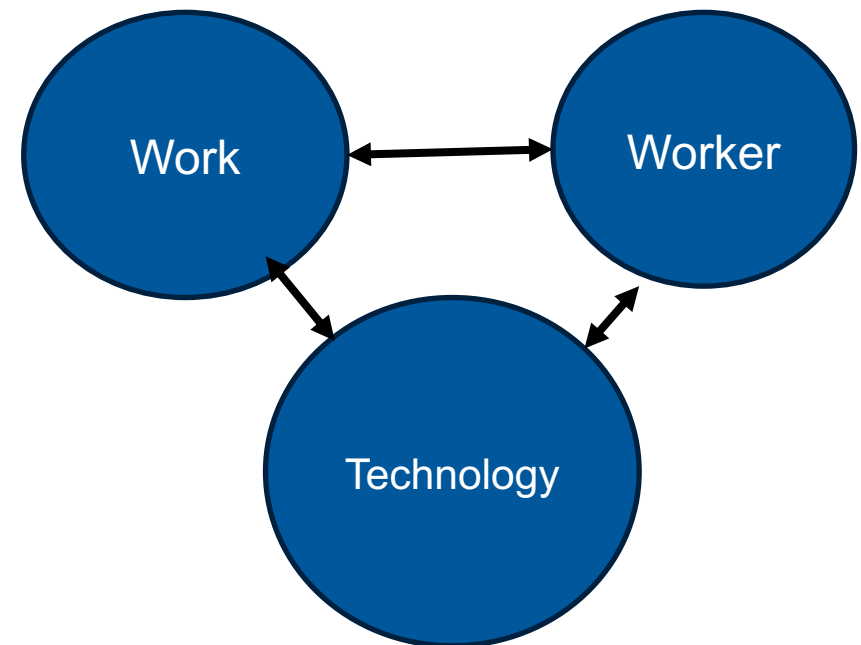
“A common fallacy is to assume that all or most productivity-enhancing innovations belong in the first category: automation. However, the second category, augmentation, has been far more important throughout most of the past two centuries.”

# NSF Big Idea: Future of Work at the Human-Technology Frontier



FWHTF

- Building the human-technology partnership
- Augmenting human performance
- Illuminating the socio-technological landscape
- Fostering lifelong learning





**“Technology presumes there’s just one right way to do things and there never is.”**

**Robert Pirsig**

**Zen and the Art of Motorcycle Maintenance**

# Four Levels of Automation

## Socially Responsible Automation: A Framework for Shaping the Future

Source: [Sampath and Khargonekar, 2018](#)

