Manufacturing and Metrology, Complementary Aspects and Challenges



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Outline

- Importance of Manufacturing for Europe
- Current Challenges
- Approaches for Solutions



Importance of Manufacturing Industry for Europe as a guarantor for prosperity, innovation and jobs

Manufacturing plays a central role in Europe's economy
Production of goods combined with high-quality services

EU Manufacturing	32.1 million	>60 million	80% of total
€8.3 trillion turnover	direct jobs	indirect jobs mainly in small and medium –sized enterprises (SMEs)	EU exports

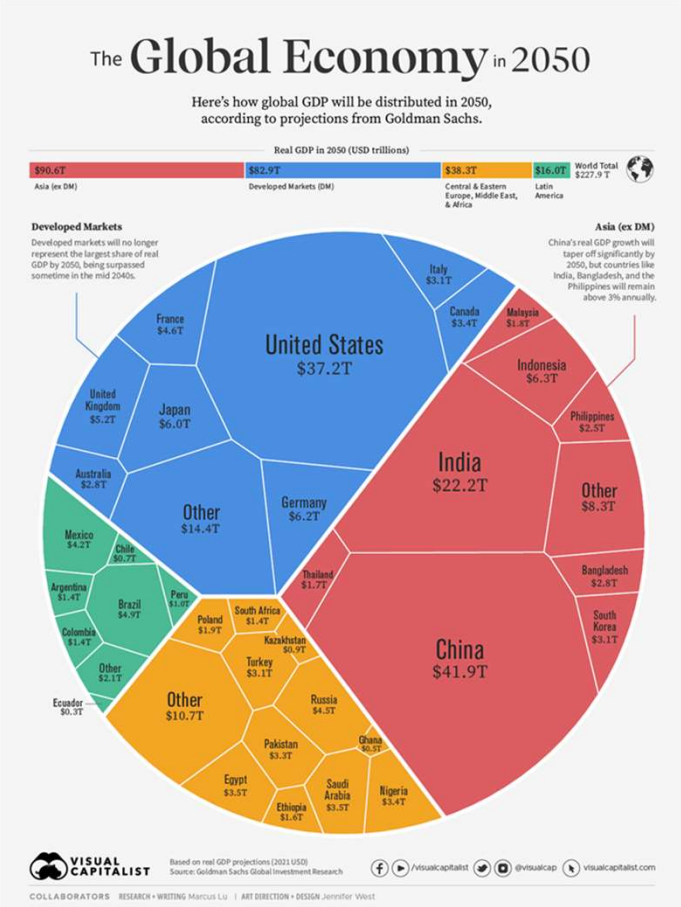






Source Eurostat 01-2024

The Challenge: Growth, jobs and prosperity under pressure



General Developments: „The new global disorder“

- Energy Scarcity & Soaring Prices
- Rising raw material prices and insecure supply of critical raw materials
- Deglobalisation / Restructuring of value chains
- Global Technology Race /Sovereignty/Strategic Value Chains/Price pressure
- Trend "Environmental Social Governance (ESG)“
- Demographic change / Skills Shortage
- World gravity centers are steadily changing
- Reluctance to invest in Europe

Draghi- and Letta-Reports brought competitiveness and productivity back on the agenda

