the origin

"Germany has one of the most competitive manufacturing industries in the world"

"Industrie 4.0 allows individual customer requirements to be met [and] one-off items can be manufactured profitably."

"Will allow Germany to increase its global competitiveness and preserve its domestic manufacturing industry"

Source: Securing the future of German manufacturing industry, Recommendations for implementing the strategic initiative INDUSTRIE 4.0, April 2013

a little push...

WORLD ECONOMIC FORUM

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Five Million Jobs by 2020: the Real Challenge of the Fourth Industrial Revolution

Published
18 Jan 2016

2016

Share

Oliver Cann, Director, Public Engagement, Tel.: +41 79 799 3405; Email: Oliver.Cann@weforum.org

· The Fourth Industrial Revolution, combined with other socio-economic and demographic changes, will transform labour markets in the next five years, leading to a net loss of over 5 million jobs in 15 major developed and emerging economies

· Skills and jobs displacement will affect every industry and geographical region, but losses can be offset by job growth in key areas

BOT LABOR

iPhone manufacturer Foxconn is replacing 60,000 workers with robots

the journey started
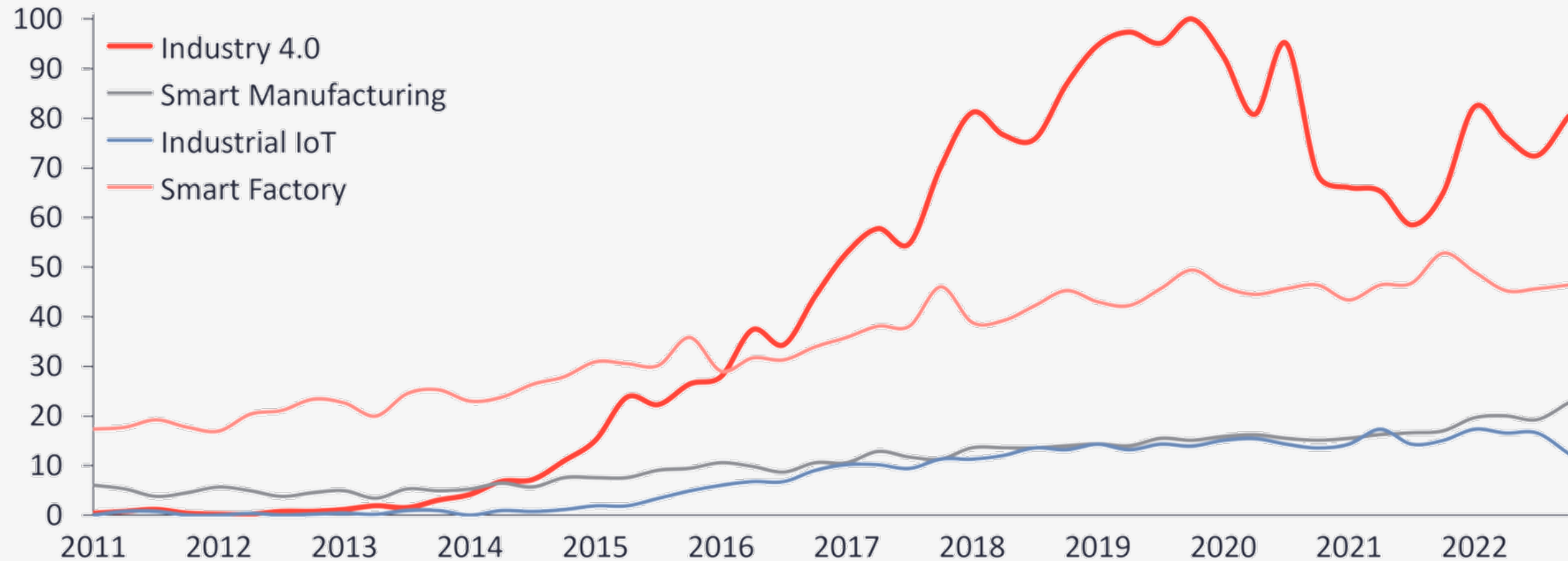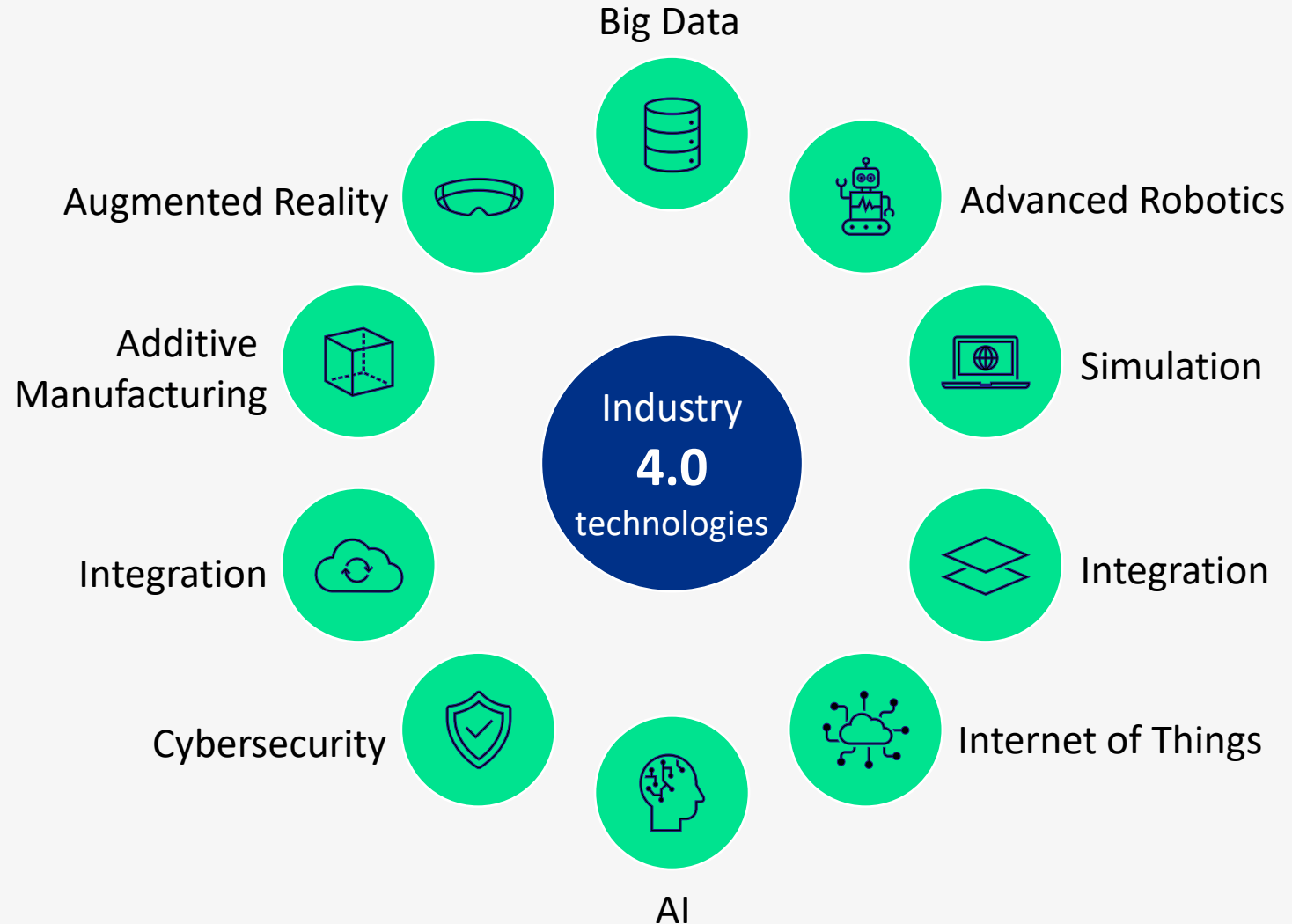
and the world was never the same again…

relative search interest on Google

Source: IoT Analytics Research, 2022, Google Trends

but what exactly is industry 4.0?