### Business Goals

### Stakeholder Values

Create new revenue streams & Good jobs

Socially responsible automation

**Society:** Employment, Prosperity, Opportunity

Enhance worker performance, skills, quality

Human centered automation

**Employee:** Safety, Autonomy, Achievement

Increase productivity, quality, accuracy

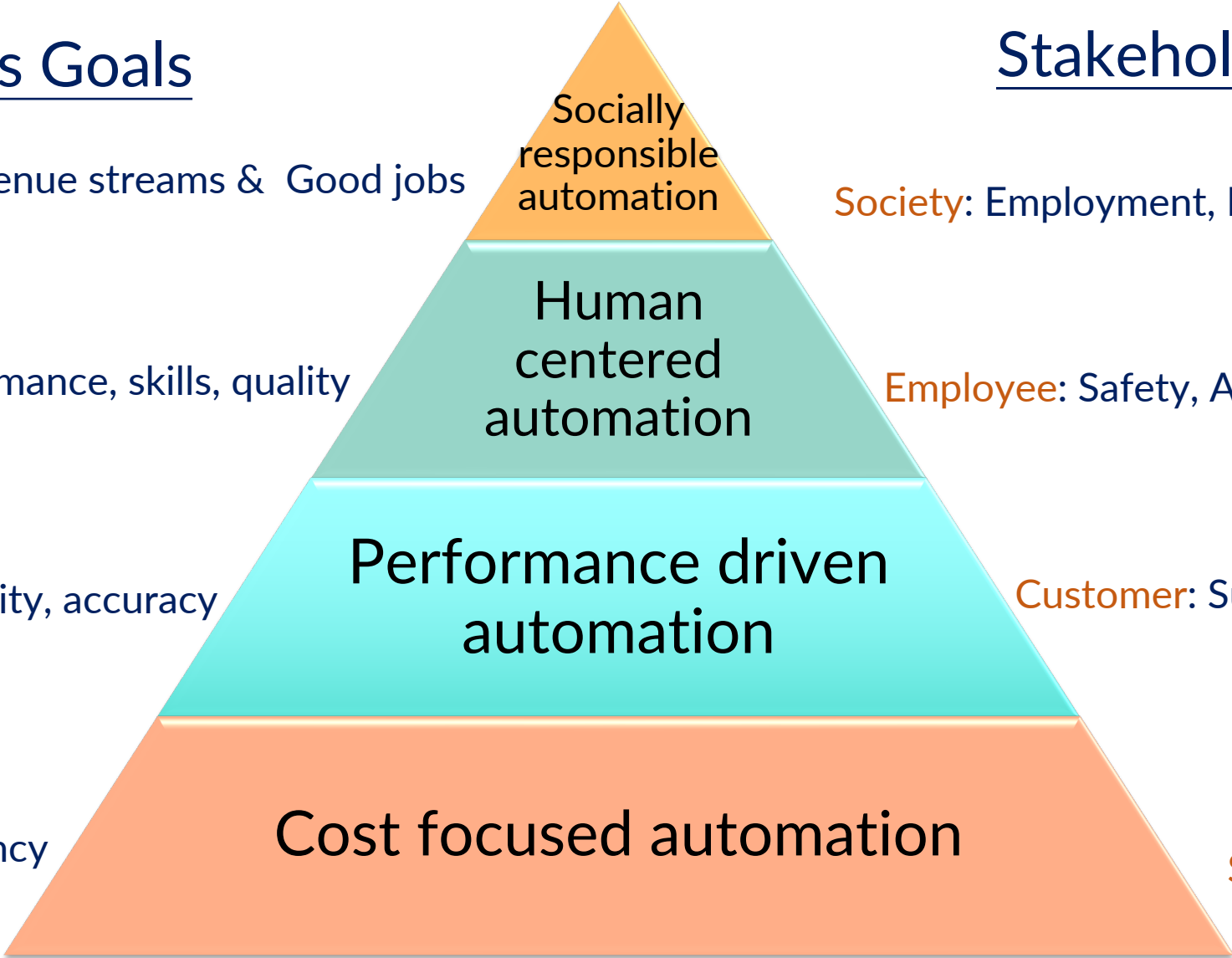
Performance driven automation

**Customer:** Superior Offering, Service

Drive cost efficiency