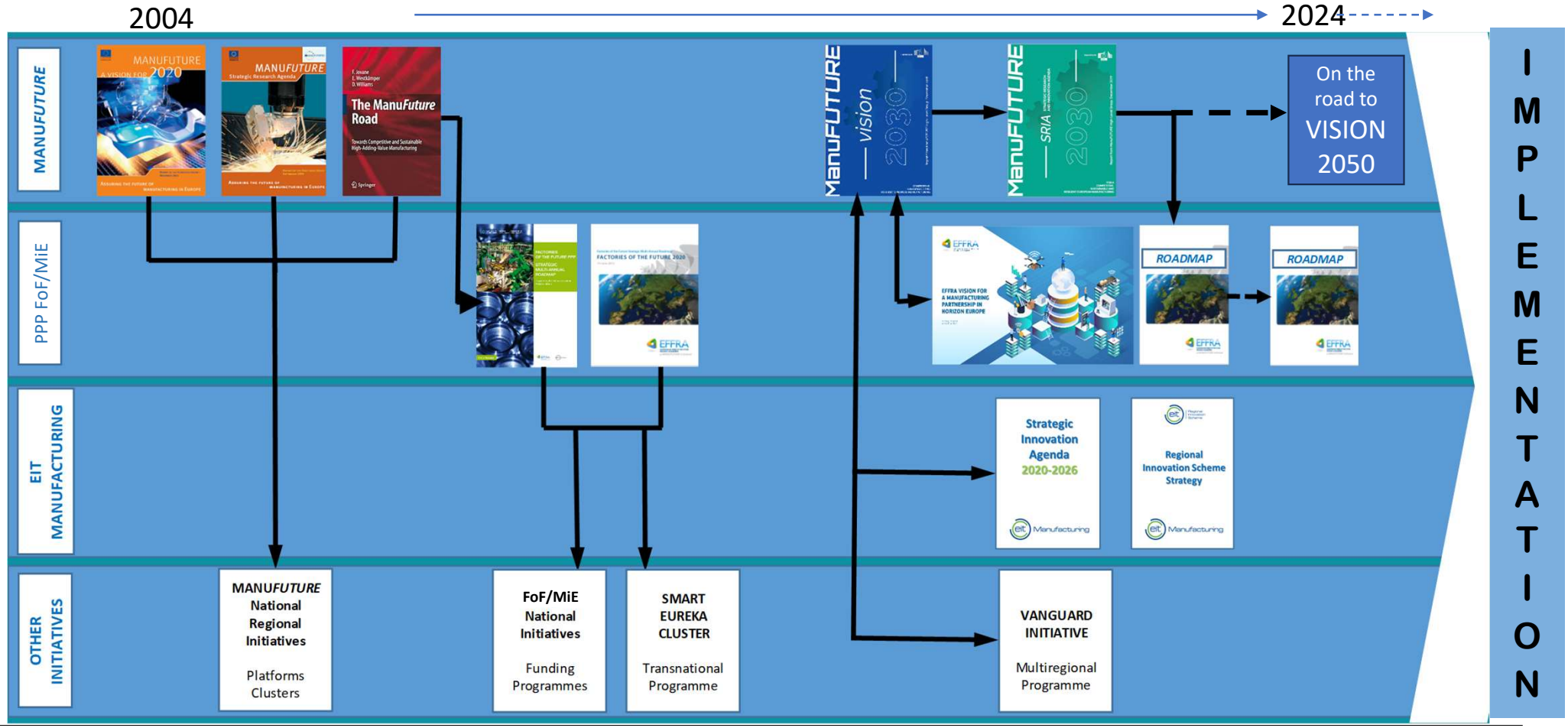
Draghi-Report

- **Need for significant investments**, including private ones
- Need for a joint **plan for competitiveness**
- **Europe must** refocus its collective efforts in **closing the gap with US and China**, especially on advanced technologies–need for targeted breakthrough technologies
- **Skills** are a major issue
- Need for increased security and reduced dependences

Letta-Report

- **Europe is facing a risk of de-industrialisation**–need for strategic adaptations
- EU Companies need to **scaleup with** the SingleMarket to be able to compete globally
- EU Companies need to **diversify supply chains**,**attract foreign investments** and **support innovation**

MANU*FUTURE* 20 Years of „Strategic Intelligence“



Trends in Manufacturing Engineering

Everything in Manufacturing is or will become smart and networked

Smart Industry, Industry 4.0 / 5.0

- Networking (Industrial Internet of Things, Big Data, Data Analytics, Cloud, Data Security, Cyber Security), Augmented Reality, Extended Reality, 3D-Internet, Metaverse

Smart Logistics

- Autonomous Transport Systems, Integrated Supplier Networks, Global Supply Chain Visibility and Control

Automation end-2-end

- Robotics, Human Robot Cooperation, Autonomous robots, Sensors and Actors (and respective technologies)

Additive Manufacturing

- new applications (laminate or metal), reduction of production times, constant high quality

High Performance and Zero-Defect Manufacturing

- Condition monitoring of production equipment, automatic re-calibration and correction

Future Competitiveness needs Progress in Relevant Technologies

Manufacturing
is interdisciplinary and
has an integrating role

Material Technologies



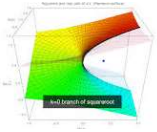
Micro- and Nano Electronics



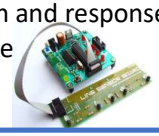
Robotics



Mathematical Methods
- big data/smart data
- artificial intelligence
- machine learning



