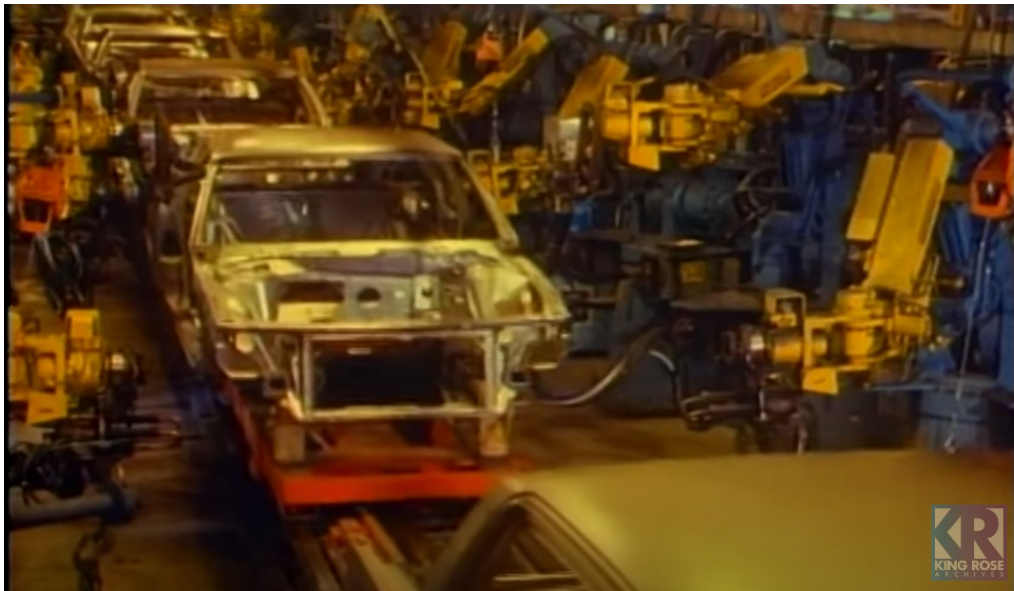
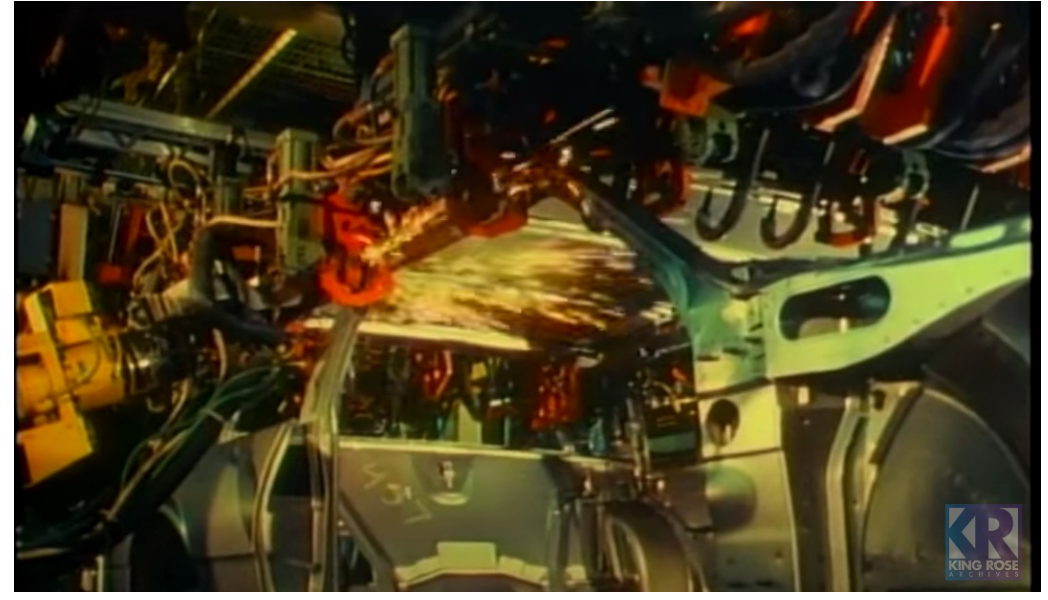
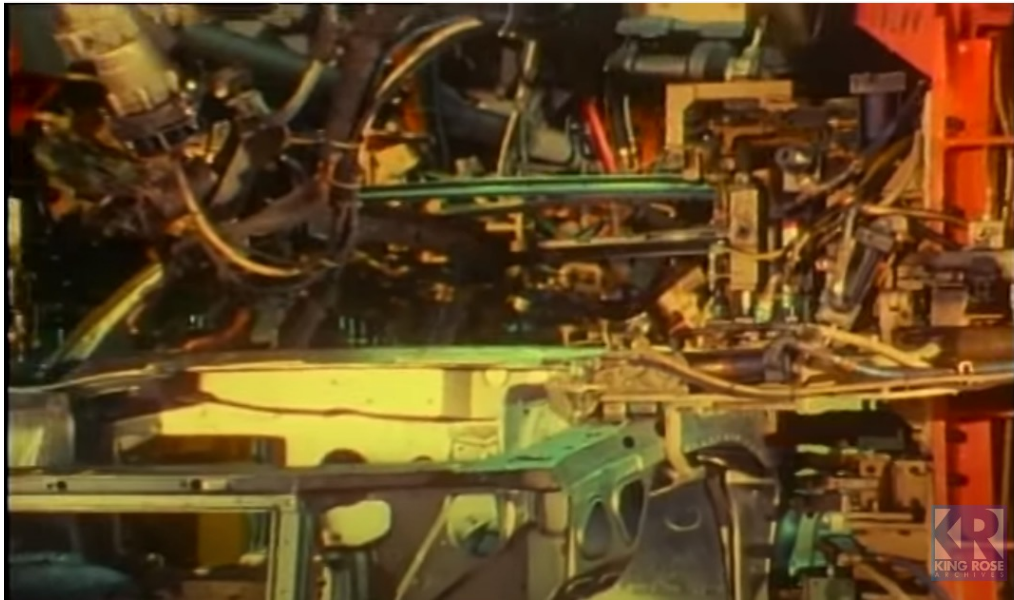