Big Data

Augmented Reality

Advanced Robotics

Additive Manufacturing

Simulation

Industry **4.0** technologies

Integration

Integration

Cybersecurity

Internet of Things

AI

investment hype

funding of Industry 4.0 startups

Number of funding rounds* / Total funding in $M

$165.4M · $227.3M · $251.9M · $349.7M · $523.1M · $1,044.8M

Covid impact

Legend: Total funding in $M — Number of funding rounds

2011 · 2012 · 2013 · 2014 · 2015 · 2016 · 2017 · 2018 · 2019 · 2020 · 2021 · 2022 · Q3
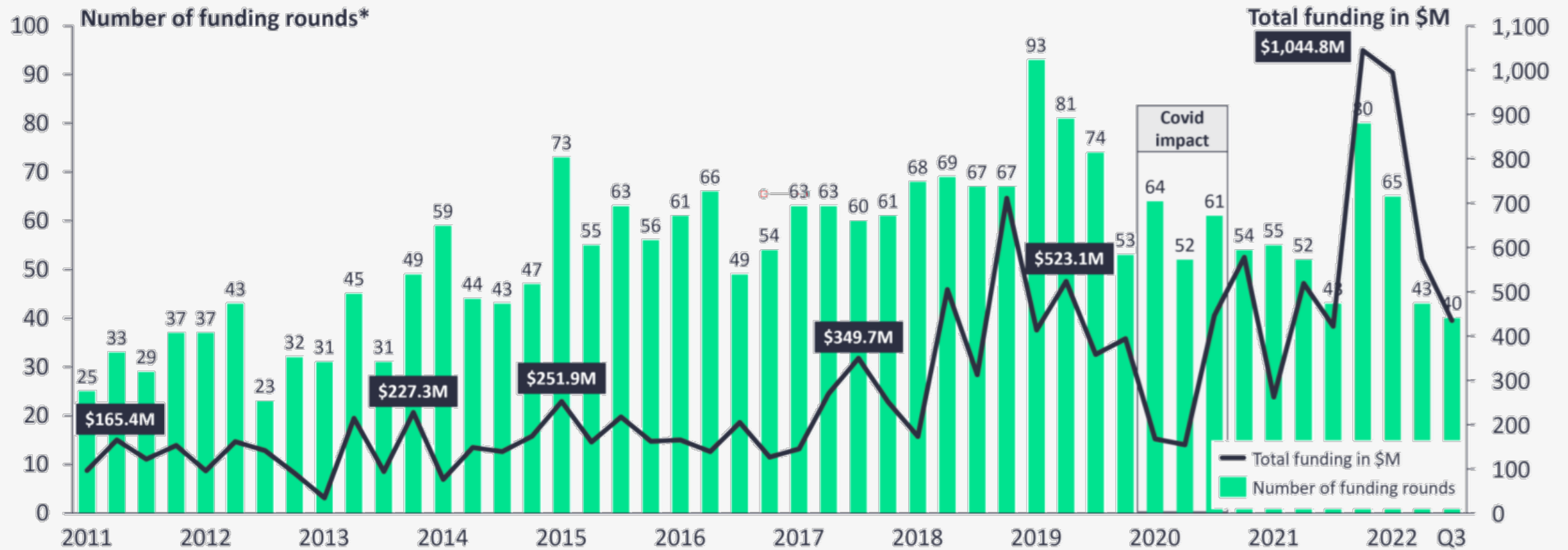
but these technologies started long time ago...
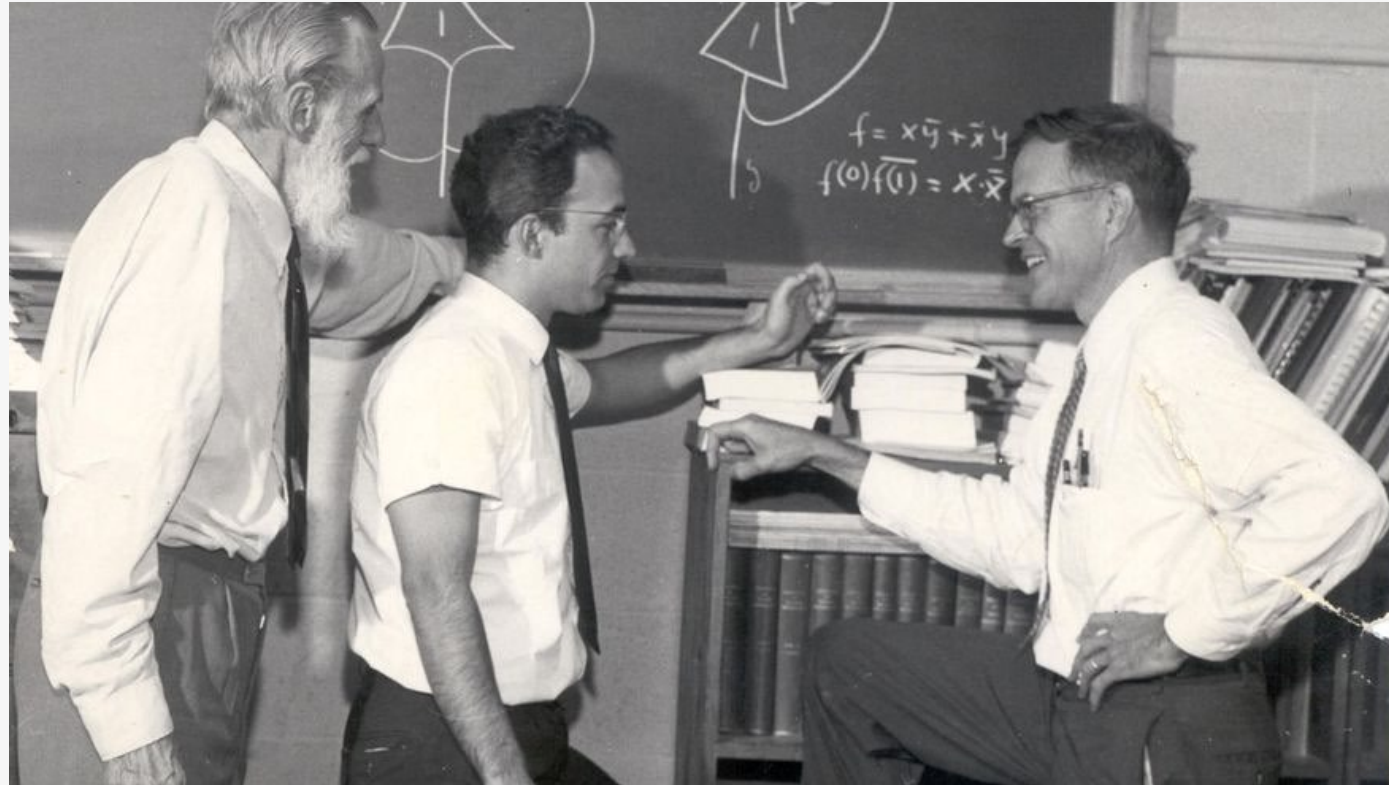
Walter Pitts and Warren McCulloch
computer model based on the neural networks of the human brain

1943

computer integrated manufacturing

JOSEPH HARRINGTON
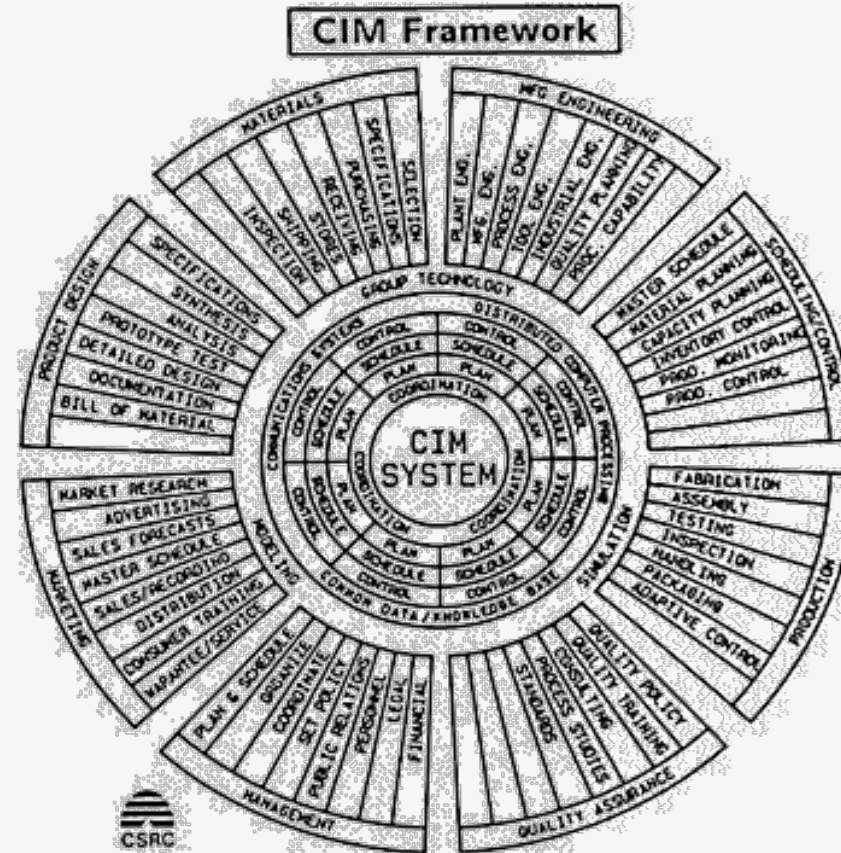Computer Integrated Manufacturing

1973

manufacturing execution systems

JONATHAN GOLOVIN
Consilium Founder

1978

so why now?

technology is like gravity, it is an accelerating force

Exponential Growth of Computing

Calculations per Second per $1,000

10^{60}
10^{55}
10^{50}
10^{45}
10^{40}
10^{35}
10^{30}
10^{25}
10^{20}
10^{15}
10^{10}
10^{5}
10^{0}
10^{5}
10^{10}