Sensor Technologies
- real time evaluation and response
- artificial intelligence



Information and Communication Technologies (ICT)
- Cyber-physical systems
- Interfaces



Photonics



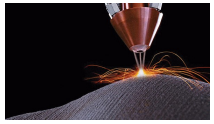
Bio Technologies



Progression of classical technologies beyond today's borders
- ultraprecision to the nano-range
- resilient manufacturing processes, zero-defects



Additive manufacturing



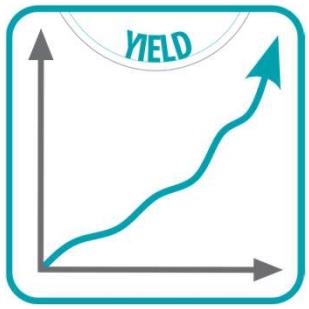
EMN's Strategic Research Agenda

Addresses manufacturing trends and metrology needs to support these trends

- https://www.euramet.org/european-metrology-networks/advanced-manufacturing/strategic-research-agenda

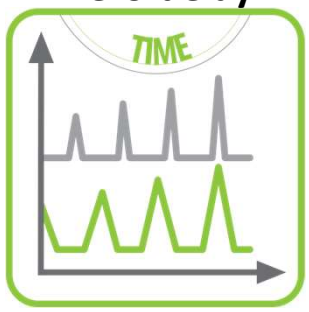
- **MANU*FUTRE* Vision 2030: Competitive, Sustainable And Resilient European Manufacturing**

zero-defect



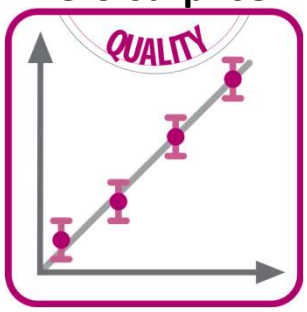
Measure to detect and eliminate defects

zero-delay



Measure to prevent delays

zero-surprise



Measure to predetermine product variation

zero-waste



Measure to qualify circular production

- Metrology strives for precise, trustworthy, fast, hybrid & holistic, integrated, affordable and easy solutions

Requirements for “Smart Manufacturing & Assembly Systems”

Smart manufacturing & assembly systems equipped with smart process control.

Such systems are much more

- adaptable,
- autonomous,
- intelligent,
- interconnected, and
- quality-oriented than traditional systems.

