The World of Industrial Automation

The Rise of the Machines

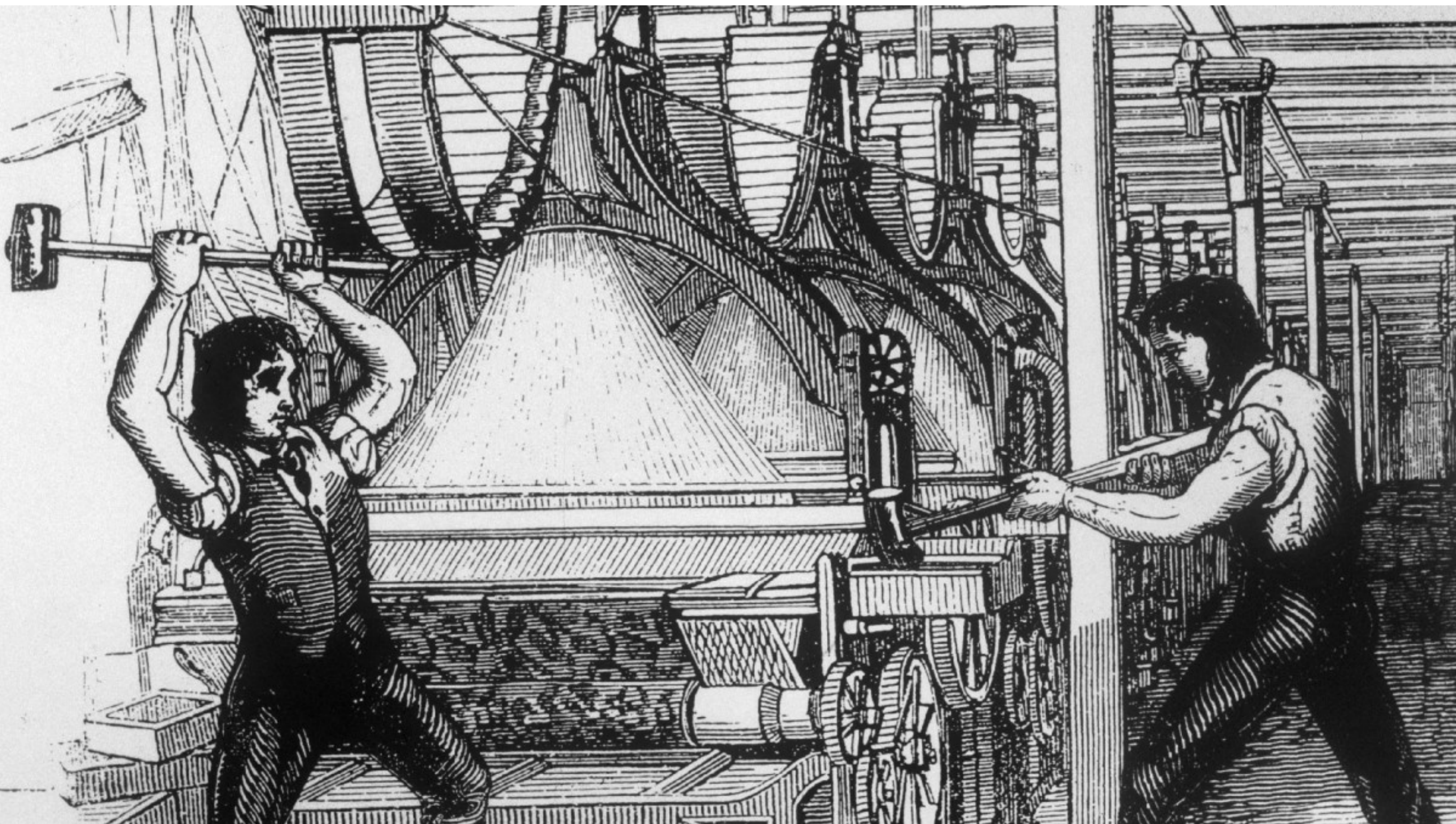PPFAS FOF | Raunak Onkar | Sept 2021

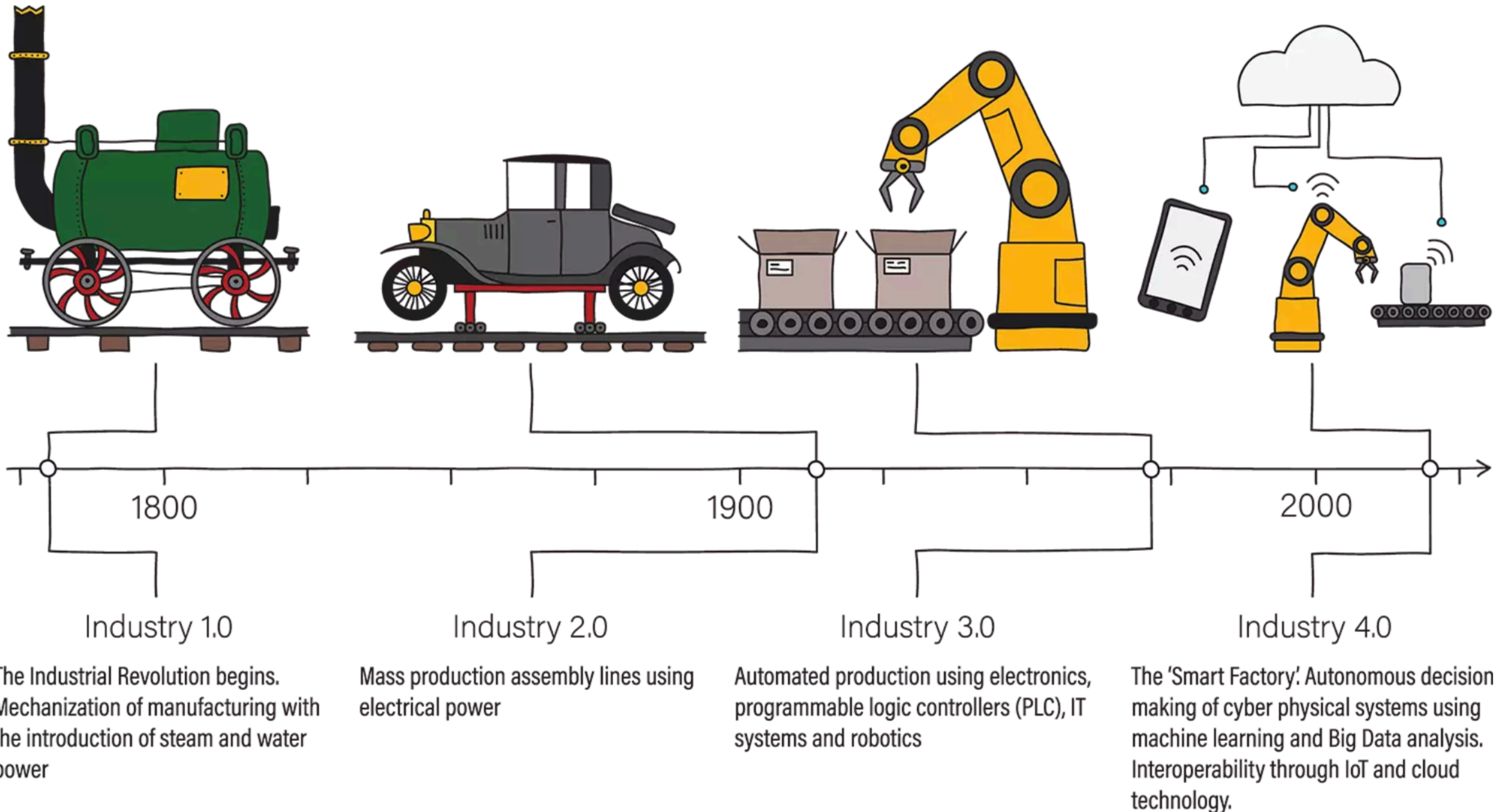# The World of Industrial Automation
The Context

- A 300 years old thorny topic

- Evolution of Industrialisation

- Automation & Applications of Automation

  - Different Business Models

- Industry 4.0

- Why is it important to understand this?

- What it means for India?

A 300 years old argument...

Race to Improve Productivity

Industry 1.0

The Industrial Revolution begins. Mechanization of manufacturing with the introduction of steam and water power

Industry 2.0

Mass production assembly lines using electrical power

Industry 3.0

Automated production using electronics, programmable logic controllers (PLC), IT systems and robotics

Industry 4.0

The 'Smart Factory'. Autonomous decision making of cyber physical systems using machine learning and Big Data analysis. Interoperability through IoT and cloud technology.

Source: simio.com

Race to Improve Productivity
Why?