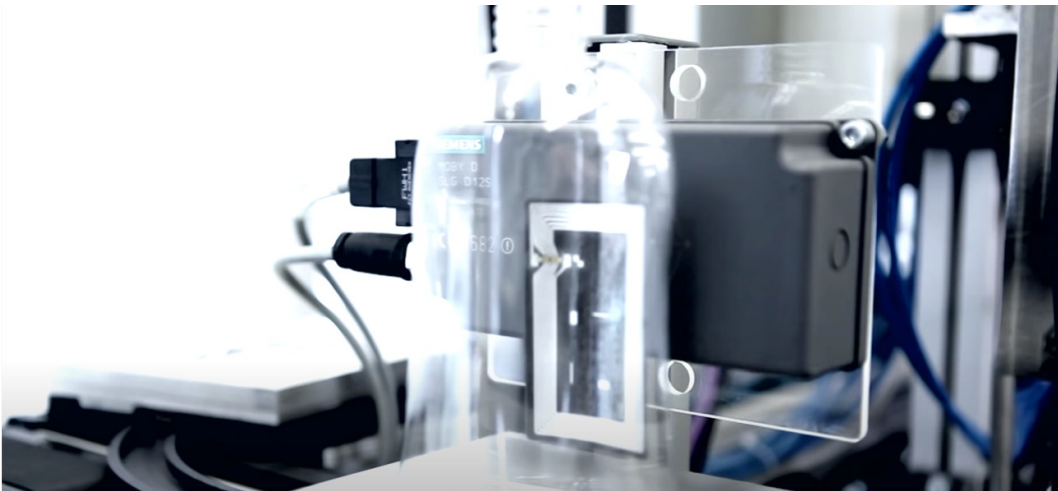
Positive-Sum Automation

Ben Armstrong

October 12, 2022



GM Automated Line, 1990s – courtesy King Rose Archives



“The objective: highly flexible, individualized and resource-friendly mass production. That is the vision for the Fourth Industrial Revolution.” – Siemens, 2013

Tradeoff: productivity for jobs?