Systems need seamless integration of

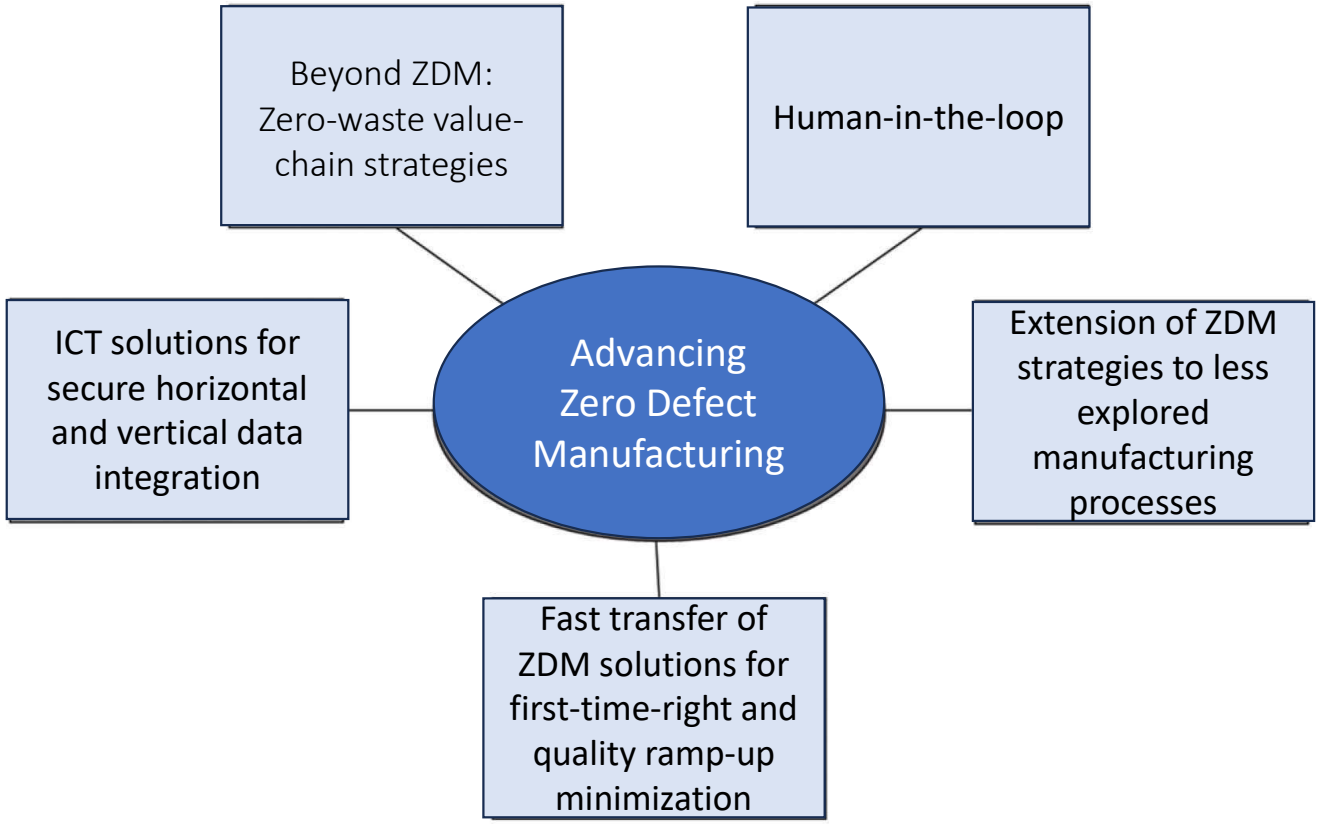
- measurement technologies,
- communication subsystems, and
- data processing methods

To generate, access, interpret, and act on metrology data with confidence at process relevant speeds

In order to achieve the aims of zero-defect, zero-delay, zero-surprise, and zero-waste [1] at the earliest opportunity during manufacture and assembly.

[1] https://www.manufuture.org/vision-2030-document/

Advancing Zero-Defect Manufacturing



Automation of End-to-End and Circular Processes

Consistent and automated end-to-end processes ensure efficient, reliable and controllable business processes...