- Reduce time to market

- Reduce errors

- Increase scale to meet demand

- Protect from extreme cyclicality

  - Labour

  - Market

- Capex vs Opex

- Productivity per sq ft
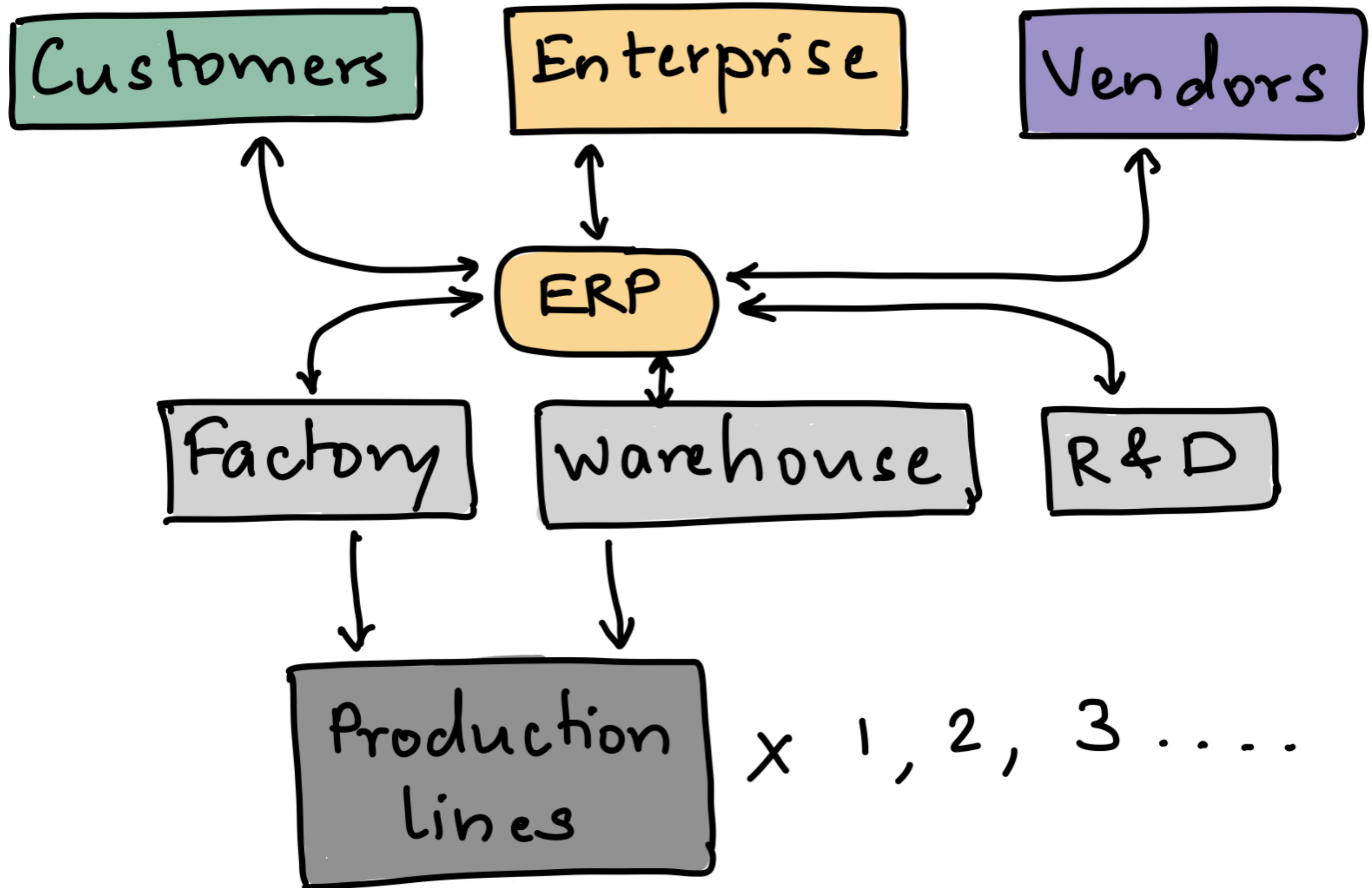
- Make industrial work safer & less tiring for humans
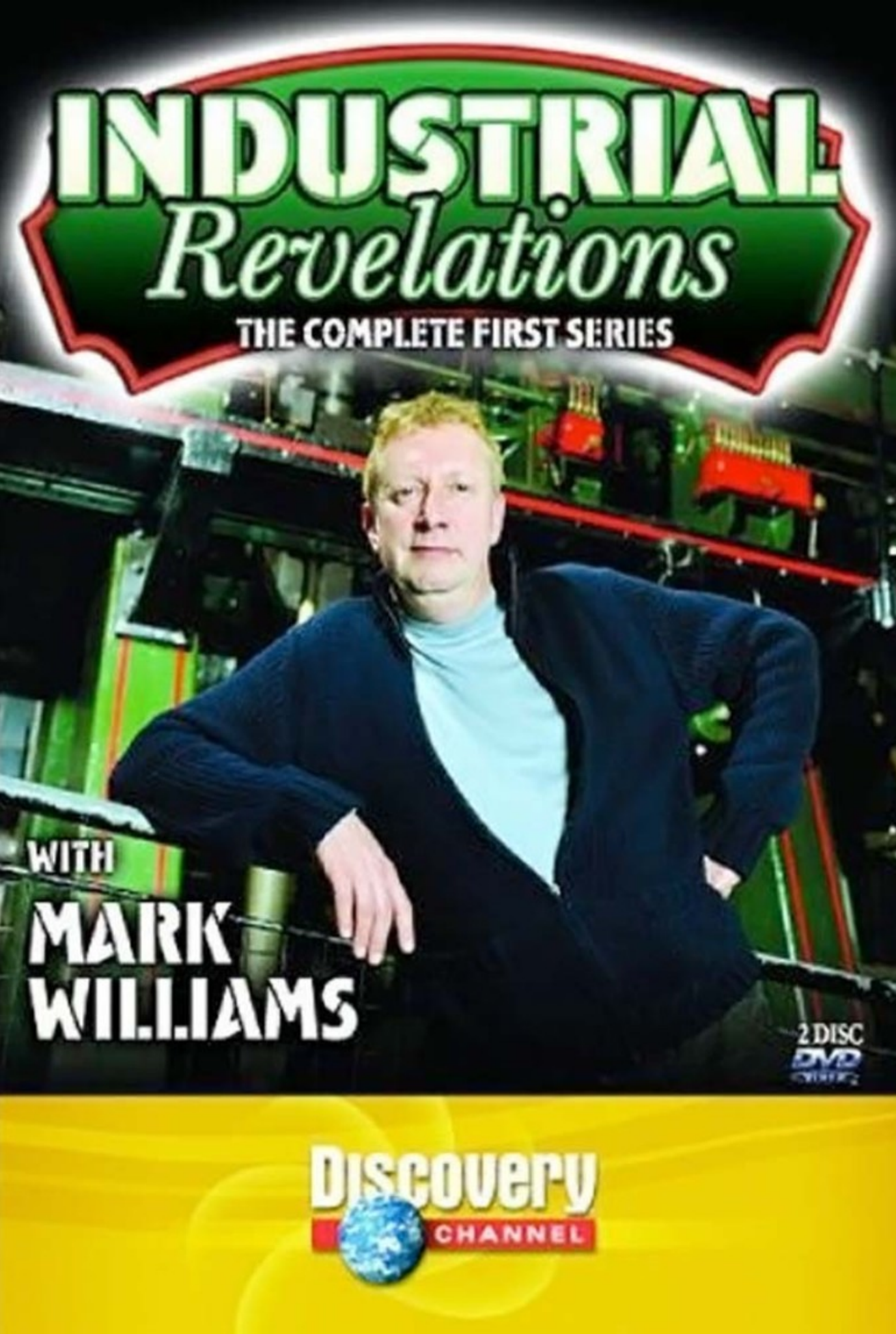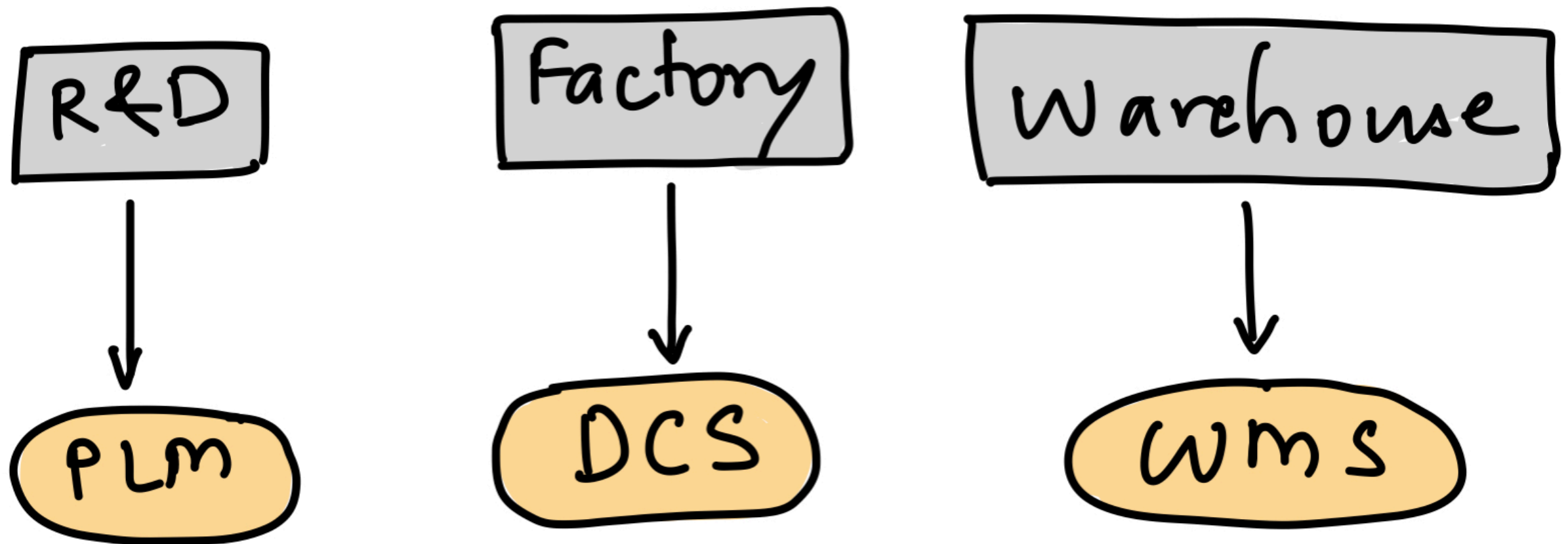
What is Automation?