1900 '20 '40 '60 '80 2000 '20 '40 '60 '80 2100

10^{26}
▷ All Human Brains

10^{16}
▷ One Human Brain

10^{11}
▷ Mouse Brain

10^{8}
▷ Insect Brain
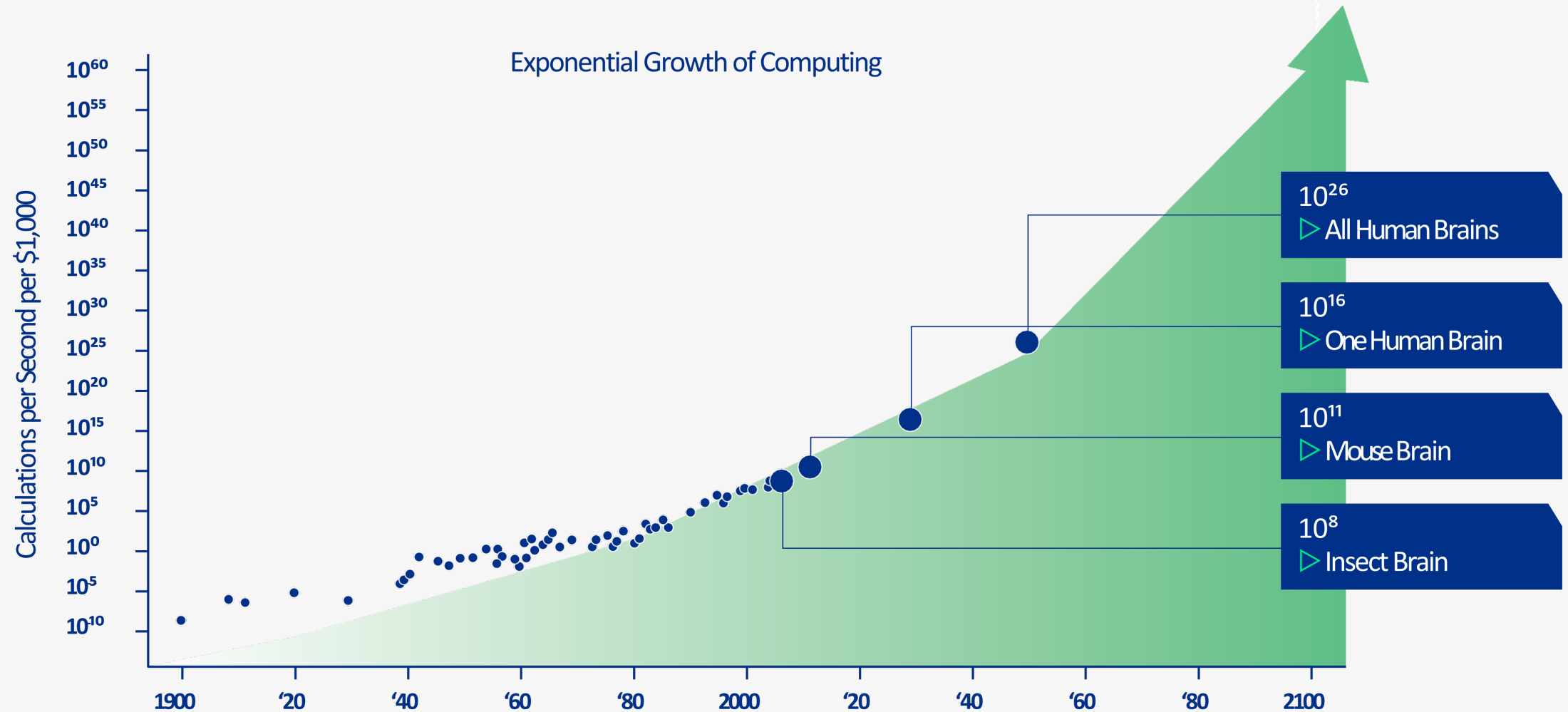
Source: HP Mega Trends, 2020

pilots and PoC's
Do these contribute to more than island solutions?

Use cases priority

Financial Impact (vertical axis: Low to High)

Ease of Implementation (horizontal axis: Low to High)

Strategically important use cases: High impact yet harder to implement	**Quick-payoff use cases:** High impact, relatively easy to implement
Wait and see use cases: Low impact, harder to implement	**2nd-tier use cases:** Lower impact, yet easier to implement
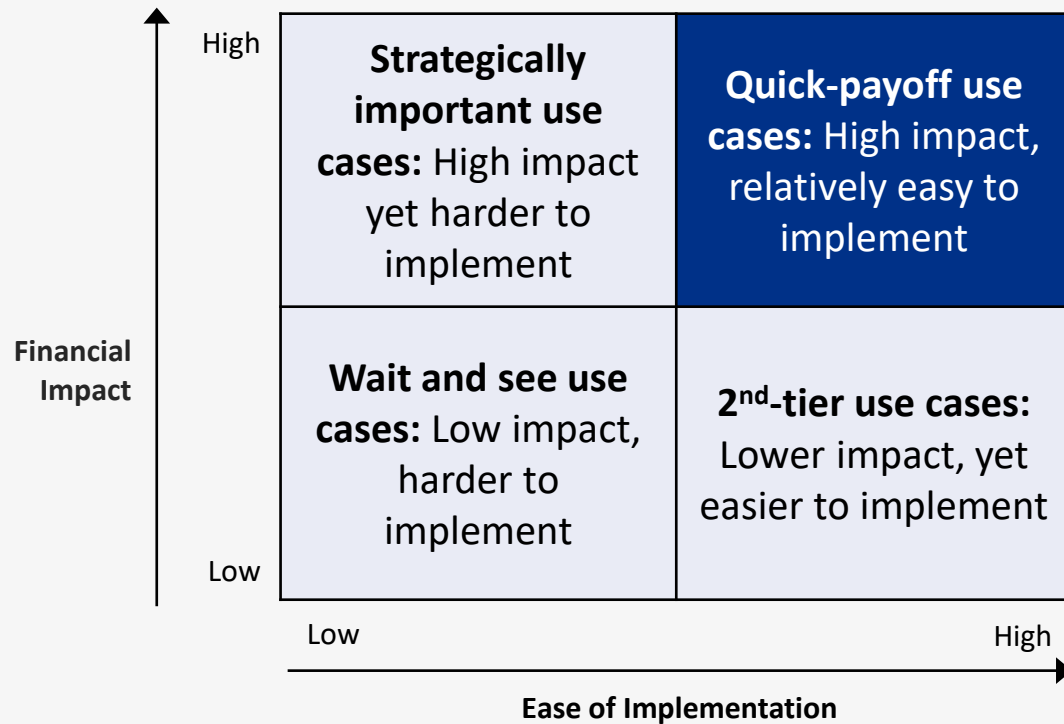
Source: A manufacturer's guide to scaling Industrial IoT, McKinsey, 2021

Implementation Strategy

Strategy	%
Corporate level proof of concept	29%
Plant level pilot	15%
Plant level proof of concept	14%
Multiple plant level pilots	14%
Corporate level pilot	13%
Multiple corporate level pilots	13%
Single plant rollout for a single function	11%
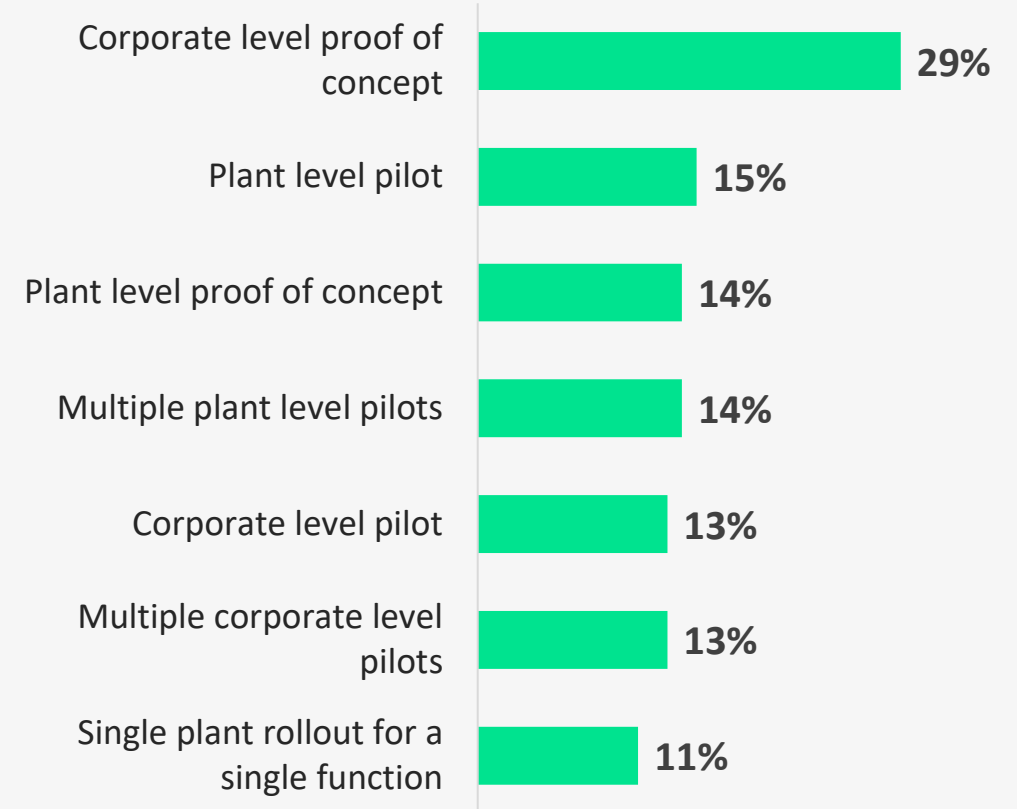
Source: Pilot Purgatory in Industrial Transformation (IX) is Fake News, LNS Research 2021