Robots could take over 20 million jobs by 2030, study claims

A study finds nearly half of jobs are vulnerable to automation

UP FRONT

Four cures for automation anxiety

The Robots Are Coming. Prepare for Trouble.

However: automation -> productivity + jobs

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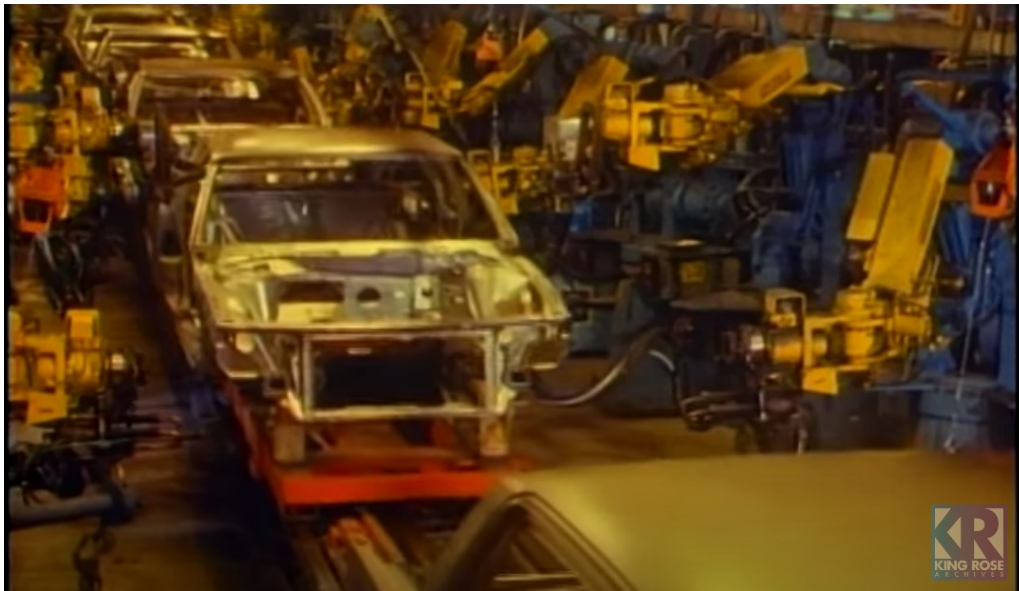
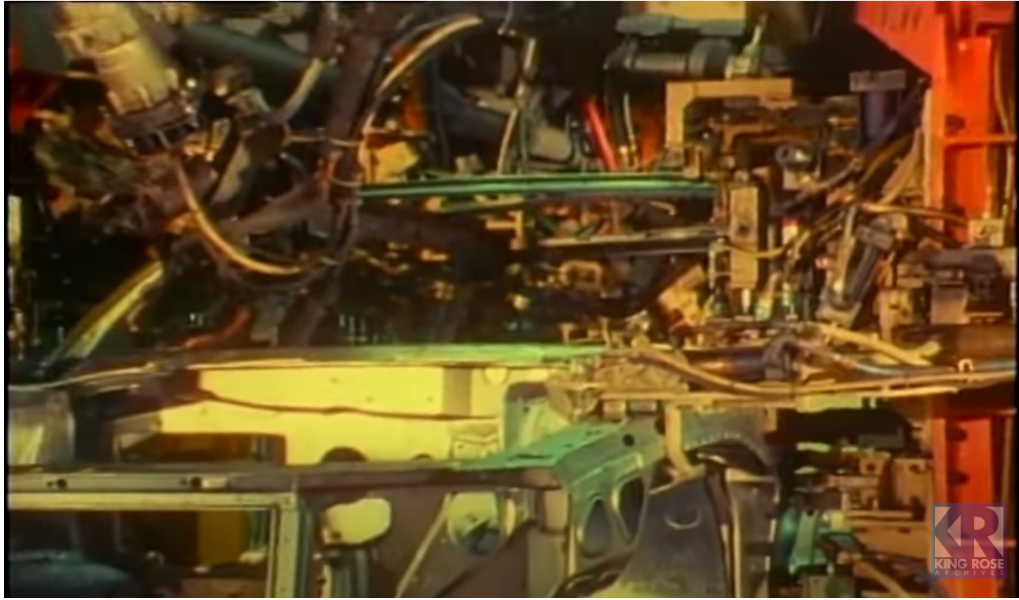
Firm-Level Automation: Evidence from the Netherlands