"Use of various technologies with pre-determined processes to reduce human, manual intervention for repetitive tasks. "

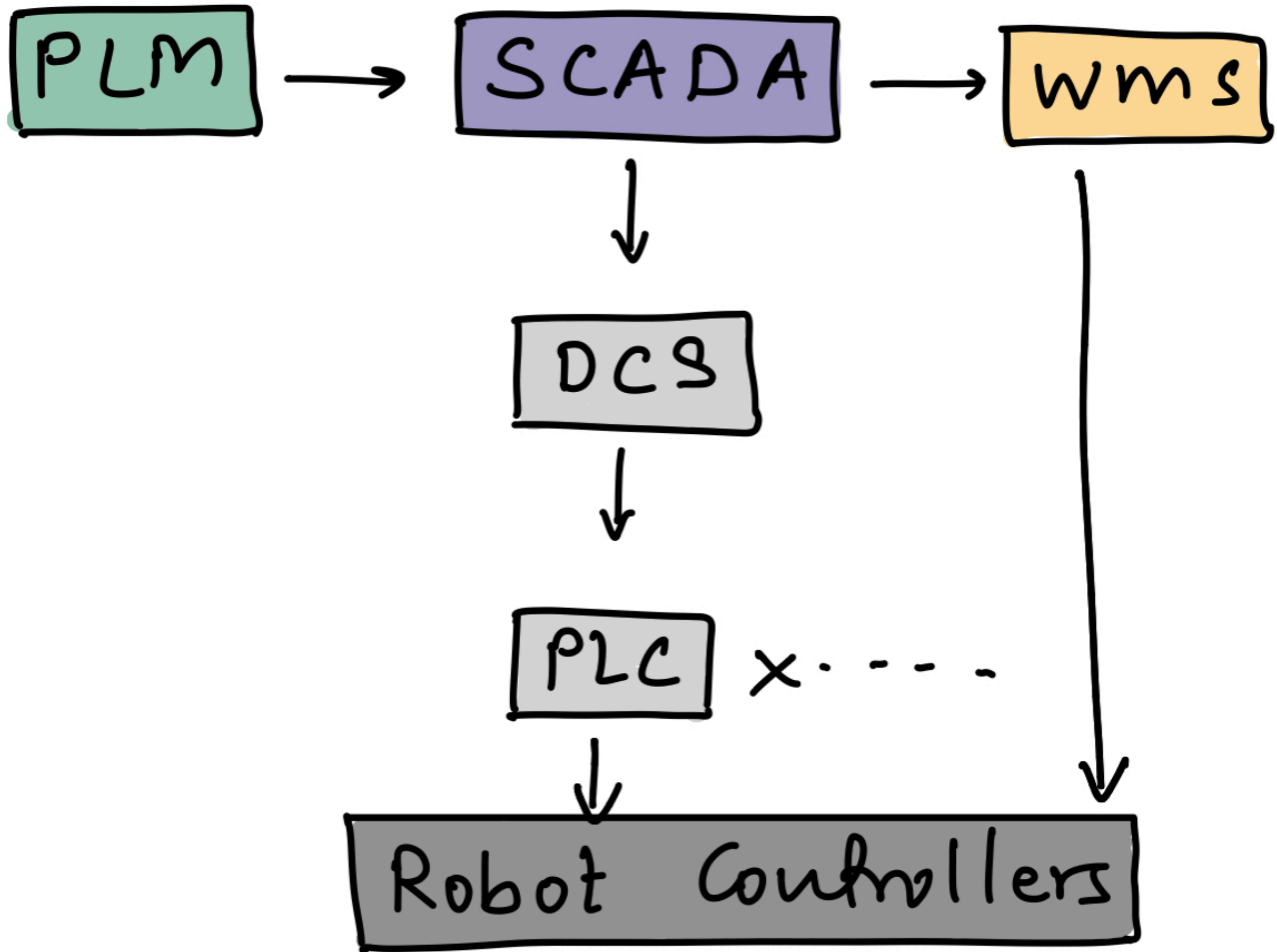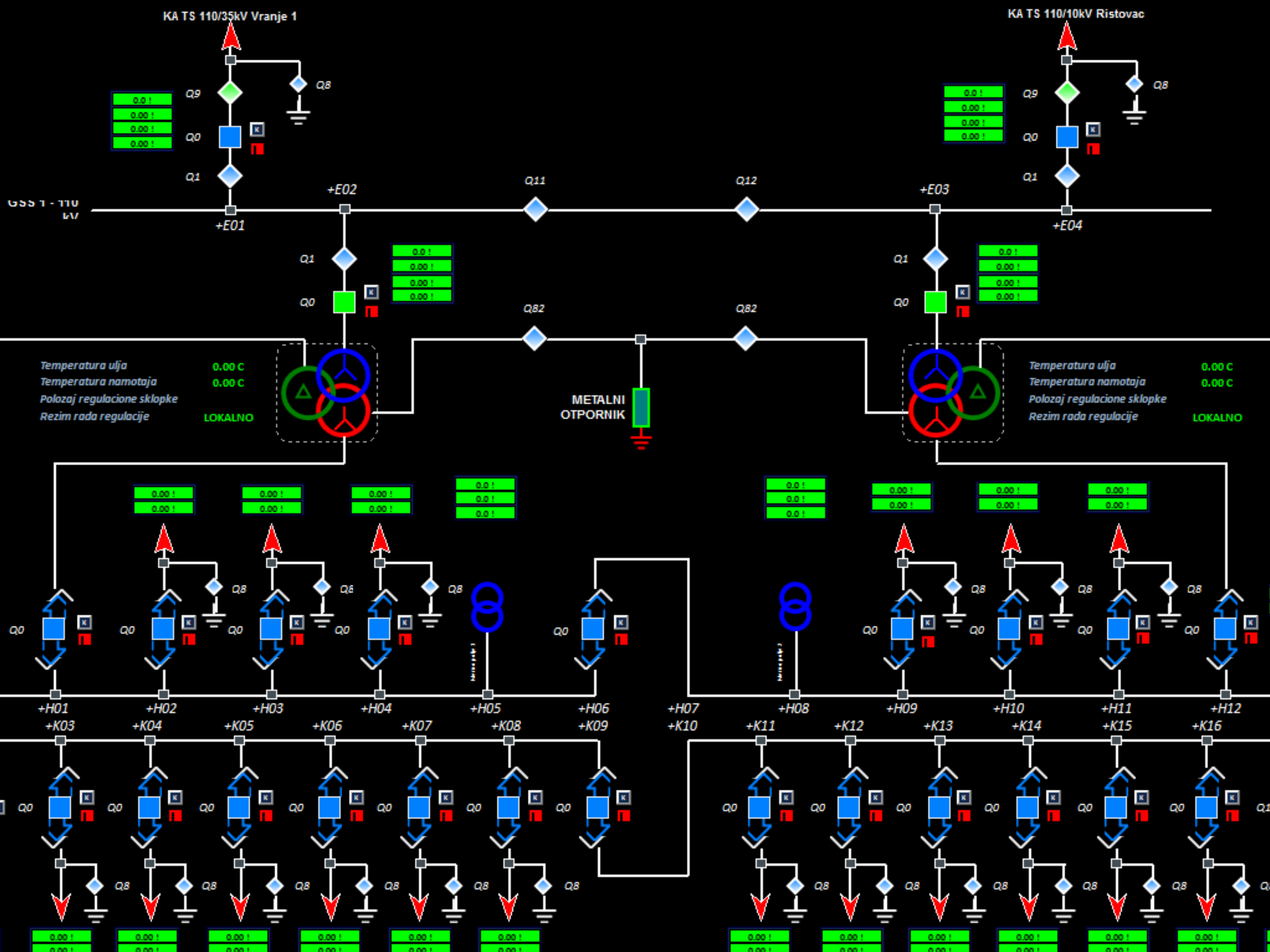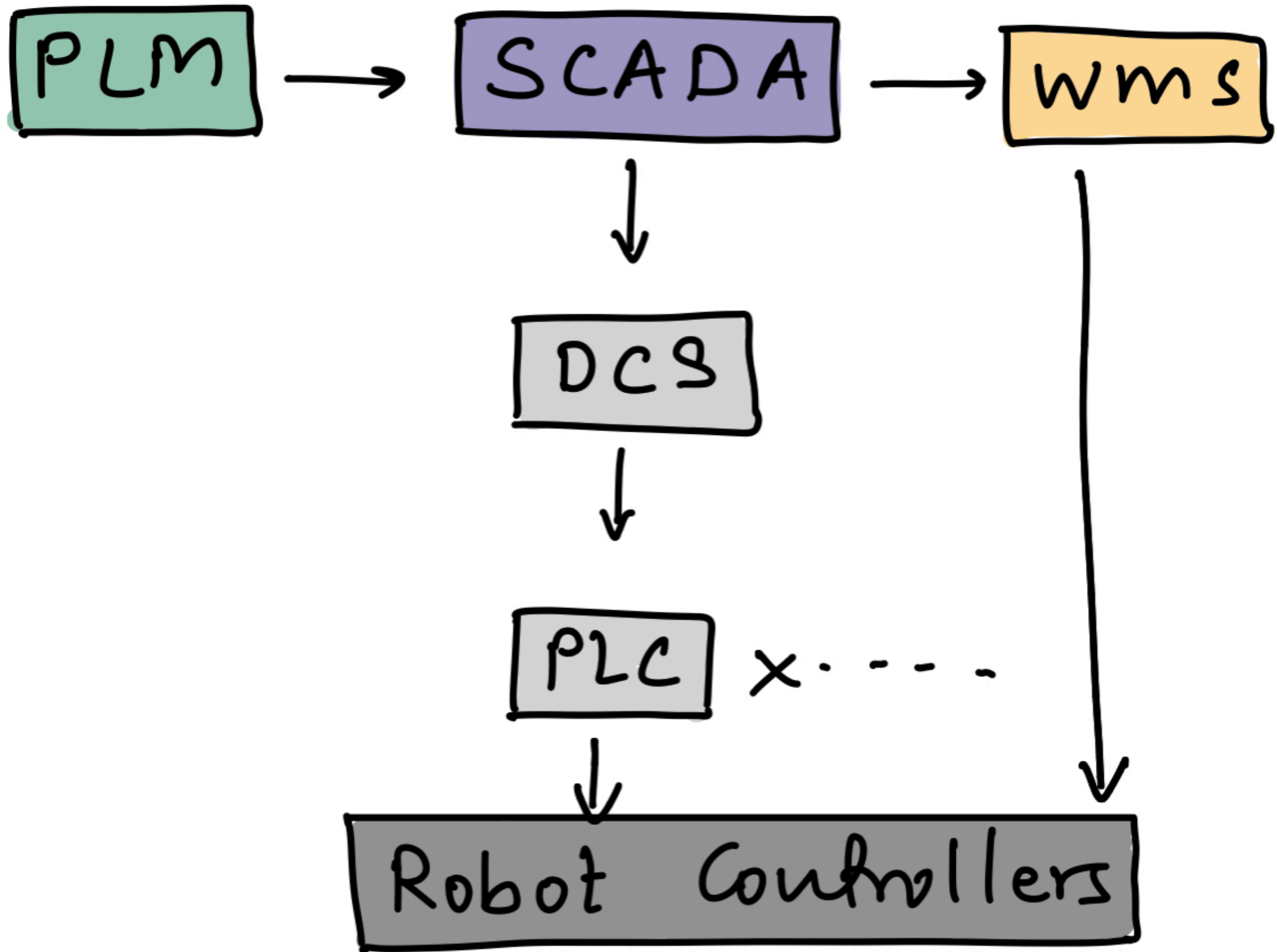Look Inside
a
Manufacturing
Enterprise

Customers | Enterprise | Vendors

ERP

Factory | Warehouse | R & D

Production lines

x 1, 2, 3 . . . .