the pilot purgatory
Very few claim to have successfully reached scale with I4.0

MES & Industry 4.0
INTERNATIONAL SUMMIT **4.0**

■ Stuck in pilot purgatory ■ Scaled industry 4.0 successfully

	2017	2018	2019	2020
Scaled industry 4.0 successfully	70	68	56	74
Stuck in pilot purgatory	30	32	44	26
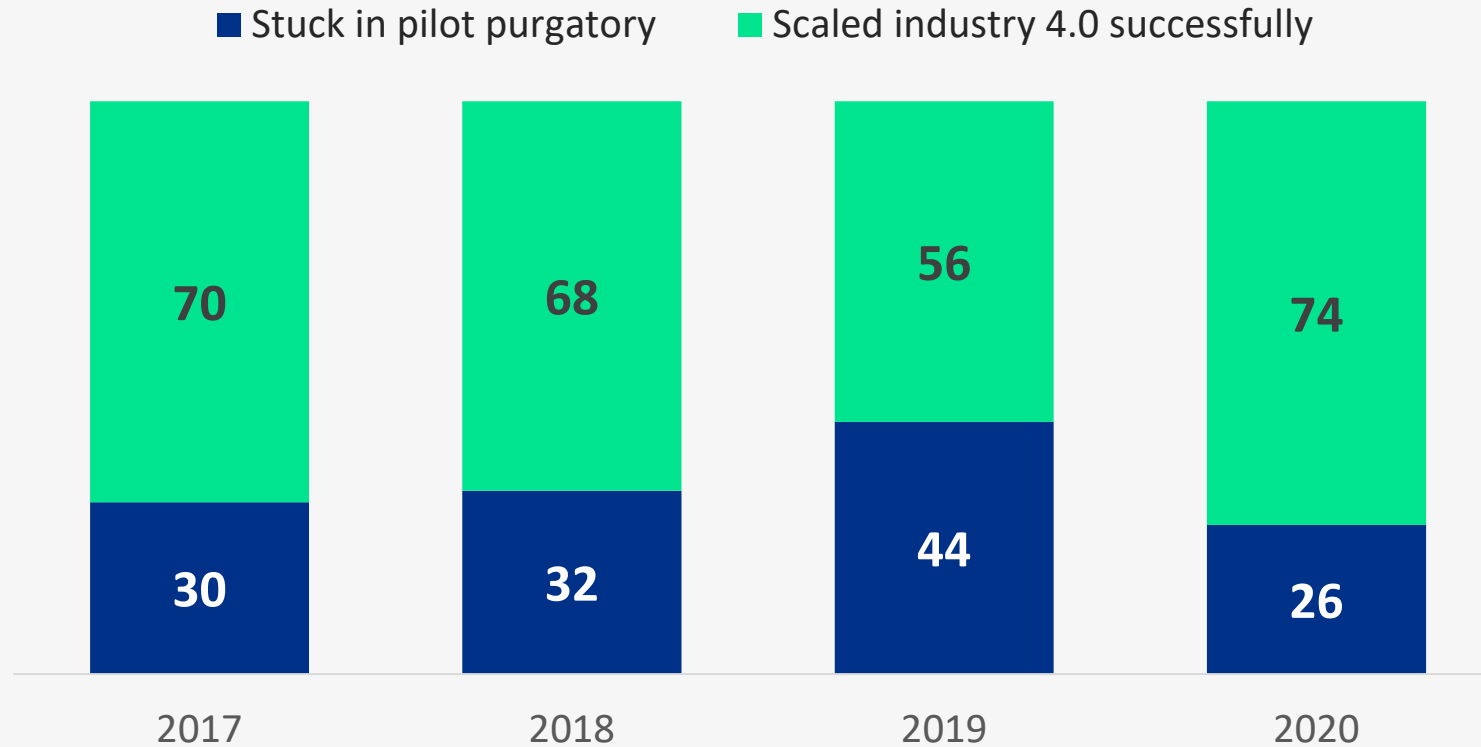
Source: McKinsey, 2021

the smart manufacturing challenges

Technology
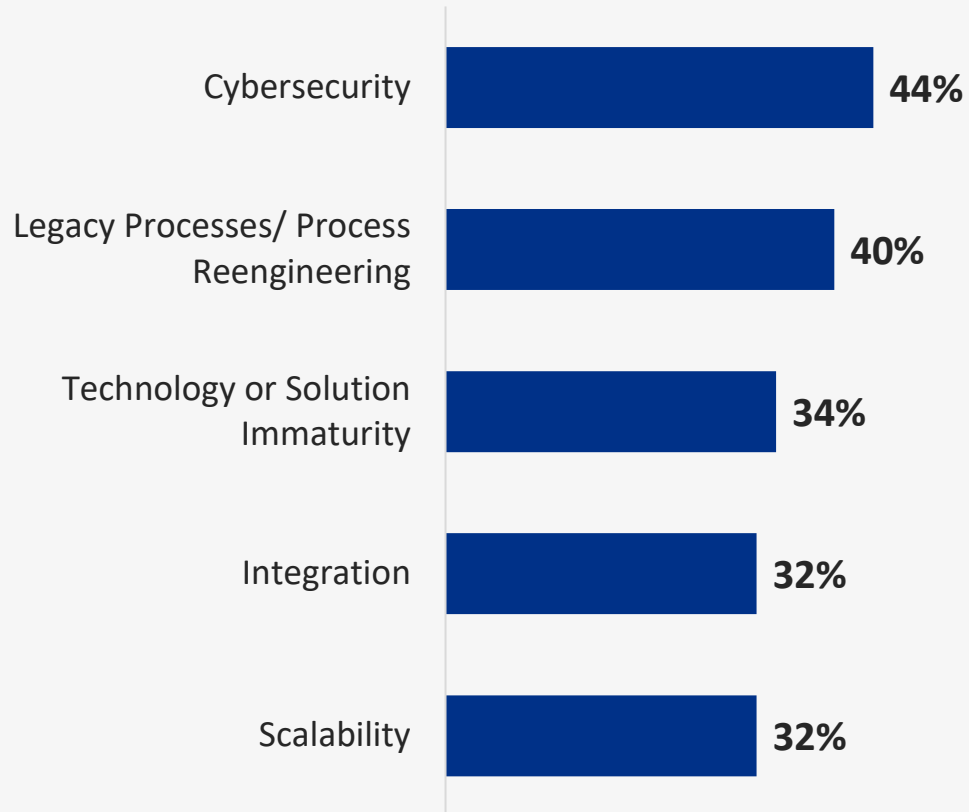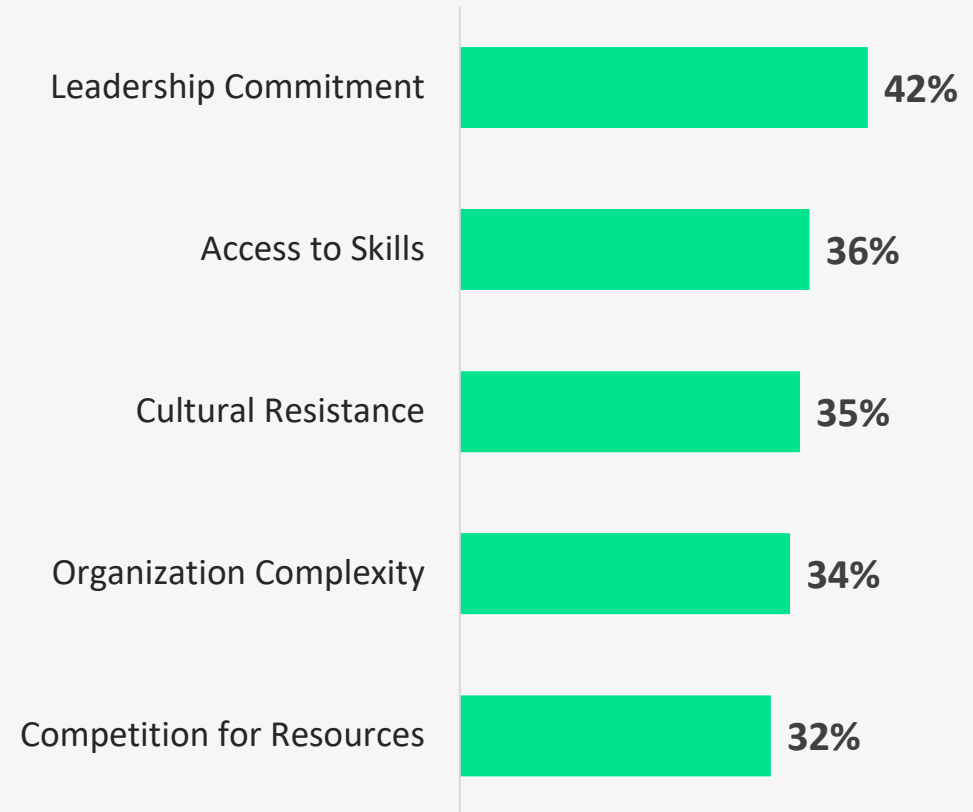
Cybersecurity	44%
Legacy Processes/ Process Reengineering	40%
Technology or Solution Immaturity	34%
Integration	32%
Scalability	32%

Organization and Culture

Leadership Commitment	42%
Access to Skills	36%
Cultural Resistance	35%
Organization Complexity	34%
Competition for Resources	32%