Cost focused automation

**Stockholder:** Profit



# SRA System Design Approach

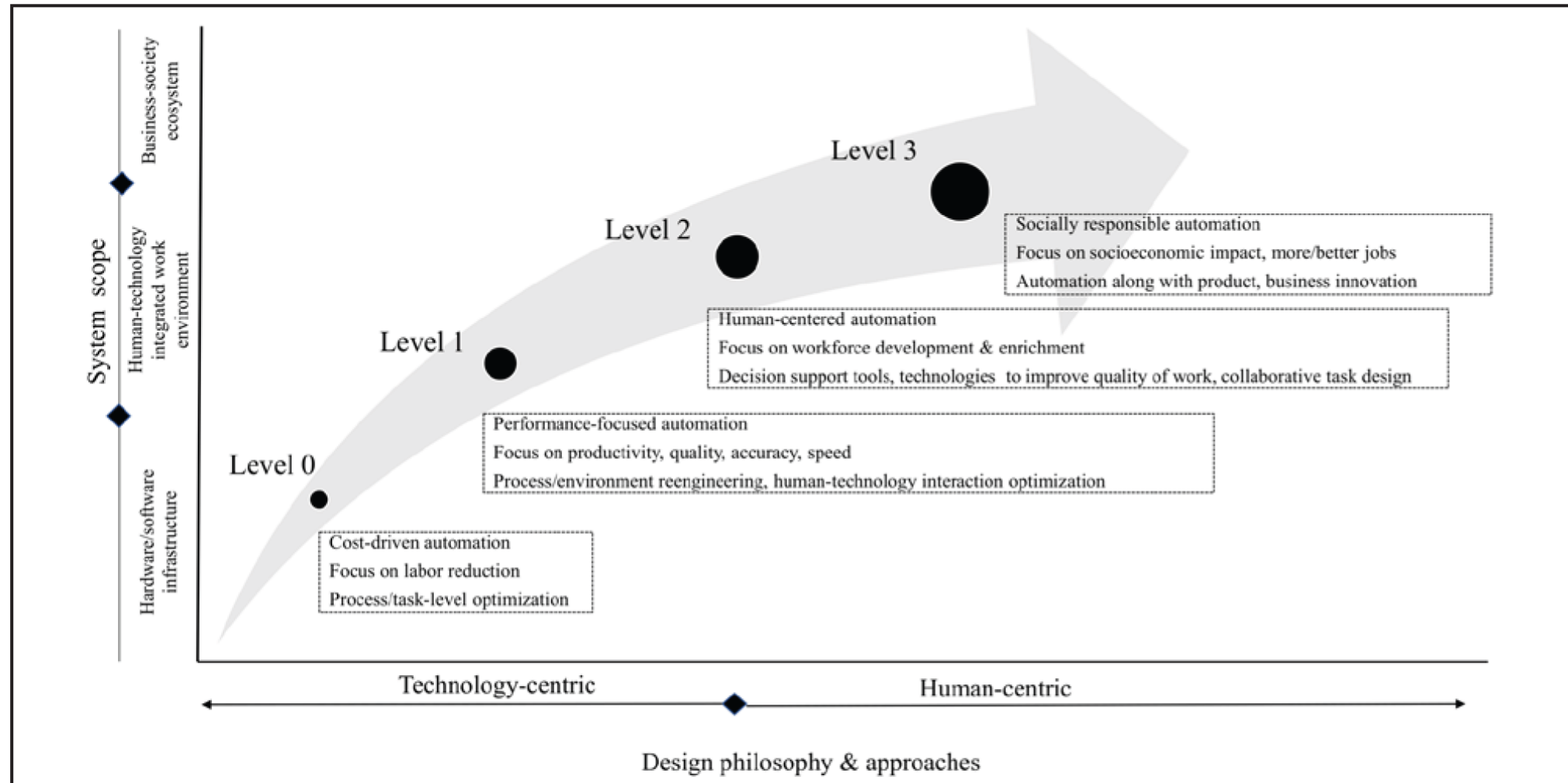
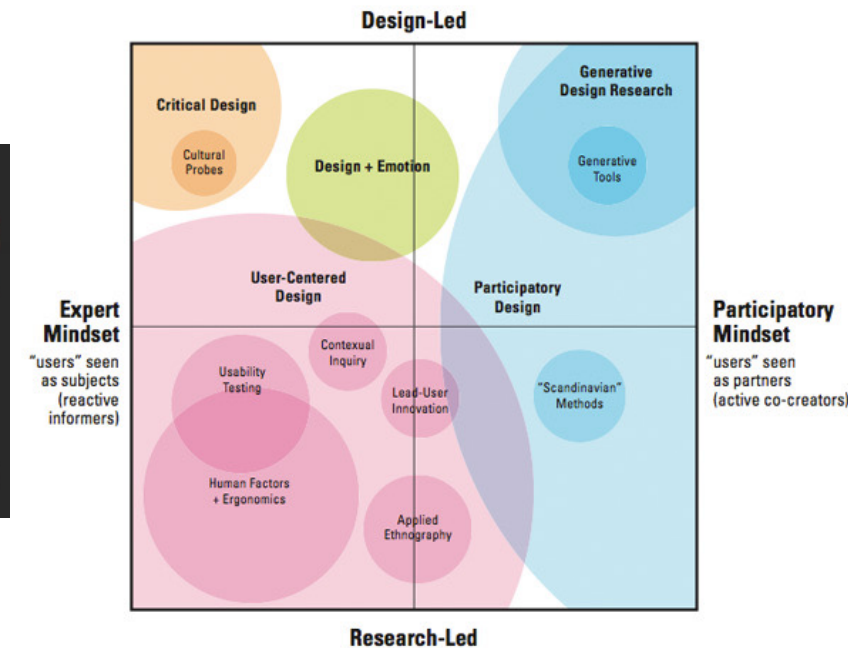
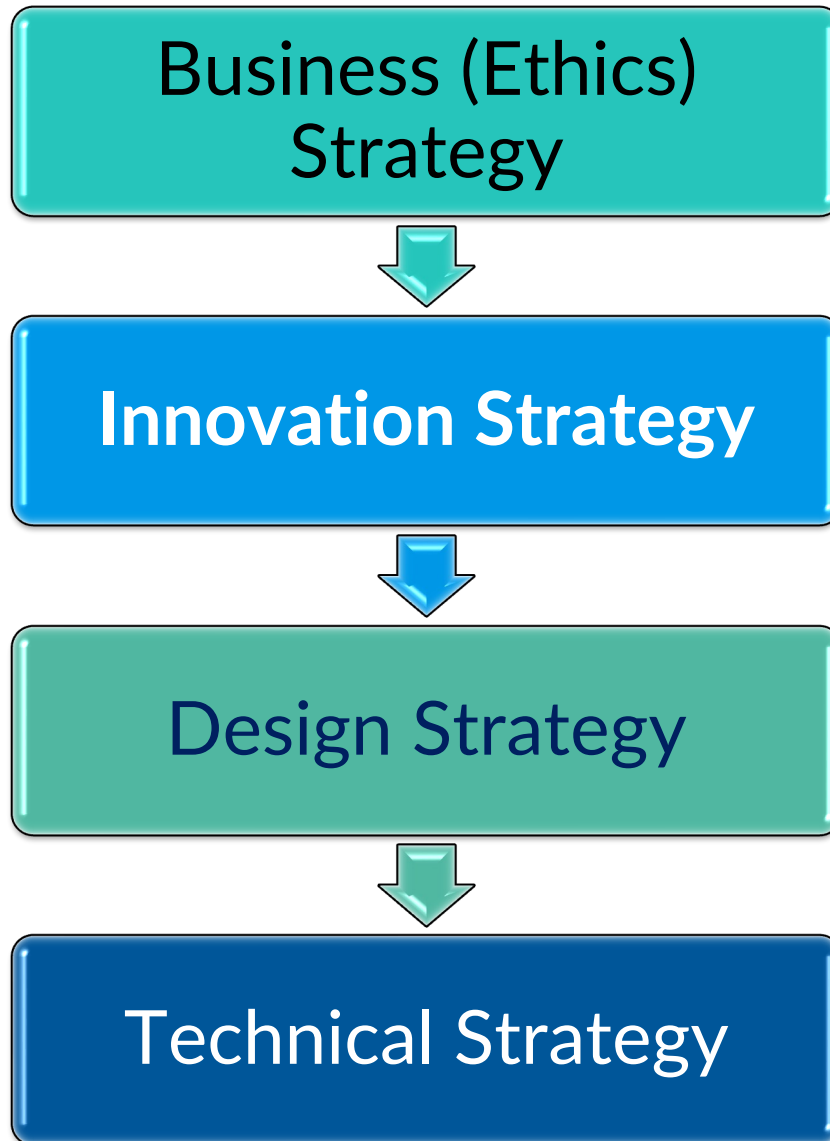