Zooming into the factory…

```
PLM  →  SCADA  →  wms
           │                    │
           ↓                    │
          DCS                   │
           │                    │
           ↓                    │
          PLC  x· - - -         │
           │                    │
           ↓                    ↓
    Robot Controllers
```

KA TS 110/35kV Vranje 1

KA TS 110/10kV Ristovac

Q9 Q8

Q9 Q8

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Q0 K

Q0 K

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GSS 1 - 110 kV

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+E04

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Temperatura ulja   0.00 C
Temperatura namotaja   0.00 C
Polozaj regulacione sklopke
Rezim rada regulacije   LOKALNO

METALNI
OTPORNIK

Temperatura ulja   0.00 C
Temperatura namotaja   0.00 C
Polozaj regulacione sklopke
Rezim rada regulacije   LOKALNO

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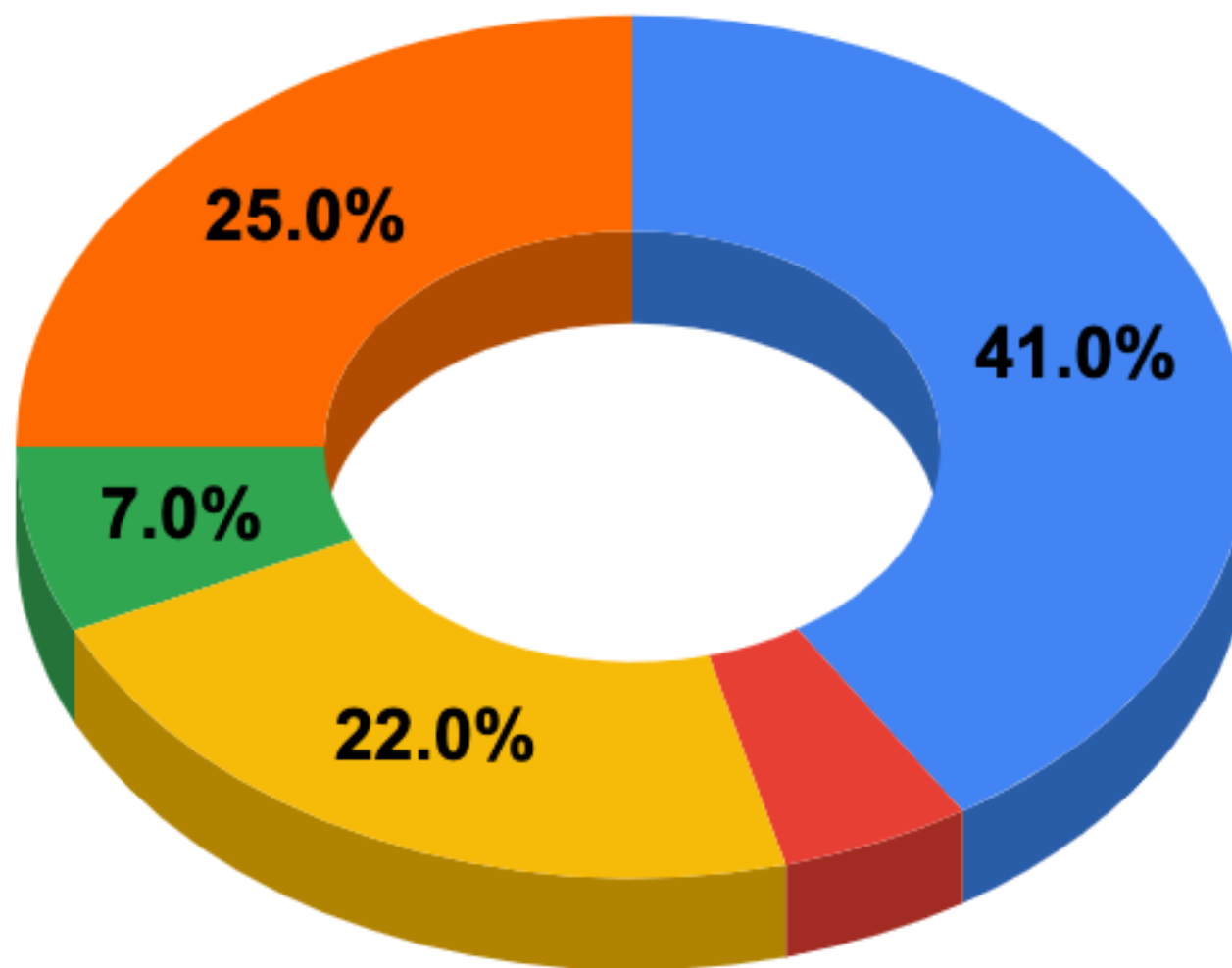0.00 !

0.00 !

Automation vs Humans

Mechanisation to Automation

Labor Reducing vs Labor Replacing

Applications of Automation

Automation by Application

Source: International Federation of Robotics

41.0%

25.0%

7.0%

22.0%

- Auto
- Electronics
- General Industry
- CSSR
- Machine Automation

Different Business Models

$ Mn	MCap	Revenue	PAT	Gross Margin	5 Yr Avg RoCE	P/E	P/S	Country
Fanuc	43,000	5,647	1,127	40%	12%	38	8	Japan
ABB	67,000	28,114	5,705	32%	10%	12	2	Swiss/Swedish
Seimens	133,000	72,961	8,007	35%	13%	17	2	German
Schneider	93,000	32,445	3,562	41%	12%	26	3	French
Omron	21,000	6,276	484	46%	13%	43	3	Japan
Rockwell	36,000	6,759	1,542	42%	29%	23	5	USA
Mitsubishi	46,500	126,100	2,618	12%	8%	18	0	Japan
Kuka	3,100	3,400	15	21%	5%	207	1	German
Yaskawa	12,800	3,810	223	30%	12%	57	3	Japan
Teradyne	17,100	3,445	952	58%	30%	18	5	USA
Keyence	140,000	5,429	2,994	82%	14%	47	26	Japan
Inovance	25,000	2,323	466	38%	20%	54	11	China
Siasun	2,440	405	40	20%	5%	61	6	China
Efort	800	192	-25	12%	-6%	-32	4	China
SMC	41,800	5,463	1,301	29%	11%	32	8	Japan

Source: Company Filings

Where is the IP?

Annual Installations of Robots ('000 Units)