Source: Smart Manufacturing Challenges Every Industrial Manufacturing CIO Must Resolve, Gartner, 2022

it's all about the strategy... or the lack of it

Strategy and Execution
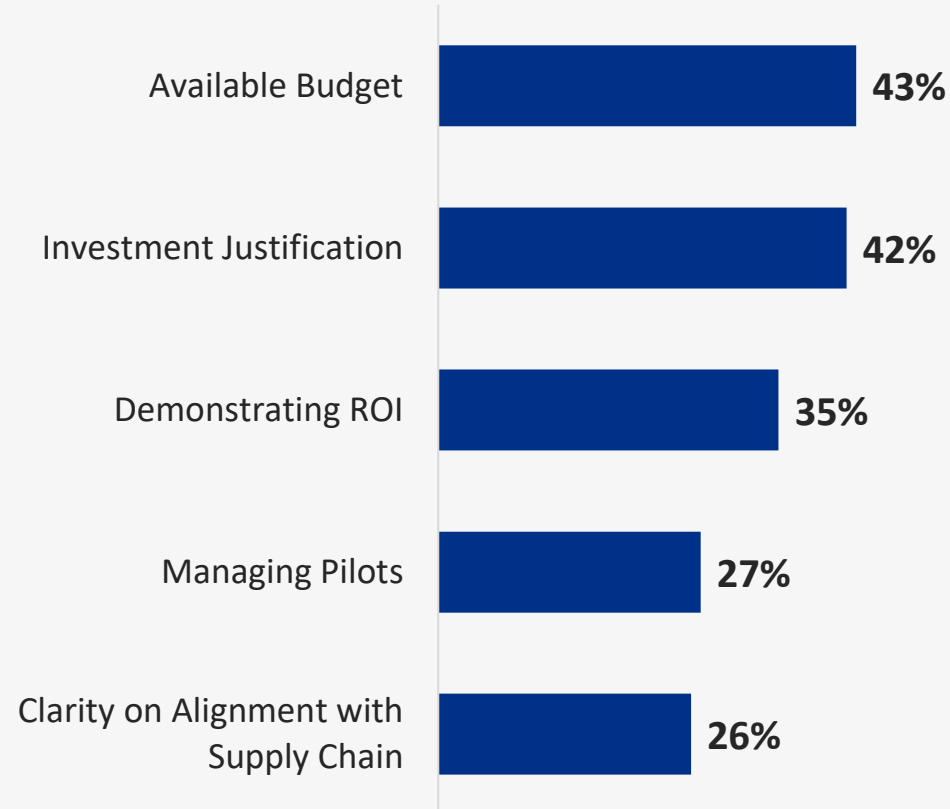
Category	Percentage
Available Budget	43%
Investment Justification	42%
Demonstrating ROI	35%
Managing Pilots	27%
Clarity on Alignment with Supply Chain	26%

Source: Smart Manufacturing Challenges Every Industrial Manufacturing CIO Must Resolve, Gartner, 2022

SIRI – Smart Industry Readiness Index
The 16 dimensions of the assessment

the SIRI results per industry
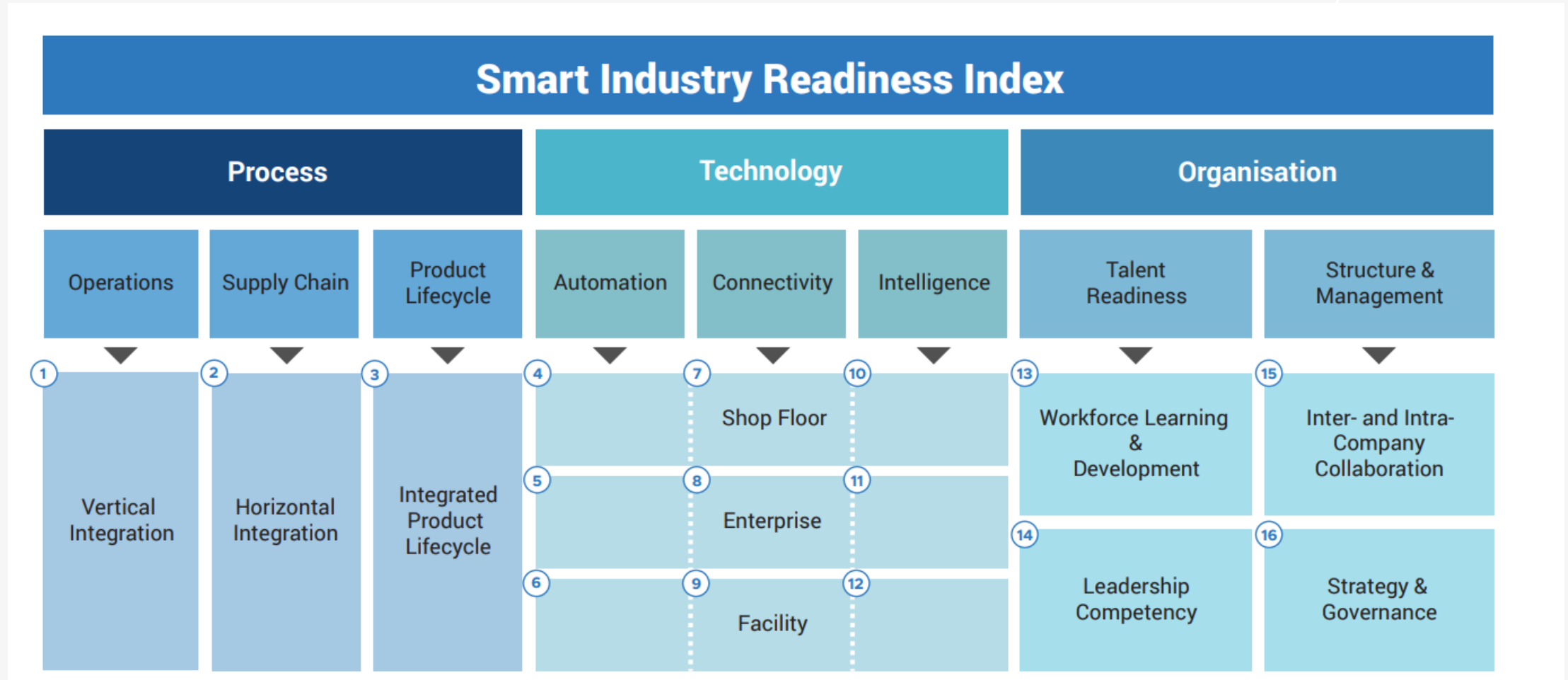

A quadrant scatter plot with axes "Siri Maturity" (vertical, Low to High) and "Siri Variance" (horizontal, High on left to Low on right). Industries plotted:

- **Semiconductors** — upper area, center
- **Electronics** — high maturity, high variance (left)
- **Pharmaceuticals** — upper center-right
- **Energy & Chemicals (Downstream)** — center-left
- **Logistics** — center-left
- **Automotive** — center
- **Aerospace** — center-right
- **Medical Technology** — right
- **Oil & Gas (Upstream)** — center-left, mid-low
- **Machinery & Equipment** — lower center-right
- **General Manufacturing** — lower center
- **Food & Beverage** — lower center-right
- **Precision Parts** — lower right
- **Textile, Clothing, Leather & Footwear** — lower right

Source: The Global Smart Industry Index Initiative: Manufacturing Transformation Insights Report, 2022

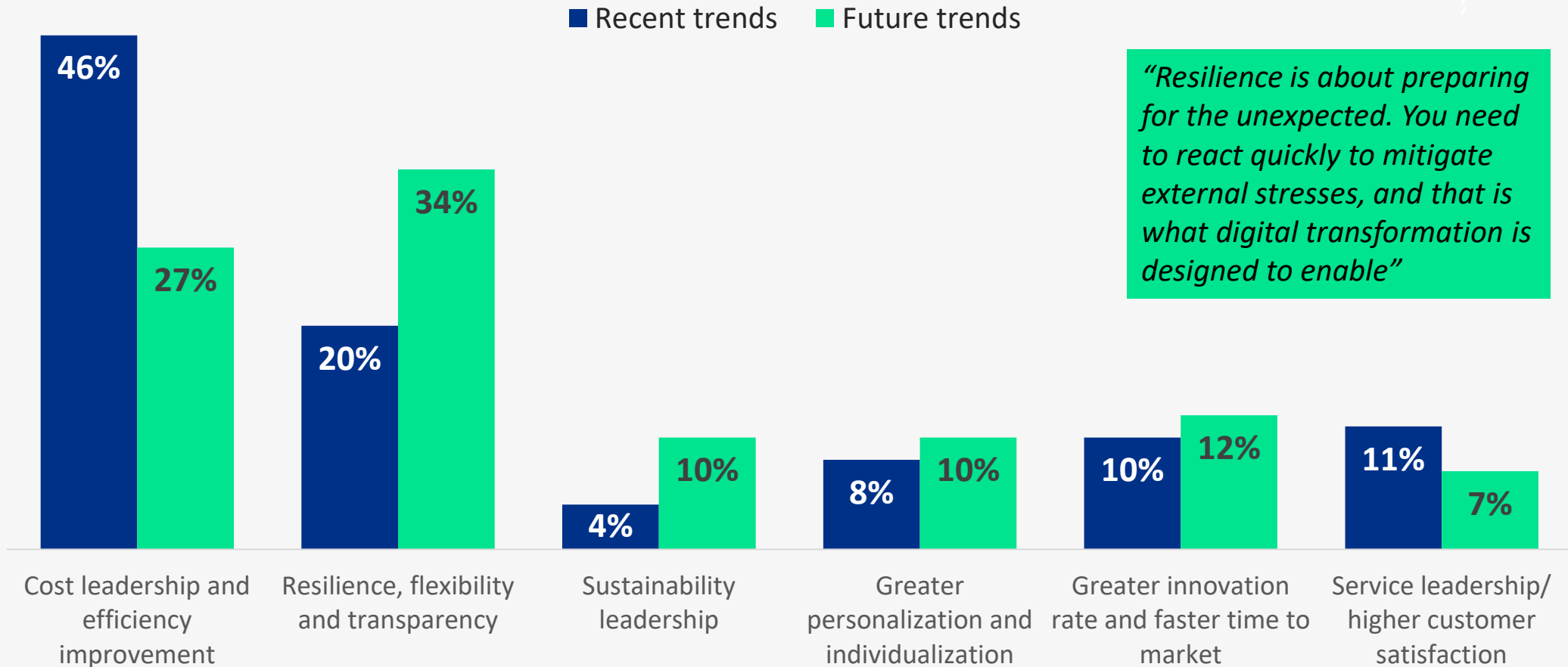# preparing for the future

Recent trends · **Future trends**

"Resilience is about preparing for the unexpected. You need to react quickly to mitigate external stresses, and that is what digital transformation is designed to enable"

- Cost leadership and efficiency improvement: 46% / 27%
- Resilience, flexibility and transparency: 20% / 34%
- Sustainability leadership: 4% / 10%
- Greater personalization and individualization: 8% / 10%
- Greater innovation rate and faster time to market: 10% / 12%
- Service leadership/ higher customer satisfaction: 11% / 7%

Source: PwC Digital Factory Transformation Survey, 2022

preparing for the future
an example in aviation

The Move to Integral Decision Making, Supported by Digital

KLM Royal Dutch Airlines has long been one of the airline industry's most innovative carriers. It has spent decades making key operational decisions that could re-shape the industry as we know it.