New Evidence on the Effect of Technology on Employment and Skill Demand*

**The Employment Consequences of Robots:
Firm-level Evidence**

Don't Fear the Robots, and Other Lessons From a Study of the Digital Economy

A task force assembled by M.I.T. examined how technology has changed, and will change, the work force.



Challenge: too little automation

Technology in Manufacturing

Robots: 10% of firms

Cloud applications: 29%

Specialized equipment: 39%

Specialized software: 42%

Digital skill requirements

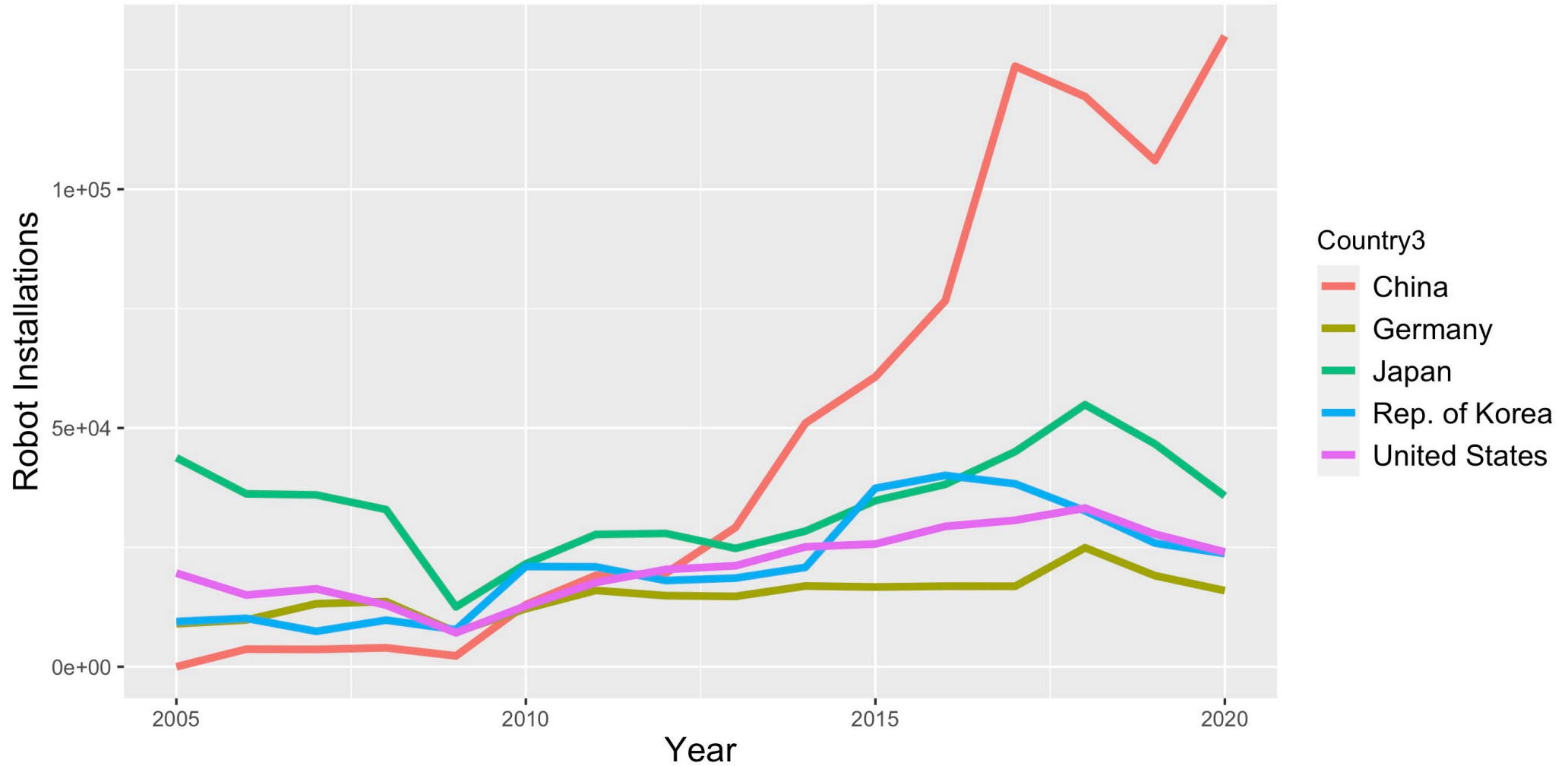