Source: International Federation of Robotics

Legend: Asia / Australia (blue), Europe (red), The Americas (yellow)
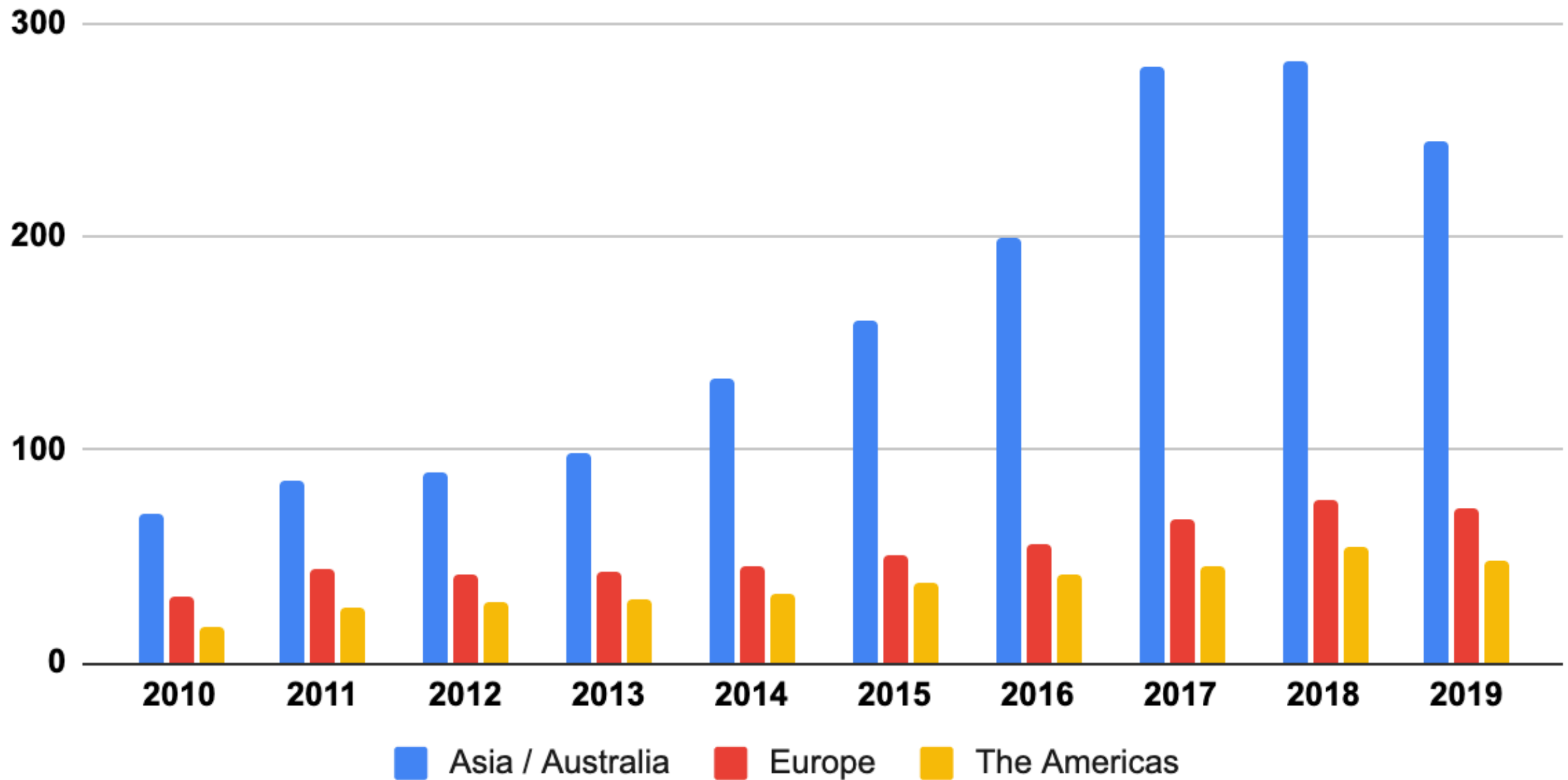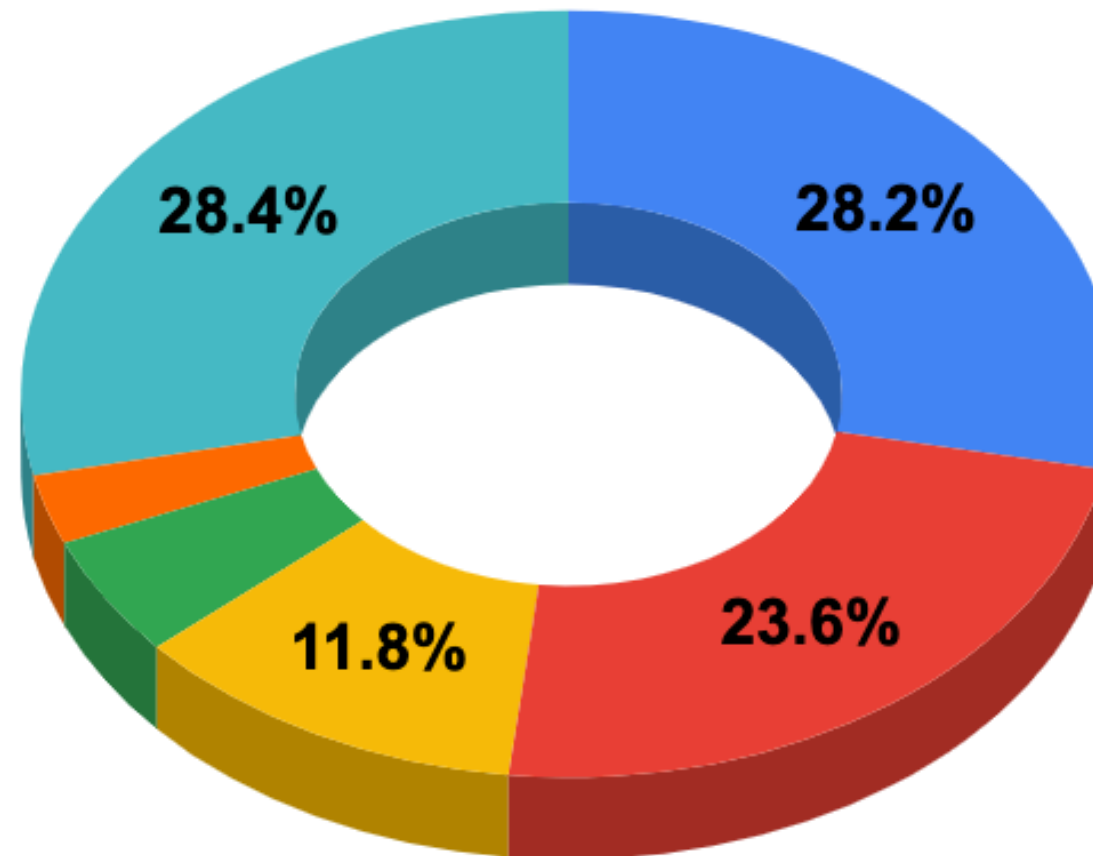
Annual Robots Installed ('000 units)

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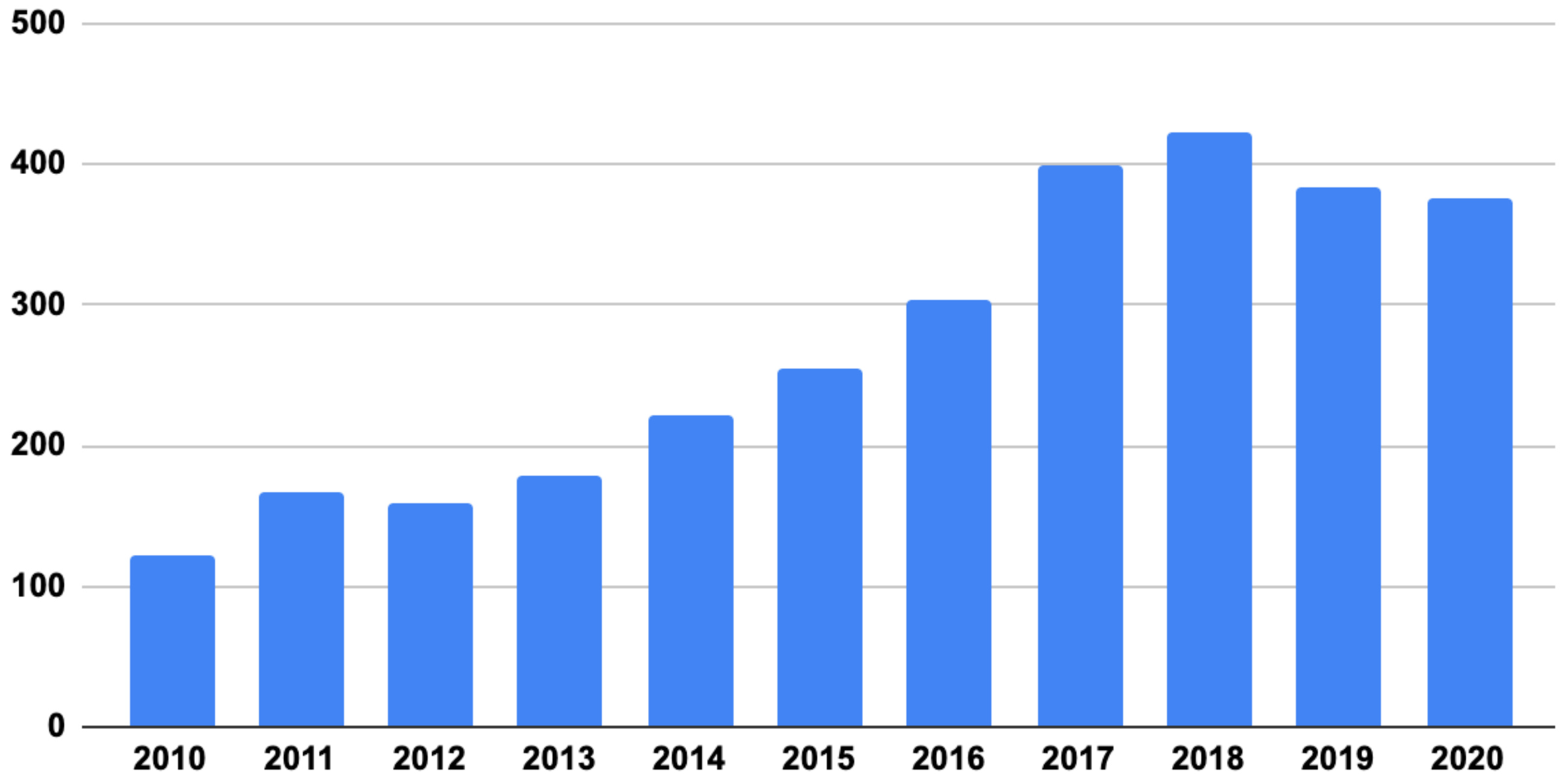
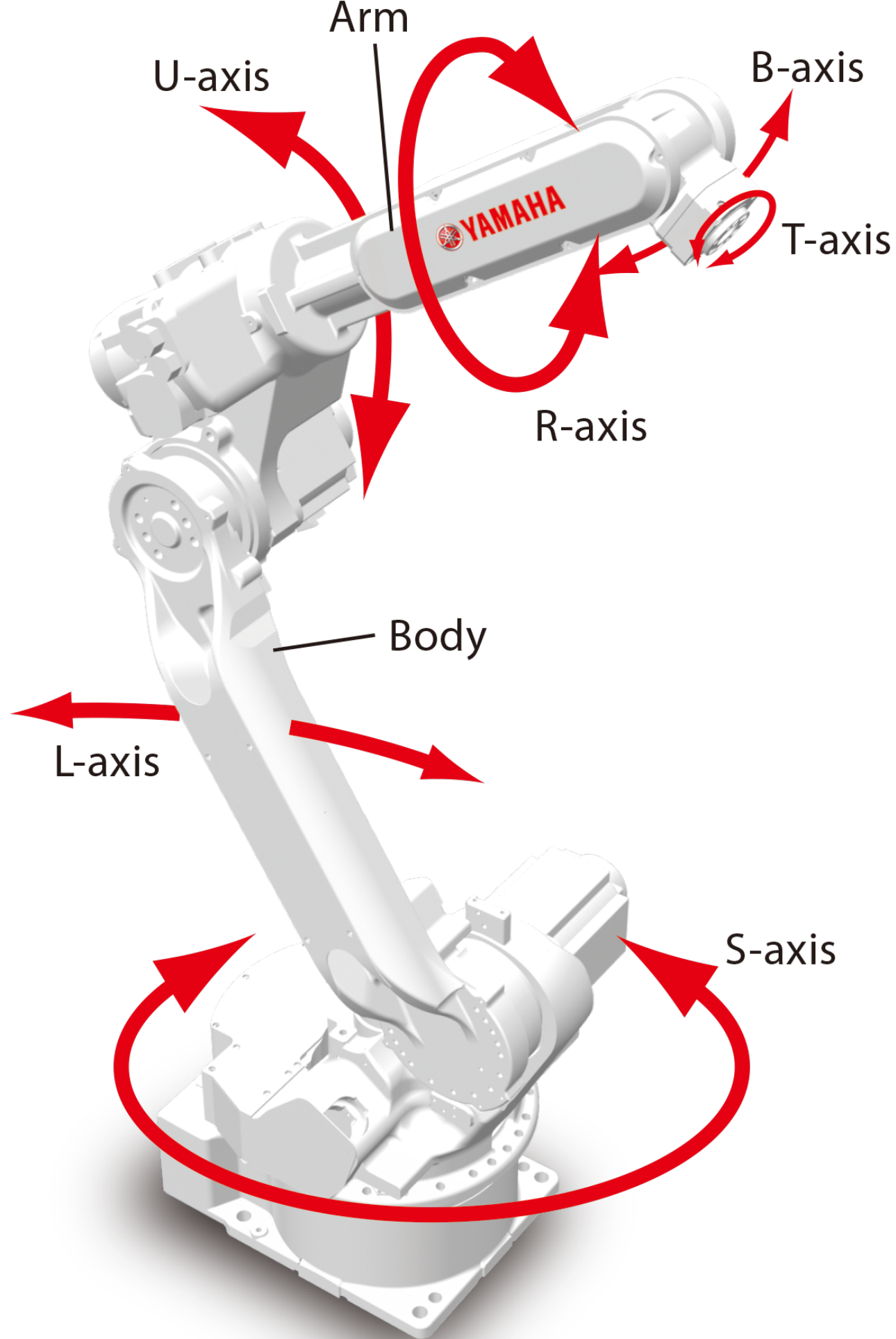# Robots Installed in 2019 by Industry