In 2016, KLM and Boston Consulting Group (BCG) started a transformational project "digitizing KLM's operational decision-making"
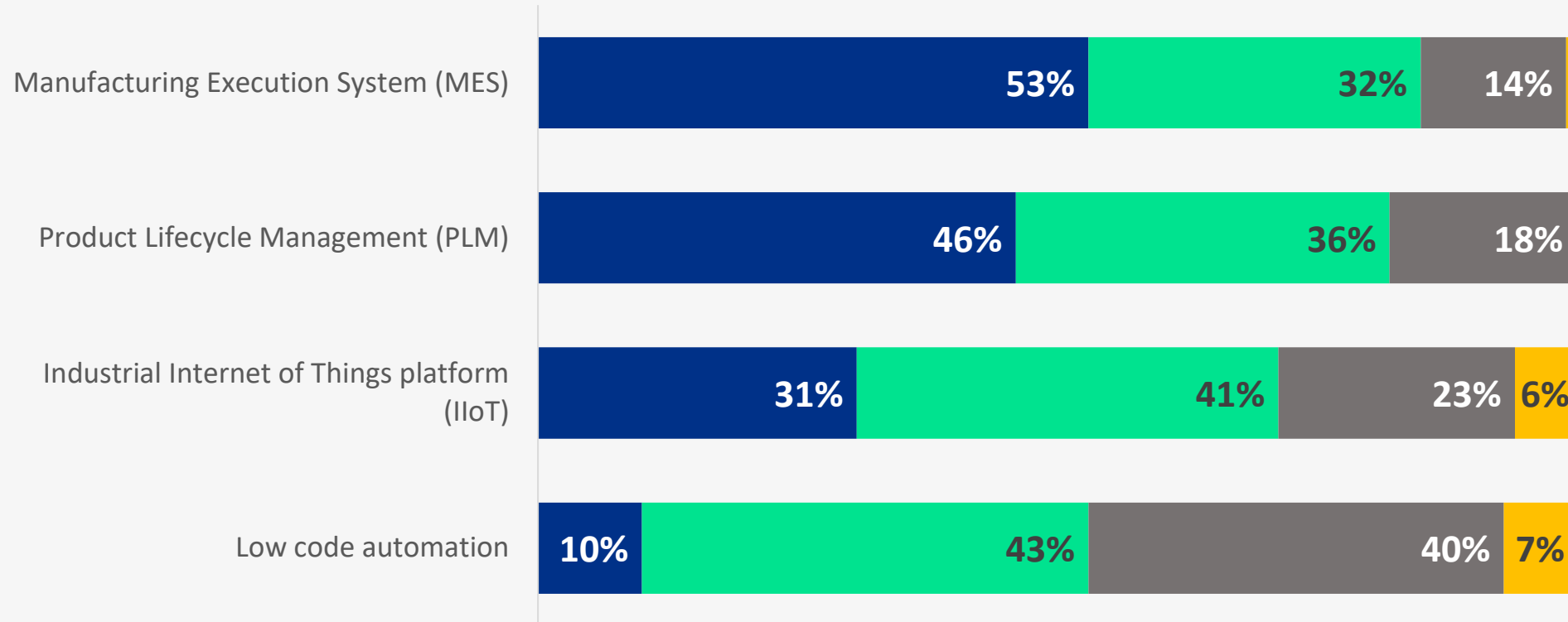
KLM wasn't looking to specific use cases, but rather systemic "win-wins" across a variety of organizational facets.

With a wide digitalization, created a single currency to find the best integral decision on the day-of operations

Source: The Move to Integral Decision Making, Supported by Digital, Wired, 2023

digital backbone
implementation stage for selected IT solutions

MES & Industry 4.0
INTERNATIONAL SUMMIT

Legend: ■ Implemented ■ In rollout ■ Piloted ■ Unplanned

Manufacturing Execution System (MES)
- Implemented: 53%
- In rollout: 32%
- Piloted: 14%

Product Lifecycle Management (PLM)
- Implemented: 46%
- In rollout: 36%
- Piloted: 18%

Industrial Internet of Things platform (IIoT)
- Implemented: 31%
- In rollout: 41%
- Piloted: 23%
- Unplanned: 6%

Low code automation
- Implemented: 10%
- In rollout: 43%
- Piloted: 40%
- Unplanned: 7%

"A standardized digital backbone is the key building block for successful factory transformation"

Source: PwC Digital Factory Transformation Survey 2022

failed ERP implementations

unable to fulfil orders of
US$64 million

Got sued by its own
shareholders

spent $400 million

initial loss of $100 million,
stock price fell 20%
class action lawsuits from
unfulfilled orders

Took 7 years and + $500
million to mitigate

lost 7 years

$580 million invested

Project cancelled

lost 8 years

$5 billion invested

Project cancelled

expectations and the customization trap

Paper on glass

A data recording approach similar to paper-based recording but in a digital environment. A paper on glass system's interface includes predefined fields into which employees enter data
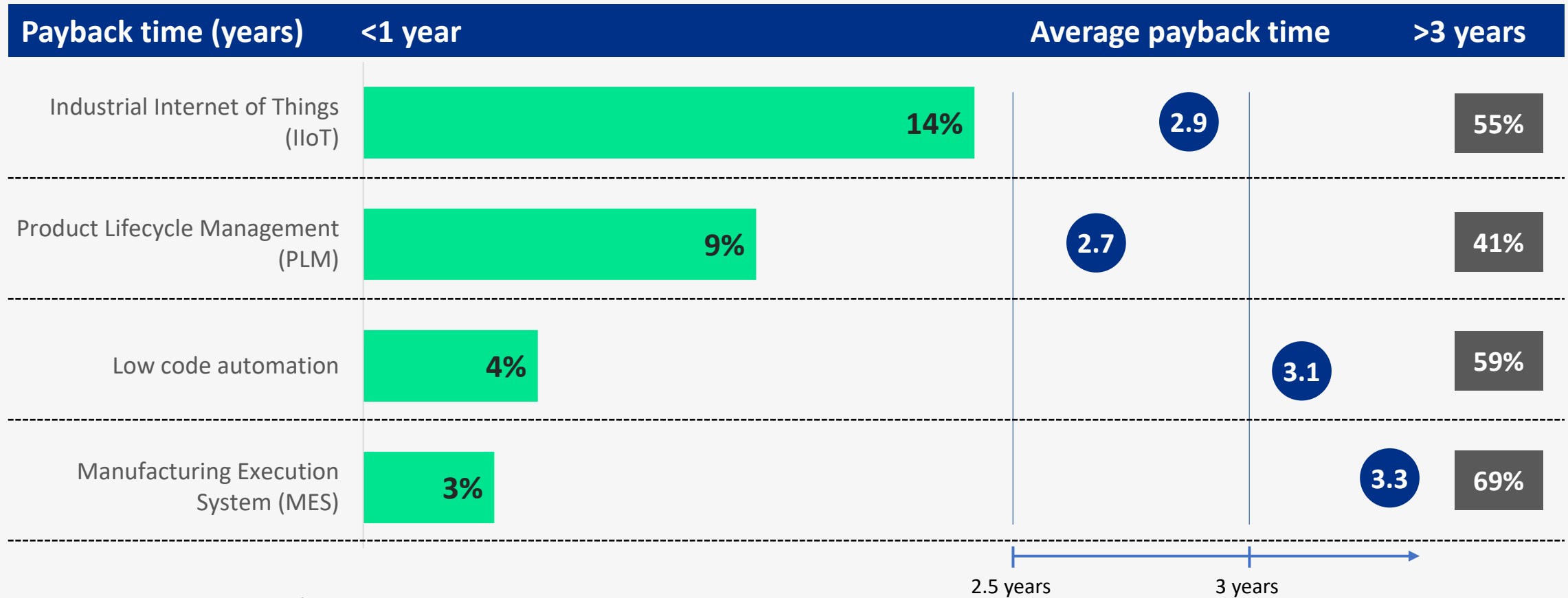
XY problem

Is a communication problem encountered in software engineering where the user requirements show in a form of the use a particular solution (Y) rather than the root problem itself (X)