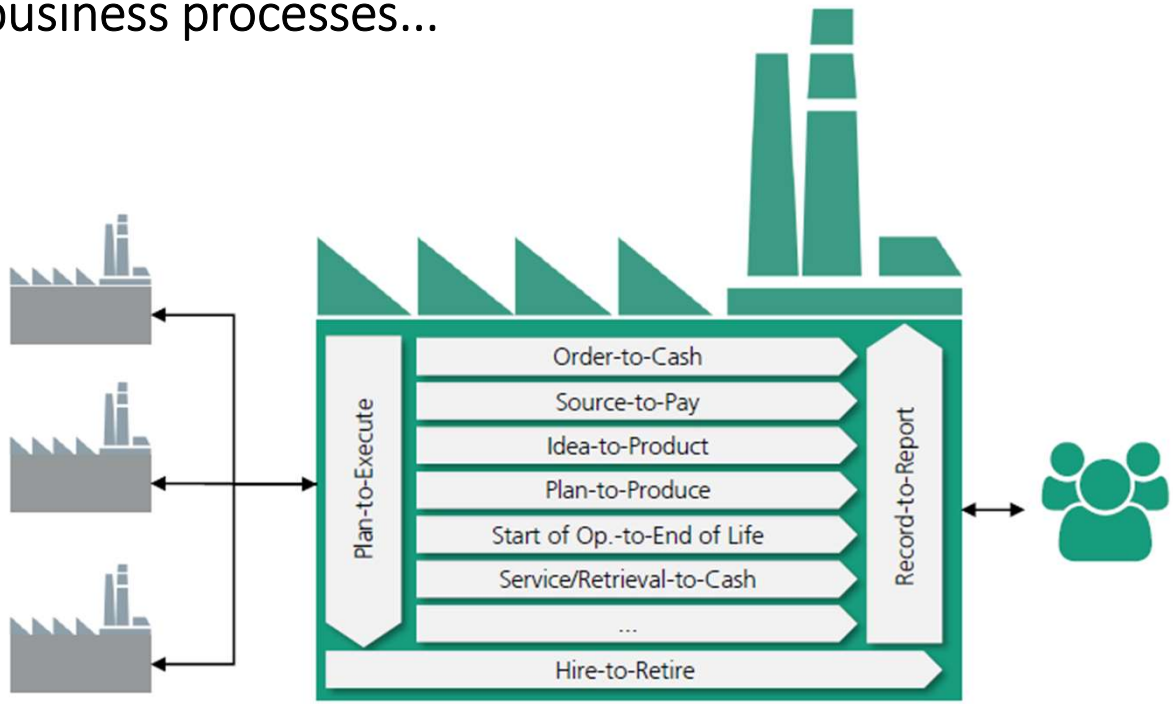


Image adapted from (Wagner et al. 2019).

...and thereby increase customer satisfaction and margin

15 -40%
Lower costs due to automation

5 -20%
Lower supplier costs

up to 30 -50%
Fewer Days Sales Outstanding

30 -40%
Faster recruitment of new employees

50 -75%
Faster reporting cycles

10 -20%
Improved customer satisfaction

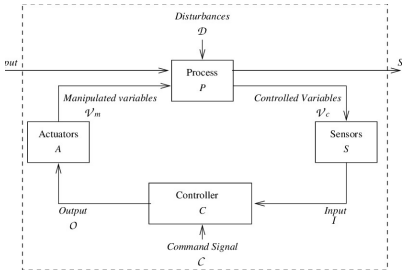
Source BCG 2023
Image adapted from (Wagner et al. 2019).

Decentralised Technical Intelligence (DTI)

Next evolutionary step to boost industry performance

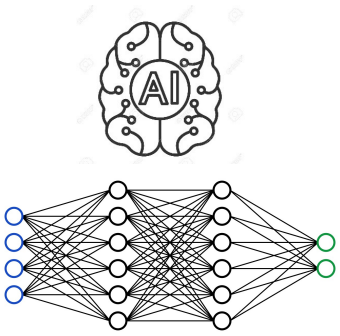
Control Theory & (Systems) Engineering

Feedback loops with sensors, actuators & controllers



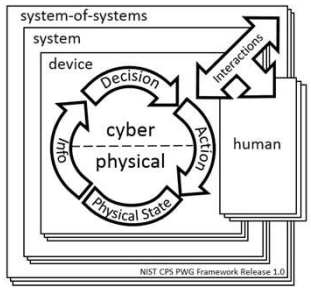
Artificial Intelligence

Simulation of some human intelligence processes by computer systems



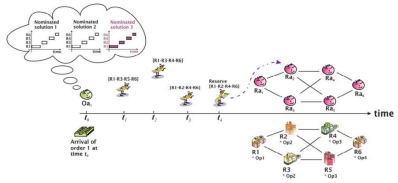
Cyber Physical Systems

Interconnection of 'cyber' (informatic, software) components with 'physical' (mechanical and electronic) parts that communicate via a data infrastructure, e.g. Internet-of-Things



agent-based/holonic manufacturing

Autonomous & cooperative agents provide manufacturing systems with flexibility, adaptability, agility, and dynamic reconfigurability …



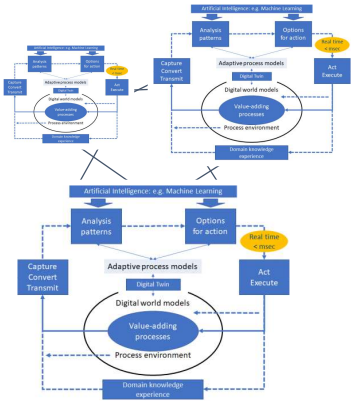
Decentralised Technical Intelligence

Next evolutionary step to revolutionise industry performance – going beyond the limits of today in an interdisciplinary approach.

⇒ **self-x in real time**

⇒ **distributed, knowledge-based intelligence**

⇒ **process optimization in manufacturing systems**



Recommendations

- EMN‘s Strategic Research Agenda addresses the relevant topics to improve Europe‘s competitiveness in Advanced Manufacturing.

- Automation end-2-end needs reliable metrology data at process relevant speeds.

- Decentralised technical intelligence going beyond the limits of today requires high-performance measurement, data processing and actuator technologies.

- …….

Thank you

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