Source: IFR 2020 Report

28.4% 28.2% 23.6% 11.8%

Auto   Electronics   Metals & Machinery   Plastic & Chemicals   Food

Others

Types of Robots

Articulated
6 Axis Robot

6-axis robots

S-axis: Rotate the body horizontally

L-axis: Move the body forward/backward

U-axis: Move the arm up/down

R-axis: Rotate the arm

B-axis: Move the tip of the arm up/down
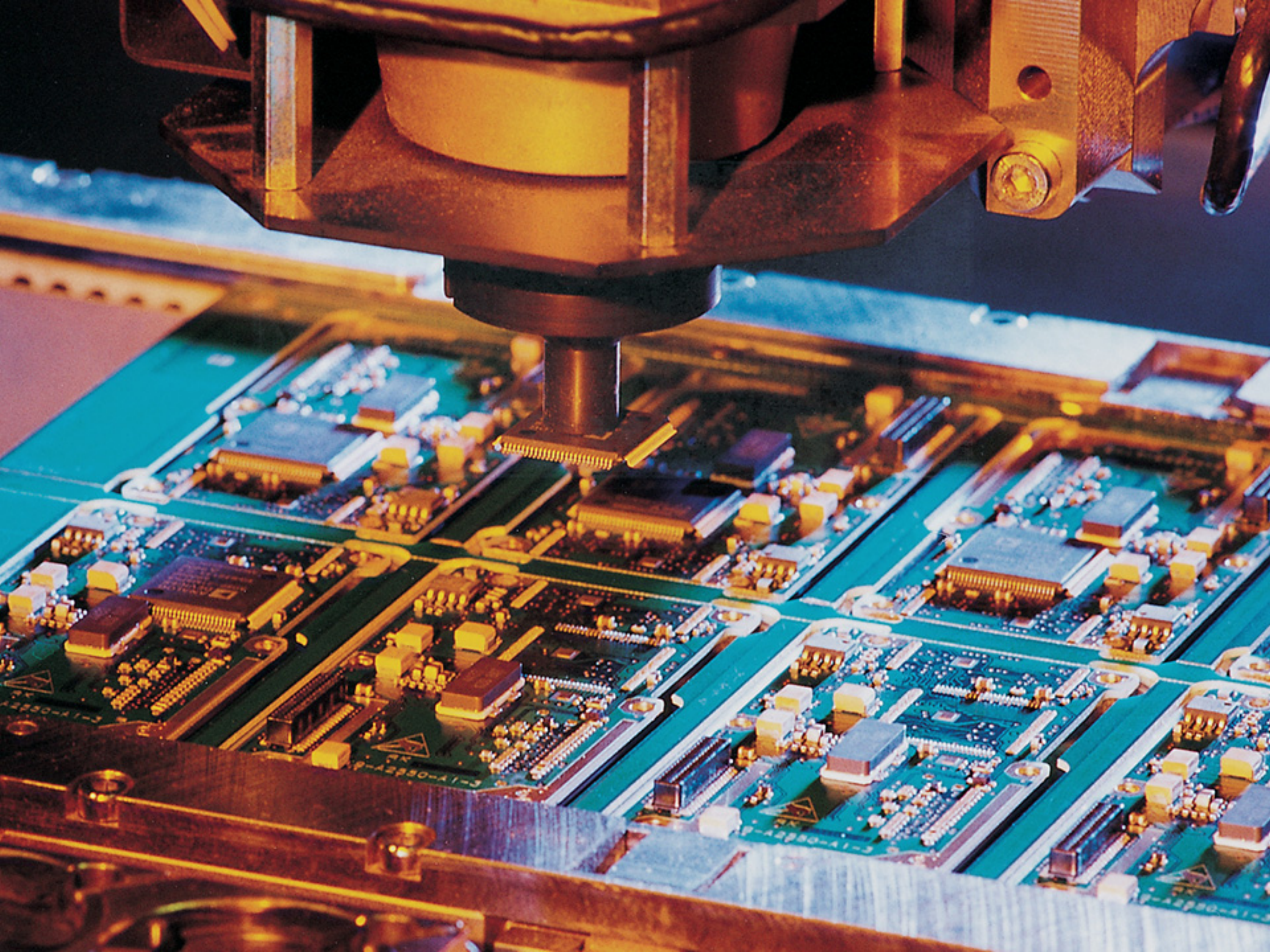
T-axis: Rotate the tip of the arm

Delta Robot

Gantry Robot

Cobot

Autonomous Mobile Robot

NAVIGATION SYSTEM
A camera facing upward reads bar codes placed under inventory racks to identify them. Another camera located at the bottom of the robot views bar codes on the floor. This location information is combined with readings from other navigation sensors, such as encoders, accelerometers, and rate gyros.

LIFTING MECHANISM
A large screw turns to raise racks of inventory 5 centimeters from the ground. At the same time, the wheels make the robot rotate in the opposite direction to keep the rack motionless.

POWER SYSTEM
Four lead-acid batteries power the motors and onboard electronics. When batteries run low, the robot automatically drives to a charging station.

COLLISION-DETECTION SYSTEM
Infrared sensors and touch-sensitive bumpers stop the robot if people or objects get in its way.

DRIVING SYSTEM
Two brushless dc motors control independent neoprene rubber wheels, moving the robot at 1.3 meters per second.