Gold plating

Is the phenomenon of working on a task or requirement past the point of diminishing returns
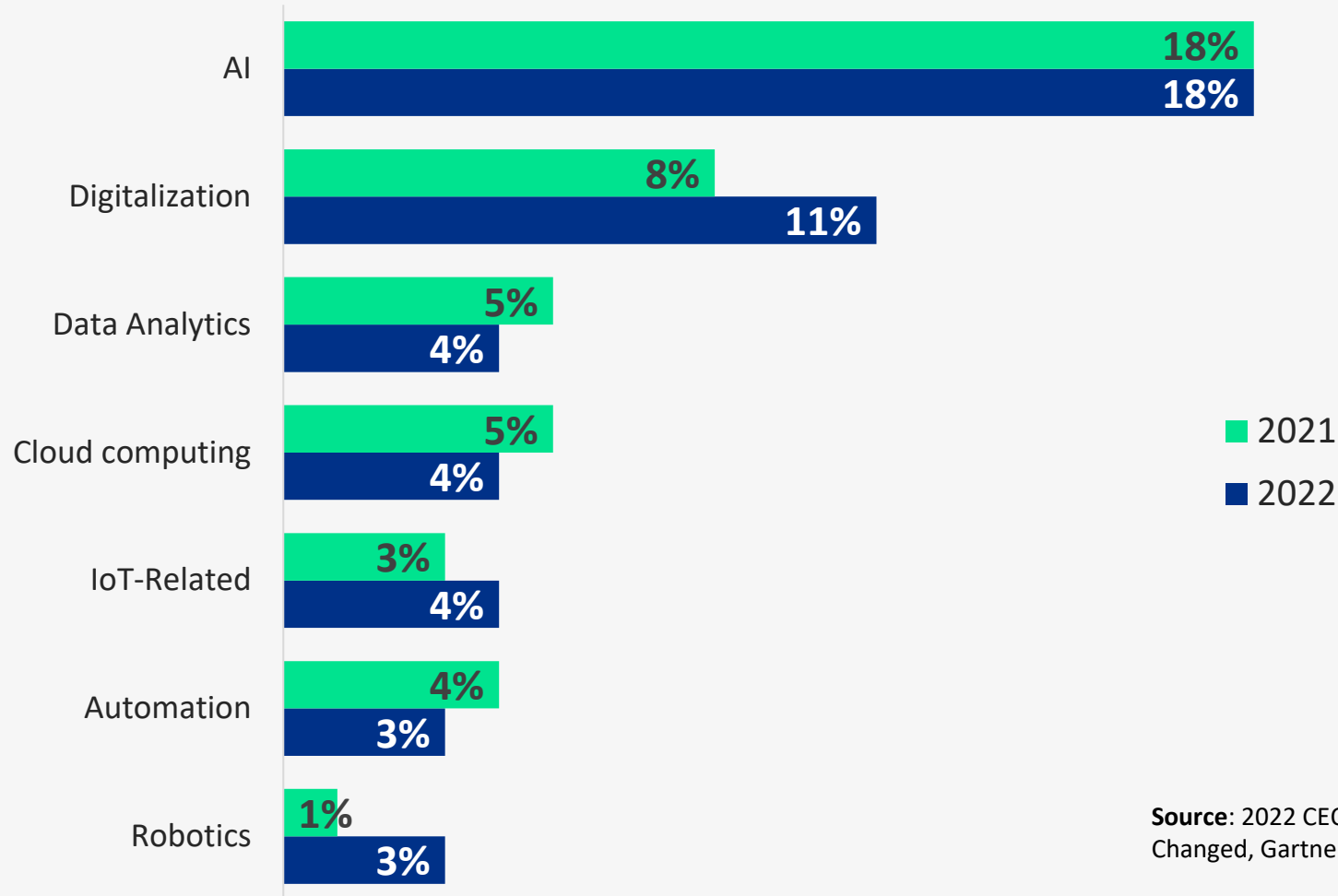
successful backbone implementations
payback periods for selected IT solution implementations

Payback time (years)	<1 year	Average payback time	>3 years
Industrial Internet of Things (IIoT)	14%	2.9	55%
Product Lifecycle Management (PLM)	9%	2.7	41%
Low code automation	4%	3.1	59%
Manufacturing Execution System (MES)	3%	3.3	69%

2.5 years   3 years

Source: PwC Digital Factory Transformation Survey 2022

successful backbone implementations
technologies CEO's believe will most significantly impact their business over the next 3 years

MES &
Industry
4.0
INTERNATIONAL SUMMIT

Technology	2021	2022
AI	18%	18%
Digitalization	8%	11%
Data Analytics	5%	4%
Cloud computing	5%	4%
IoT-Related	3%	4%
Automation	4%	3%
Robotics	1%	3%

■ 2021
■ 2022

Source: 2022 CEO Survey — The Year Perspectives Changed, Gartner, 2022

so let's do AI
chihuahua or muffin?

so let's do AI
chihuahua or muffin?

test1.png

test13.png

msft_captions	a brown and white teddy bear (69)
msft_tags	

test11.png

msft_captions	a close up of a stuffed animal (55)
msft_tags	indoor (94) , food (87) , bread (74) , dessert (30)

Source: Chihuahua or muffin? My search for the best computer vision API, Mariya Yao, 2017

data enrichment

Data enrichment is defined as merging third-party data from an external authoritative source with an existing database

Examples from other industries:
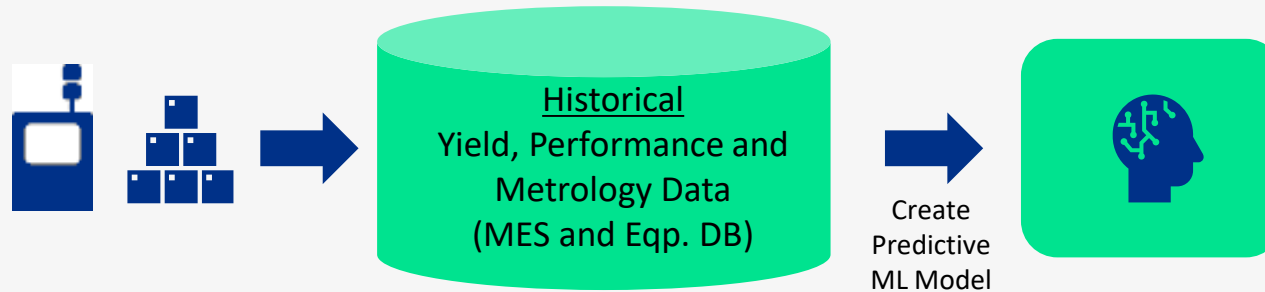

Social Media

Customer Relationship Management

Insurance

MES contextualized AI
Example: Perform process parameter tuning for optimal yield and performance

Predictive Model Creation & Deployment based on Historical Equipment and MES Data

Application of Predictive Model for Performance Parameter Tuning for Optimal Yield and Performance
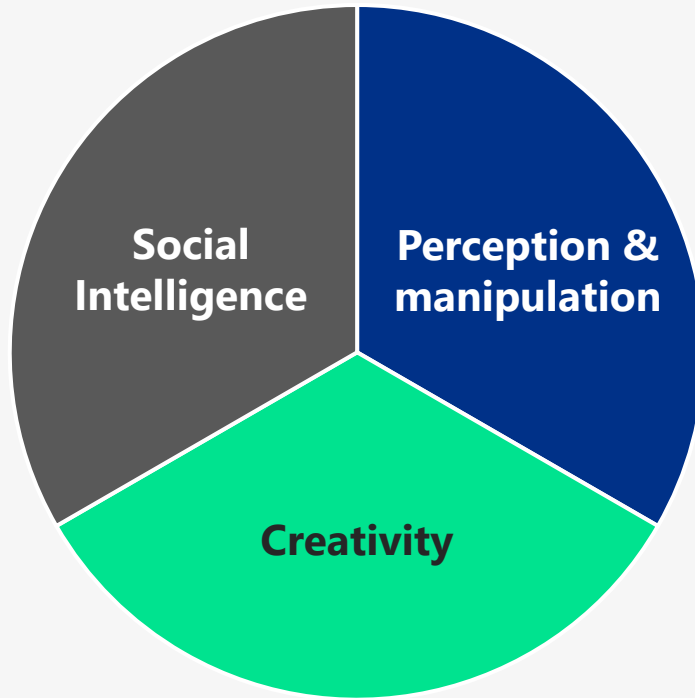

Other examples:
Predict Lot Yield and Performance
Golden Tools / Route Selection Calculation
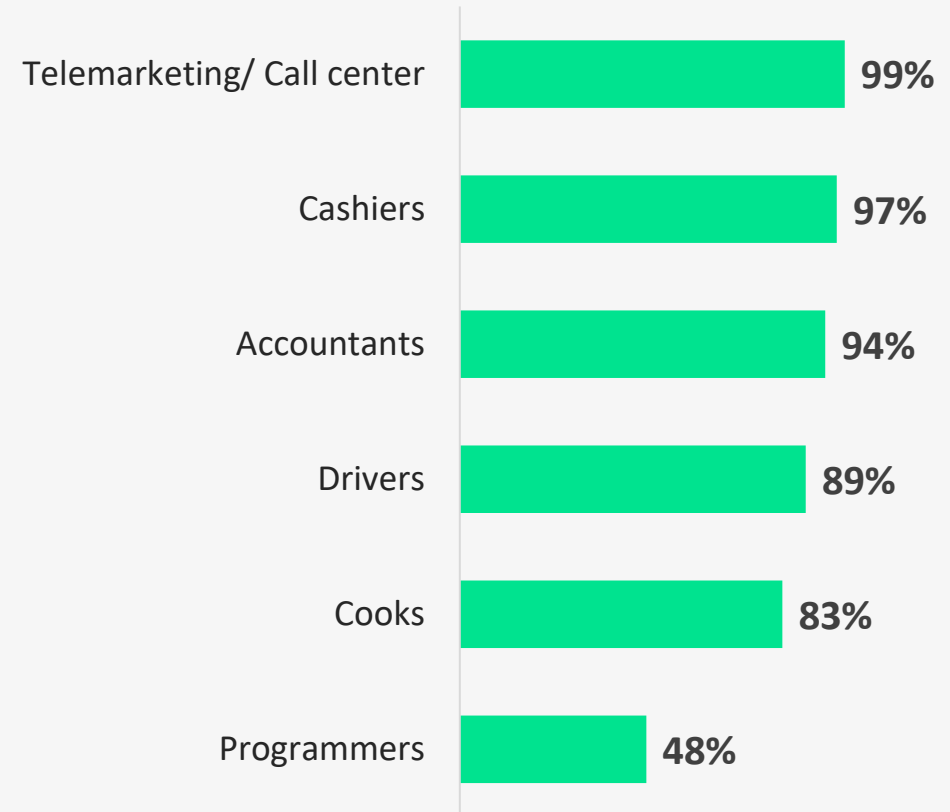Automatic (and Early) Excursion Detection

the future of employment

Source: The Future of Employment, 2013

Organization and Culture

Telemarketing/ Call center	99%
Cashiers	97%
Accountants	94%
Drivers	89%
Cooks	83%
Programmers	48%