Production: 18.6% of new jobs

Maintenance / repair: 14.6%

Administrative support: 46%

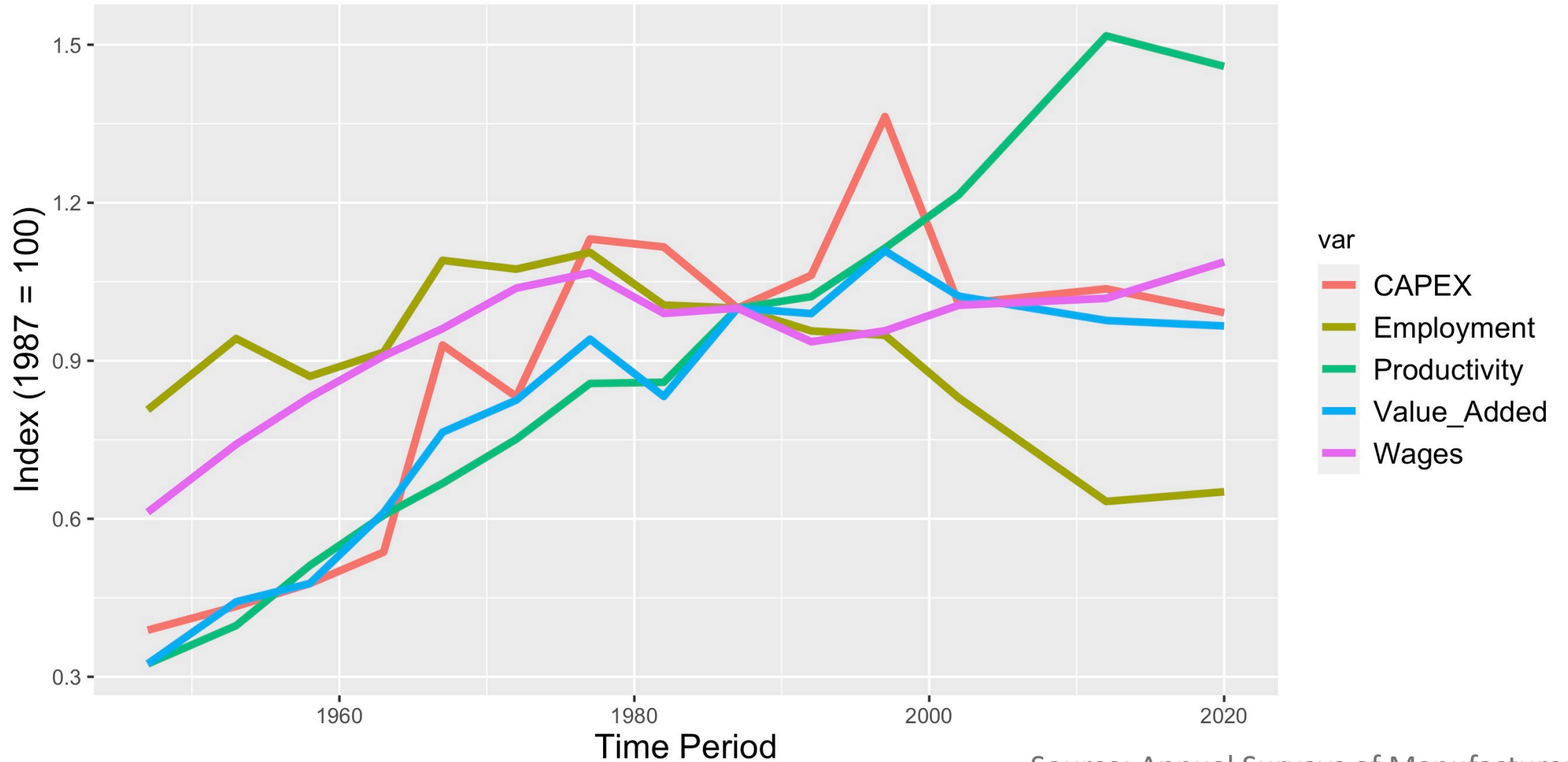
Business operations: 58.7%

Challenge: too little automation



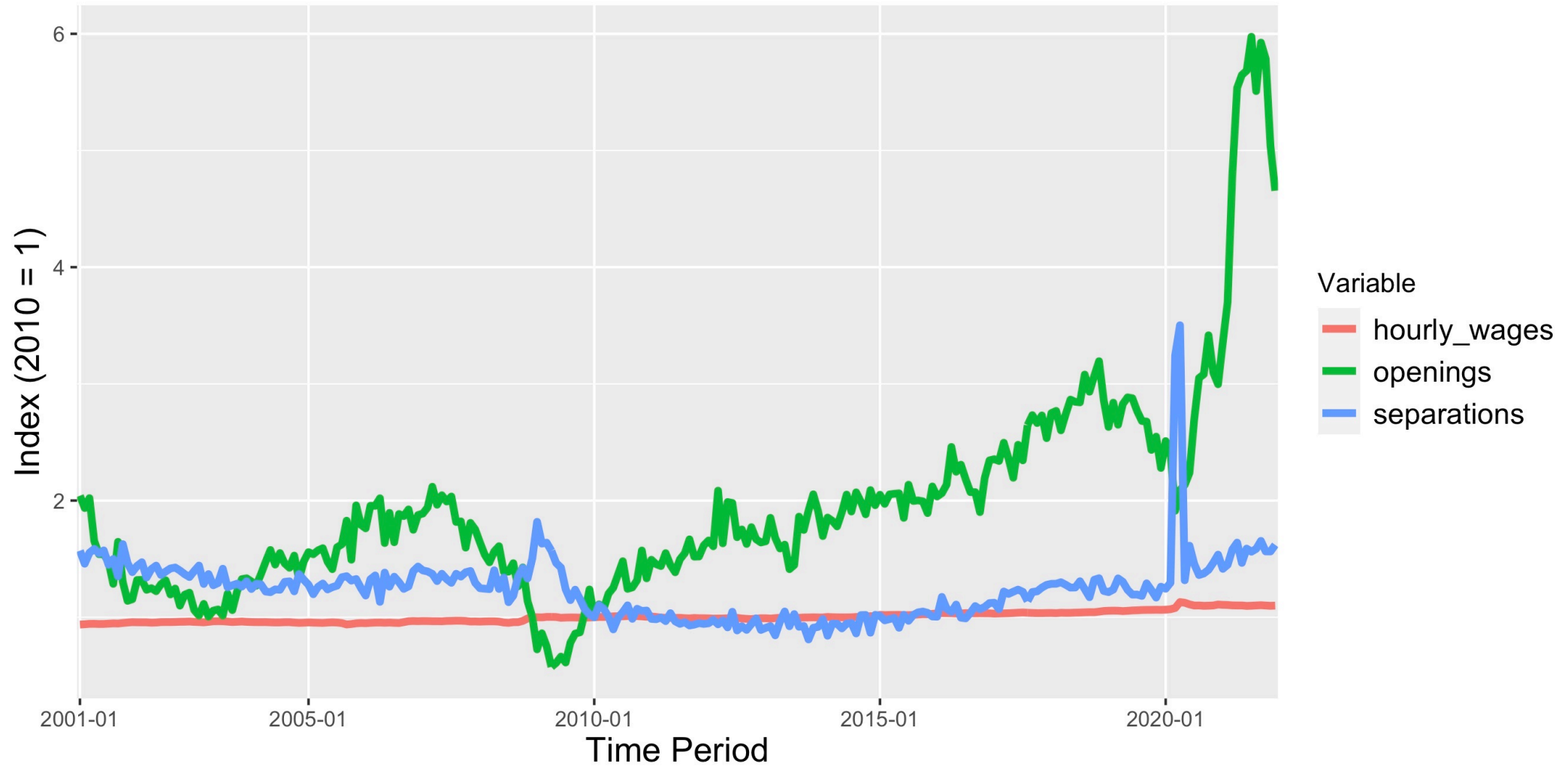
Source: International Federation of Robotics (2005-2020)