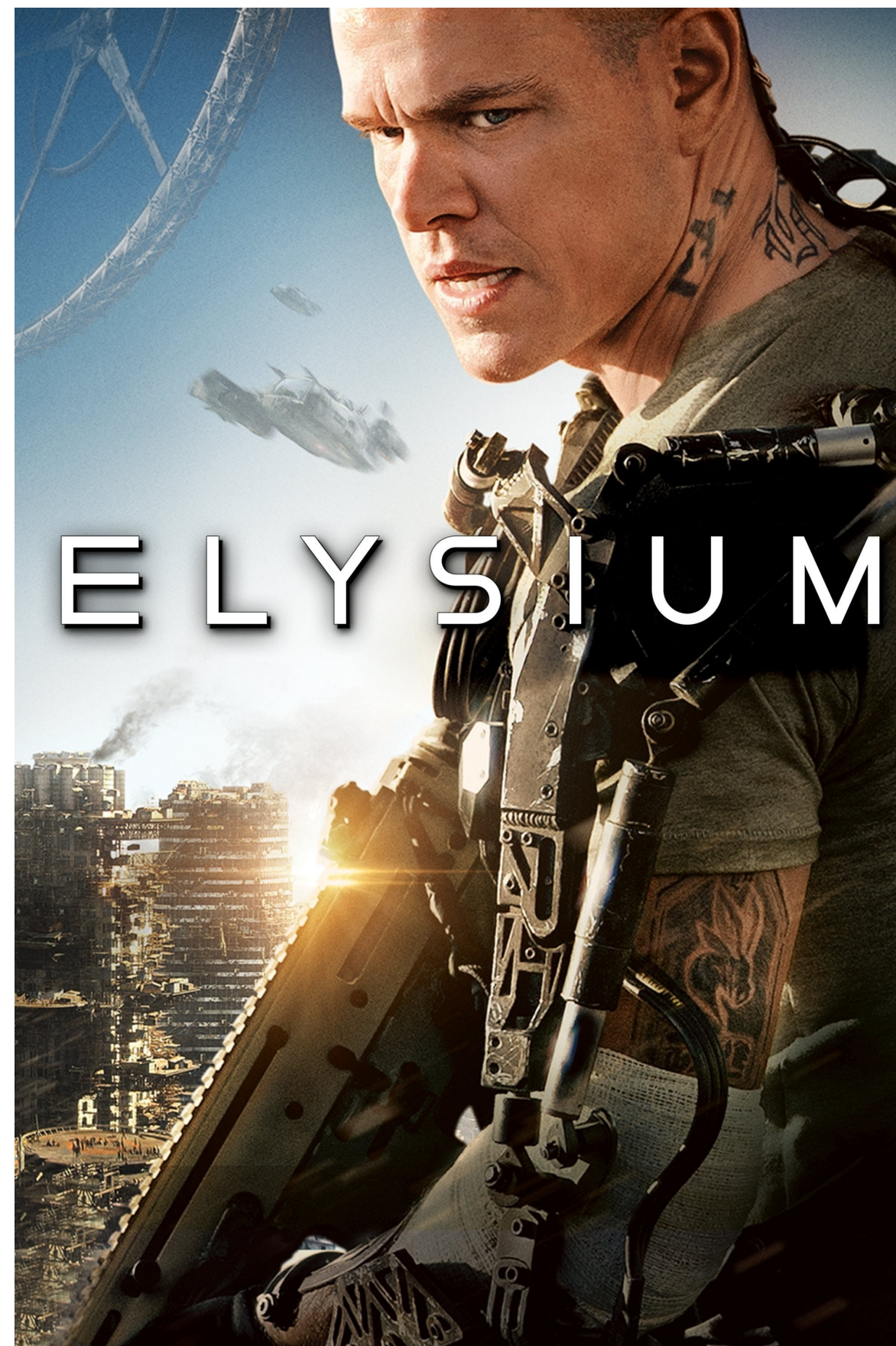KIVA Systems
1867

Autonomous Mobile Robot

Exoskeleton Robot
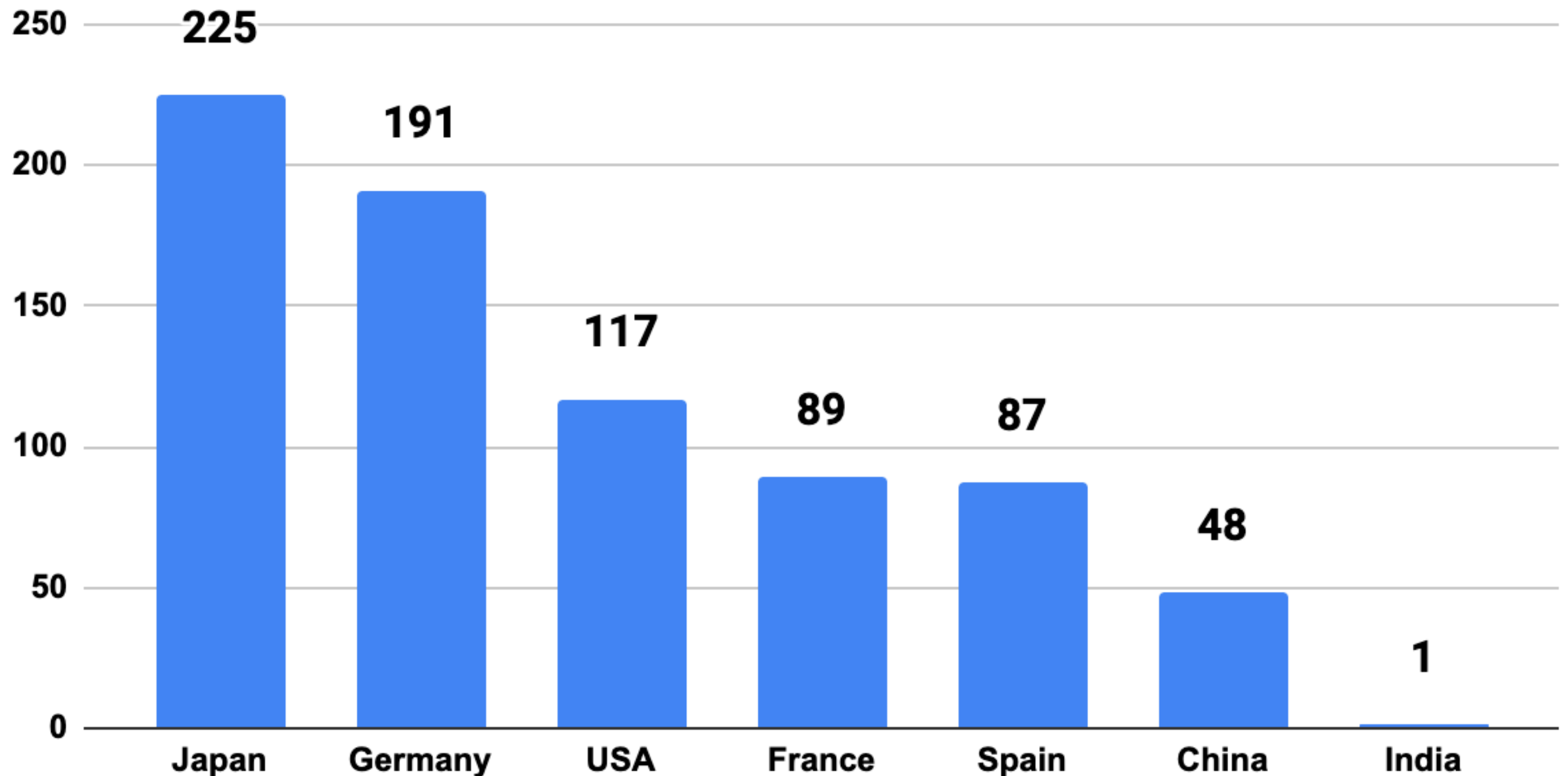
Adam Jensen's
Exo-suit

Deus Ex
MANKIND DIVIDED™

Death Stranding
Exo-suit for
carrying heavy load

LIVE
DIE
REPEAT

TOM EMILY
CRUISE BLUNT

EDGE of TOMORROW

FROM THE DIRECTOR OF THE BOURNE IDENTITY AND MR. & MRS. SMITH

COMING SOON IN 3D

ELYSIUM

Robot Density per 10,000 Workers (2017)

Source: International Federation of Robotics

Country	Value
Japan	225
Germany	191
USA	117
France	89
Spain	87
China	48
India	1

Global Avg: 113 / 10k Workers

Annual Installations of Robots ('000 Units)

Source: International Federation of Robotics

Legend: Asia / Australia, Europe, The Americas
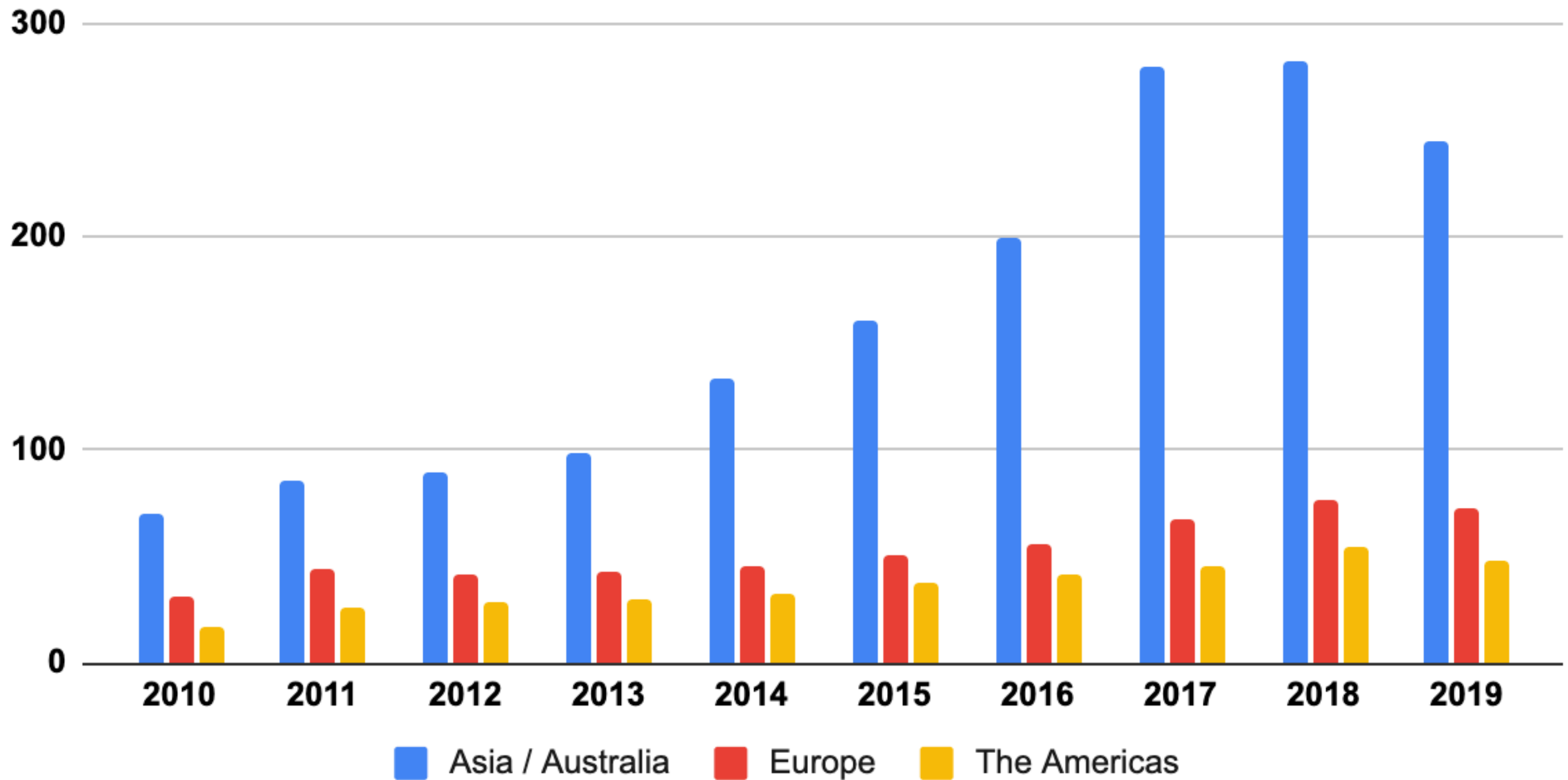
Annual Robots Installed ('000 units)