Pie chart segments: Social Intelligence, Perception & manipulation, Creativity

the future of employment by WEF
projected job creation and displacement, 2023-2027

1 million jobs

Jobs lost

Stable lots

Jobs created
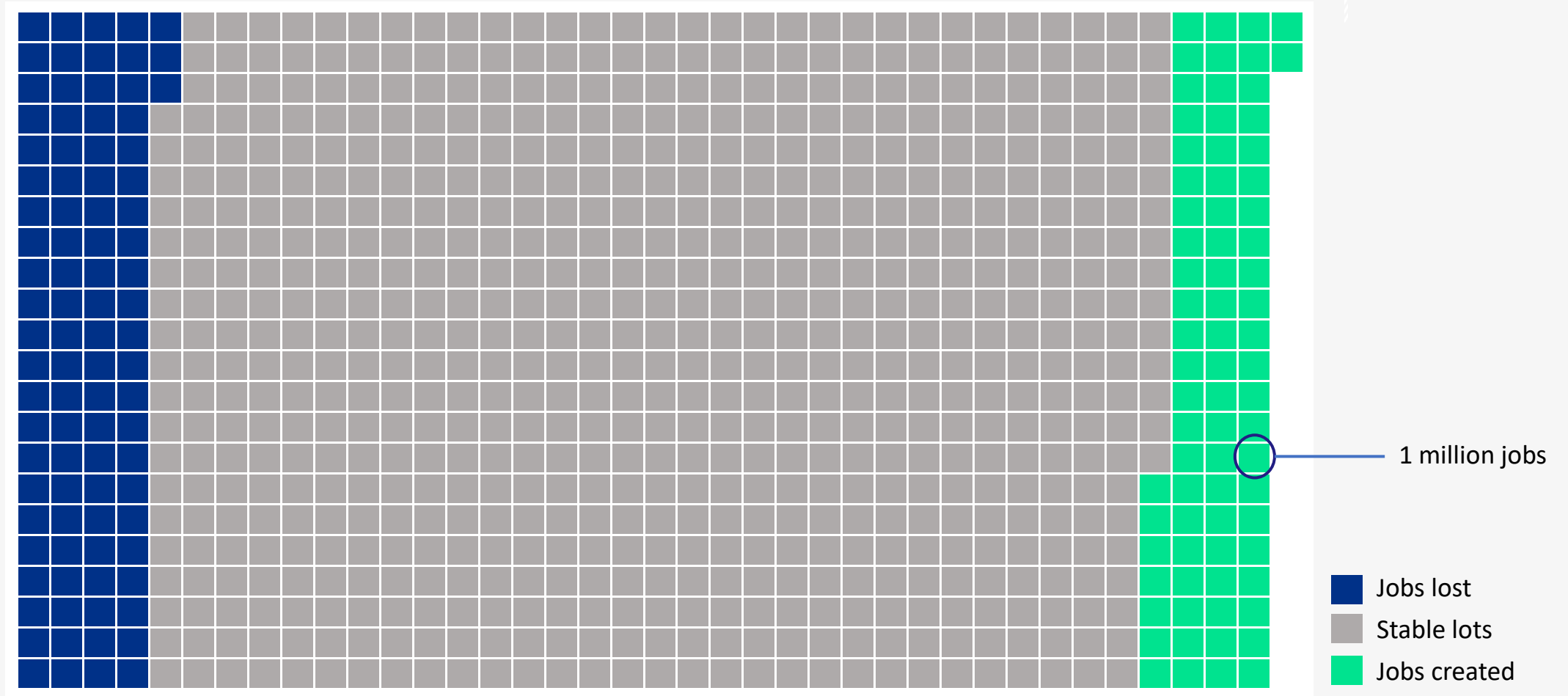
Source: World Economic Forum, Future of Jobs Survey 2023

the future of employment by WEF
Expected impact of technology adoption on jobs, 2023–2027

Technology	Impact
Big-data analytics	58.0%
Climate-change mitigation technology	49.5%
Environmental management technologies	45.8%
Encryption and cybersecurity	43.3%
Biotechnology	42.9%
Agriculture technologies	41.3%
Digital platforms and apps	41.0%
Health and care technologies	40.3%
Education and workforce development technologies	39.8%
Augmented and virtual reality	39.6%
Power storage and generation	37.6%
E-commerce and digital trade	36.6%
Biodiversity protection technologies	35.0%
Cryptocurrencies	35.1%
Cloud computing	34.8%
Water-related adaptation technologies	33.7%
New materials	32.9%
Distributed ledger technology	30.5%
3D and 4D printing and modelling	28.8%
Satellite services and space flight	28.5%
Internet of things and connected devices	28.1%
Nanotechnology	28.0%
Artificial intelligence	25.6%
Quantum computing	23.5%
Text, image, and voice processing	17.6%
Electric and autonomous vehicles	16.5%
Robots, humanoid	-2.6%
Robots, non-humanoid (e.g. industrial automation, drones)	-8.8%

one last topic: Industry 5.0?

European Commission

"a vison of industry [...] beyond efficiency and productivity [...] and reinforces the role and the contribution of industry to society."

It places the wellbeing of the worker at the centre of the production process and uses new technologies to provide prosperity beyond jobs and growth while respecting the production limits of the planet.

"It complements "Industry 4.0" [...] by putting research and innovation at the service of the transition to a sustainable, human-centric and resilient European industry.

Source: research-and-innovation.ec.europa.eu, European Union 2023

One of These Lines Is Not Like the Others

Total factor productivity growth, and projections using two mathematical models
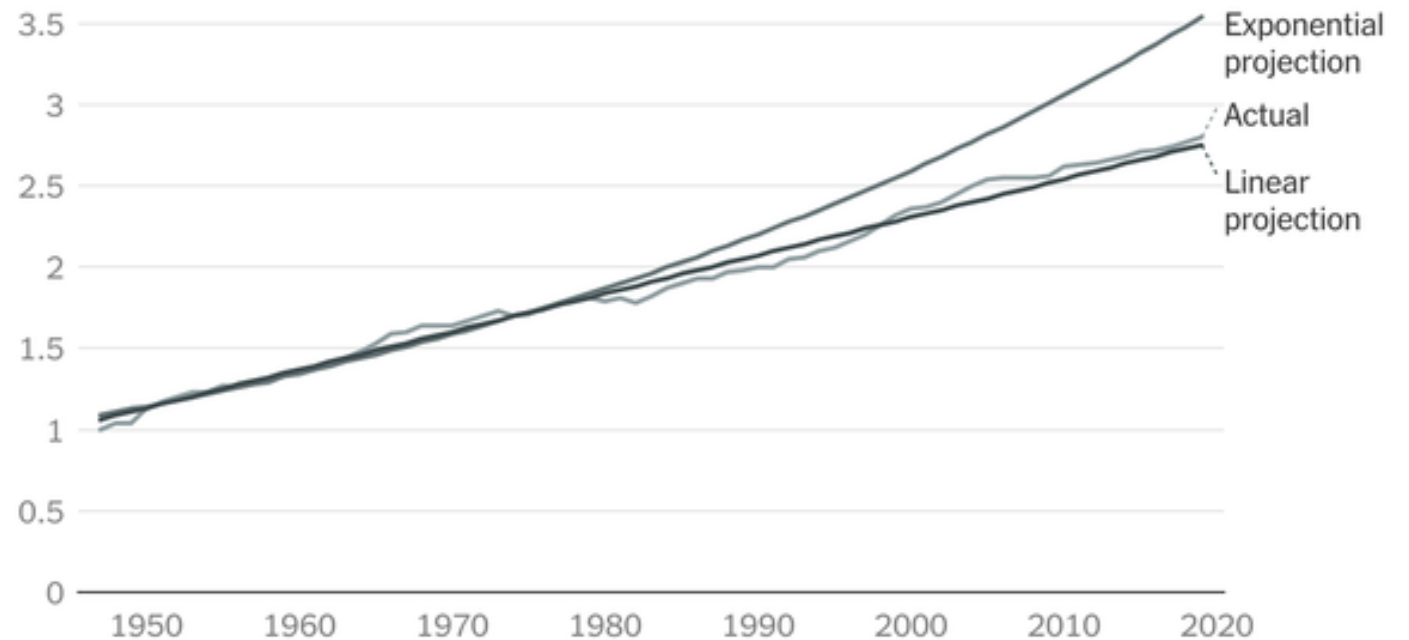
Index: 1947 = 100

Source: Here's the Secret Ingredient in Economic Growth, NY Times, 2022

summing it up...

1 Industry 4.0 (and digital transformation) is a journey

2 You need a strategy... and a backbone

3 MES is a great backbone (at least some are...)

4 Mind gold plating, paper on glass, XY problem, customization trap

5 Evolve iteratively – you don't know what the future holds

THANK YOU!

✉ franciscolobo@criticalmanufacturing.com

in /in/falmadalobo

Connect for a smarter future

MES & Industry 4.0

INTERNATIONAL SUMMIT 4.0