FIGURE 4 SRA requires a systems design approach. The progressively increasing system scope through the four levels of automation and the priorities at each level call for different design philosophies and design approaches that are technology- and/or human-centric.

# Realizing SRA: Multi-level Strategy

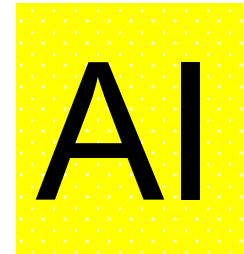
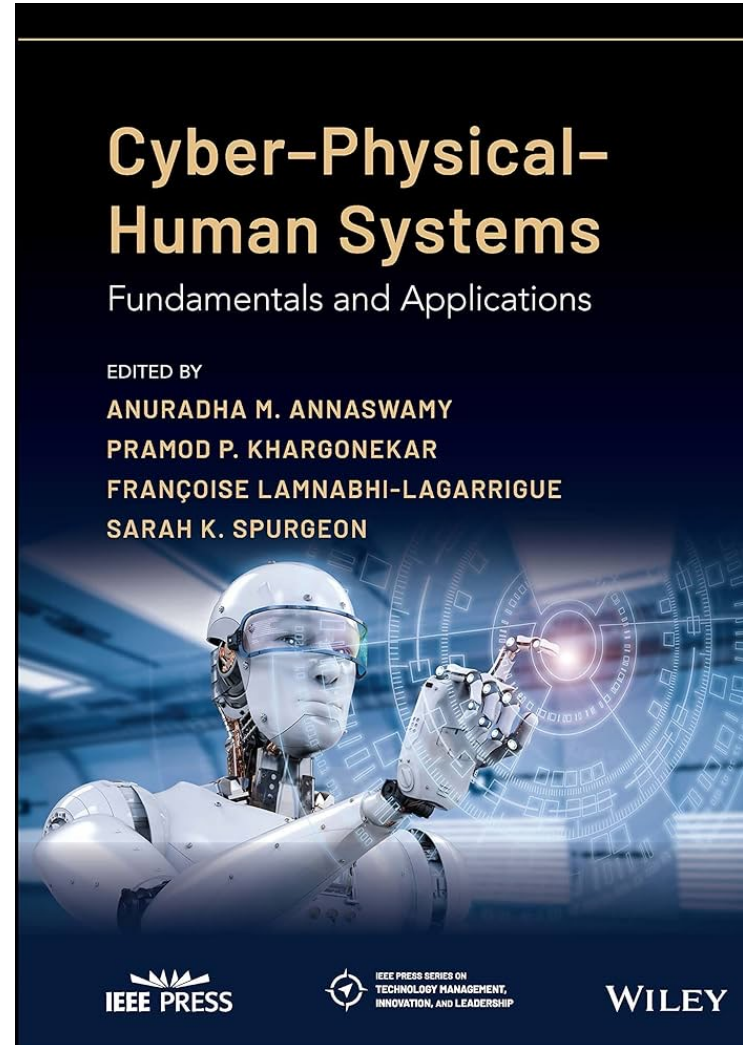
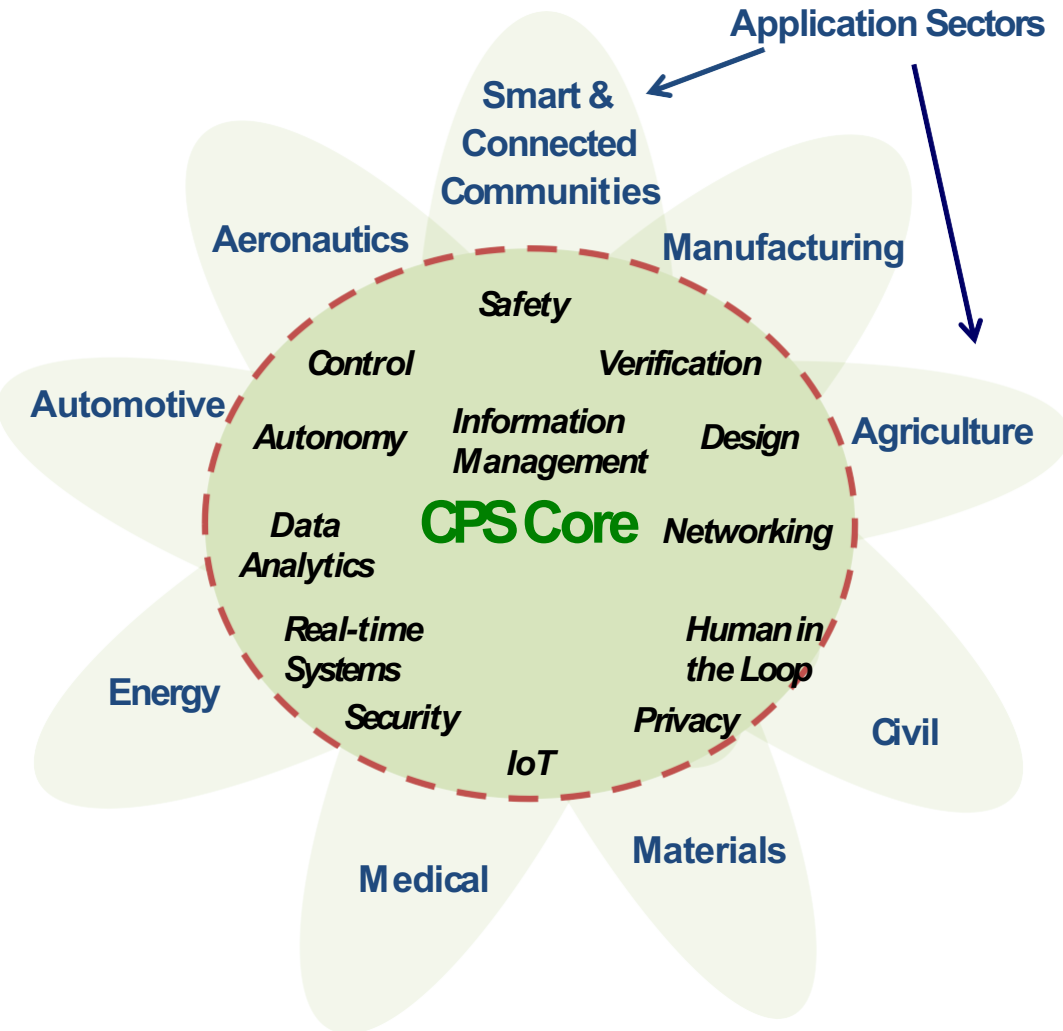


## Moravec's Paradox

“it is comparatively easy to make computers exhibit adult level performance on intelligence tests or playing checkers, and difficult or impossible to give them the skills of a one-year-old when it comes to perception and mobility”



# Cyber-Physical Systems Meet Humans and AI



# Potential Opportunities for Our Community

- Fully seize the intellectual opportunity in the nascent field of cyber-physical-human systems (CPHS) (including AI).
- Build new visions for work and tasks by going beyond traditional human-computer interface (HCI) to human-CPS interface.
- Focus on human augmentation rather than automating humans out of work
- Focus on unmet needs, e.g., care work: children, elderly, education, health, ...
- **Your idea here**

# Conclusions

- Cyber-Physical-Human Systems - CPHS provides a nascent but promising framework for our community to engage in the future of work and the coming socio-technological transformation.
- Collaborations with cognitive scientists, economists, social scientists, and work domain experts will be necessary and useful.
- What should we ask AI integrated CPHS to do?



**Comments**

**Ideas**

**Questions?**

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