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Industry 4.0
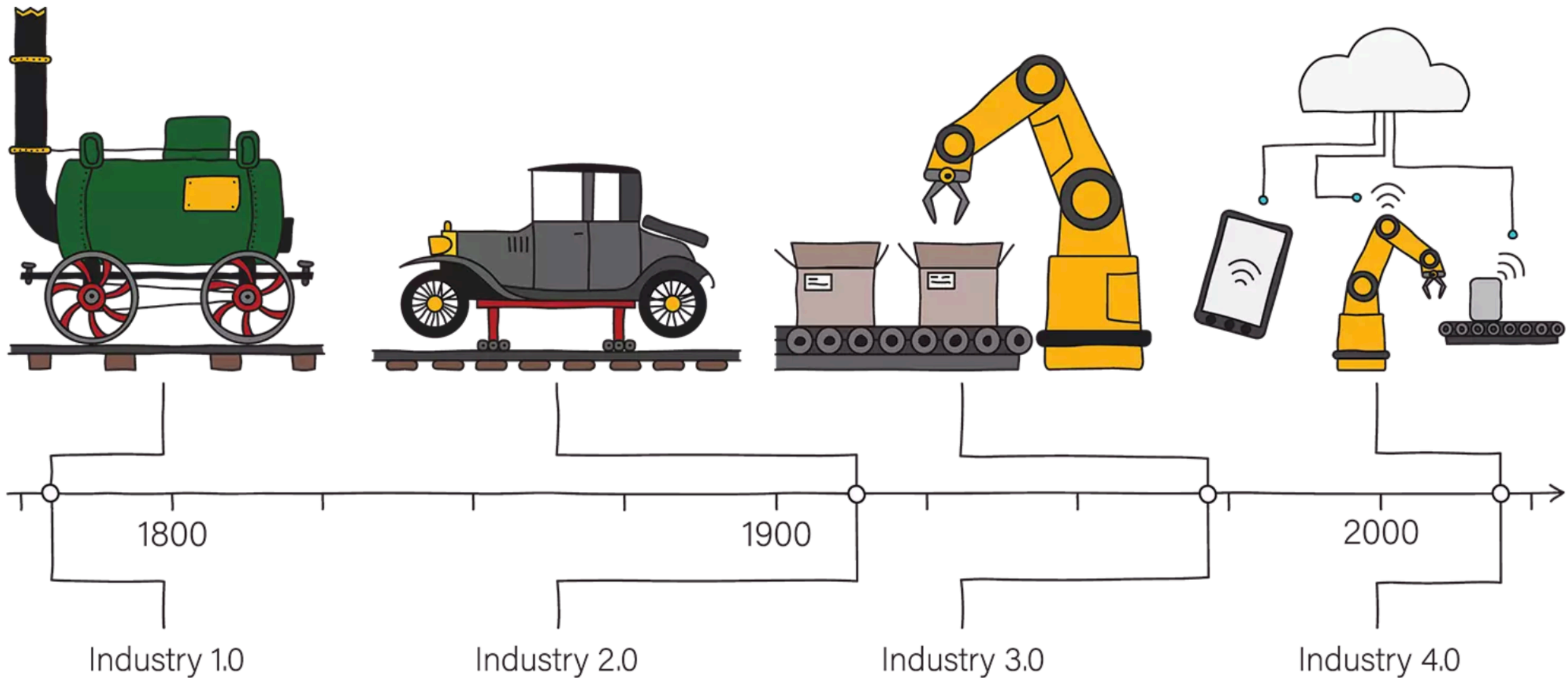
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The 'Smart Factory'. Autonomous decision making of cyber physical systems using machine learning and Big Data analysis. Interoperability through IoT and cloud technology.

Source: simio.com

Industry 4.0 Challenges
Why it is not as easy as it seems

- One size doesn't fit all

- Integration is a lot harder than it seems

- Software doesn't define hardware

  - Hardware defines software

- Customisation vs Standardisation

- Will it take the same path of Software Services Industry?

Why Now?

The Technology Trap

Carl Benedikt Frey

- Capital vs Labor across 3 centuries

- Policy action & implications

- Universal Basic Income

- Impact of Mechanisation, Automation

- Role of Education

- Labor Shortage
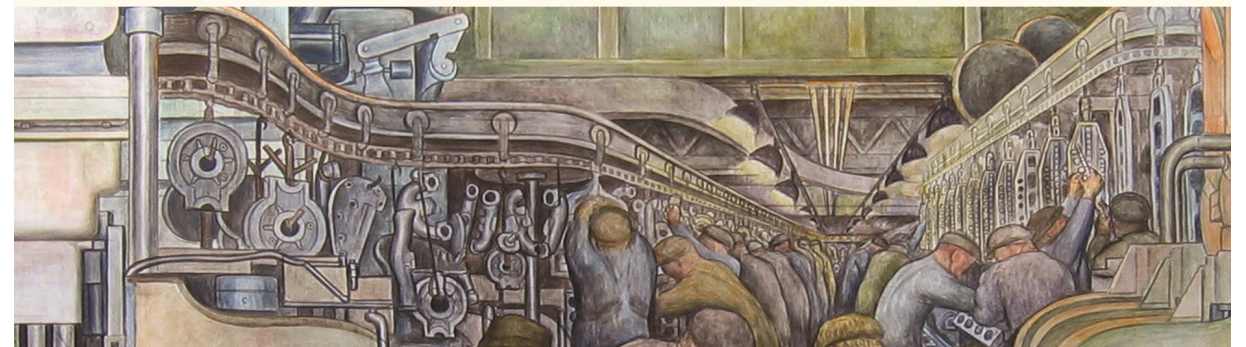
BUSINESS BOOK OF THE YEAR 2015 WINNER

FT FINANCIAL TIMES McKinsey&Company

THE RISE OF THE ROBOTS

Technology and the Threat of Mass Unemployment

MARTIN FORD

RULE OF THE ROBOTS

HOW ARTIFICIAL INTELLIGENCE WILL TRANSFORM EVERYTHING

MARTIN FORD

AUTHOR OF THE *NEW YORK TIMES* BESTSELLER *RISE OF THE ROBOTS*

RICHARD SUSSKIND   DANIEL SUSSKIND
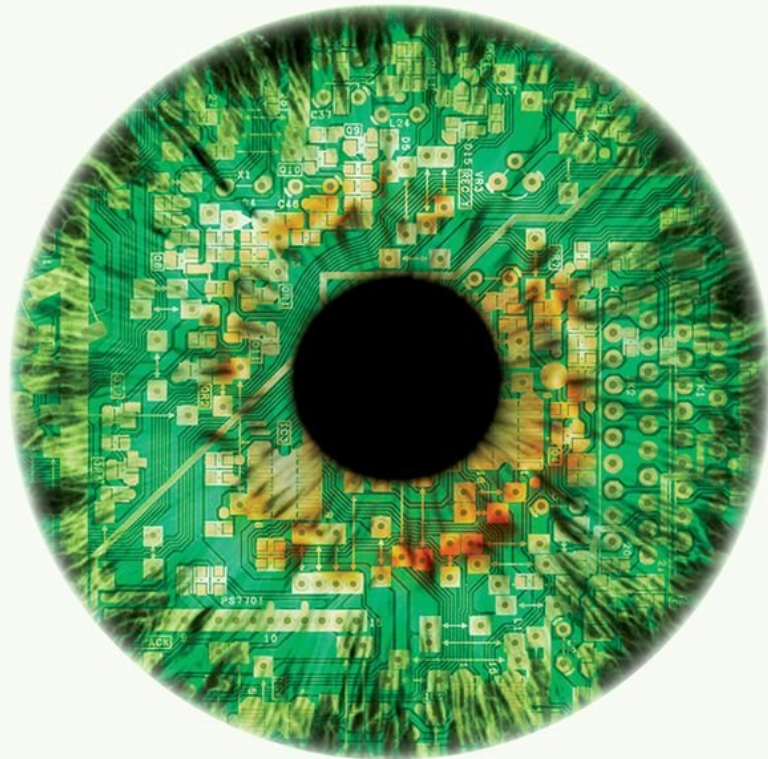
THE FUTURE OF THE PROFESSIONS

HOW TECHNOLOGY WILL TRANSFORM
THE WORK OF HUMAN EXPERTS

A WORLD WITHOUT WORK

Technology, Automation,
and How We Should Respond

DANIEL SUSSKIND

Artificial Intelligence

Melanie Mitchell

- What are the limits of AI

- How machine learning works

- Use of AI & ML

- Implications for autonomous robots

Janesville
Amy Goldstein

- What happens to a factory town when the largest employer shuts down?

Implications for India

Implications for India
Job Creation vs Productivity

- 2nd Order Effect of Labor Policy changes?

- Wage Inflation (Lessons from China)?

- Comparative Advantage?

- Craftsmanship?

- Services Industry Growth?

- 2nd Order Effect of More Manufacturing in India?

Resources for Learning

- Company Filings & History of these businesses

- Books mentioned

- Youtube & Podcast content by authors & other media

  - The Compass by BBC - Future of Work Series by Daniel Susskind

  - Industrial Revelations on Youtube

  - BBC - The Genius of Design Series on Youtube

  - ABB Podcast

  - Robot Brains Podcast

Thank you
Happy to take questions