Challenge: too little automation



Source: Annual Surveys of Manufacturers

Challenge: too little automation



Source: JOLTS BLS Data

Ohio manufacturing owner / operator:

- 1. We can't find workers to meet demand.**
- 2. We need to offer higher wages.**
- 3. But we can't offer higher wages unless we automate.**

“Humans are underrated.” – Elon Musk, after failing to develop a “lights-out” Model 3 Tesla factory

“We have tried to make robots assemble components, but robots often break delicate and expensive components. From the process, I have realized that the human body is magic.” – Anonymous Chinese electronics executive, quoted by Ya-Wen Lei

“Why would I want a lights-out factory? A factory without people is a factory not innovating?” –Manufacturing executive

Why is automation so hard?

1. Hard to adapt to changes in environment
2. Needs specific skills to operate / repair
3. “Black box” systems

How can automation deliver productivity gains **while also improving flexibility and generating innovation?**

Path to Flexible Automation

Feature	Technical constraints	Organizational challenges	Positive-sum investments
Design	Lack of adaptability to the external environment	High switching costs	Low-code, intuitive systems
Integrate	Dependence on specific skills to program and repair	Reliance on external personnel	Bottom-up deployment
Measure	“Black box” systems	Stagnant innovation environment	Success as speed within and between tasks

Path to Flexible Automation

Feature	Technical constraints	Organizational challenges	Positive-sum investments
Design	Lack of adaptability to the external environment	High switching costs	Low-code, intuitive systems

Example:

- Robot collaborating with technician to assemble scientific equipment
- Robot manipulates heavy assembly, human performs dexterous work to install sensors
- The potential is for more productive assembly that improves job quality.
- Robot remains unused because it's not easily reprogrammed to worker specifications.

Path to Flexible Automation

Feature	Technical constraints	Organizational challenges	Positive-sum investments
Integrate	Dependence on specific skills to program and repair	Reliance on external personnel	Bottom-up deployment

Example:

- Hospital system automating administrative tasks with robotic process automation (RPA)
- Without internal software expertise, need to rely on consultants to set up and optimize software tools
- But a bottom-up approach that trains internal personnel who know the tasks to program the software can provide flexibility and labor hours saved

Path to Flexible Automation

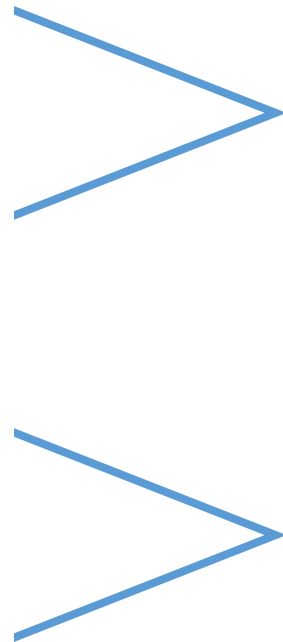
Feature	Technical constraints	Organizational challenges	Positive-sum investments
Measure	"Black box" systems	Stagnant innovation environment	Success as speed within and between tasks

Example:

- High-mix, low-volume factory adopts automation across its machines
- Skill requirements for production workers goes up, so do wages (\$30/hr minimum wage)
- Bonuses linked to overall machining hours from automated cells – incentives to lower switching costs and deliver process improvement

How to think about flexible automation?

1. Automation is for repetitive, high-volume tasks
2. Automation can solve labor shortages and workforce challenges
3. Automation is to deliver high-quality products to customers
4. Automation is to grow and innovate in new products and processes



Robots as more productive workers

Robots as tools to make teams better – productivity, quality, innovation