AIM-NET - Artificial Intelligence in Manufacturing NETwork

https://www.aim-net.eu/

LMS

Laboratory for Manufacturing Systems & Automation

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POLITECNICO MILANO 1863

MONDRAGON
HUMANITY AT WORK
Finance Industry Retail Knowledge

FLANDERS MAKE
DRIVING INNOVATION IN MANUFACTURING

CNR ISTC
ISTITUTO DI SCIENZE E TECNOLOGIE DELLA COGNIZIONE

STIIMA

DANISH TECHNOLOGICAL INSTITUTE

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CZECH TECHNICAL UNIVERSITY IN PRAGUE

SIDENOP

Chicago Pneumatic

materialise

ADDILAN

Atlas Copco

Teaching Factory

ŠKODA

BAZIGOS
Precision and Trust

arianeGROUP

Electronics LACROIX

COMAU

Prima Additive

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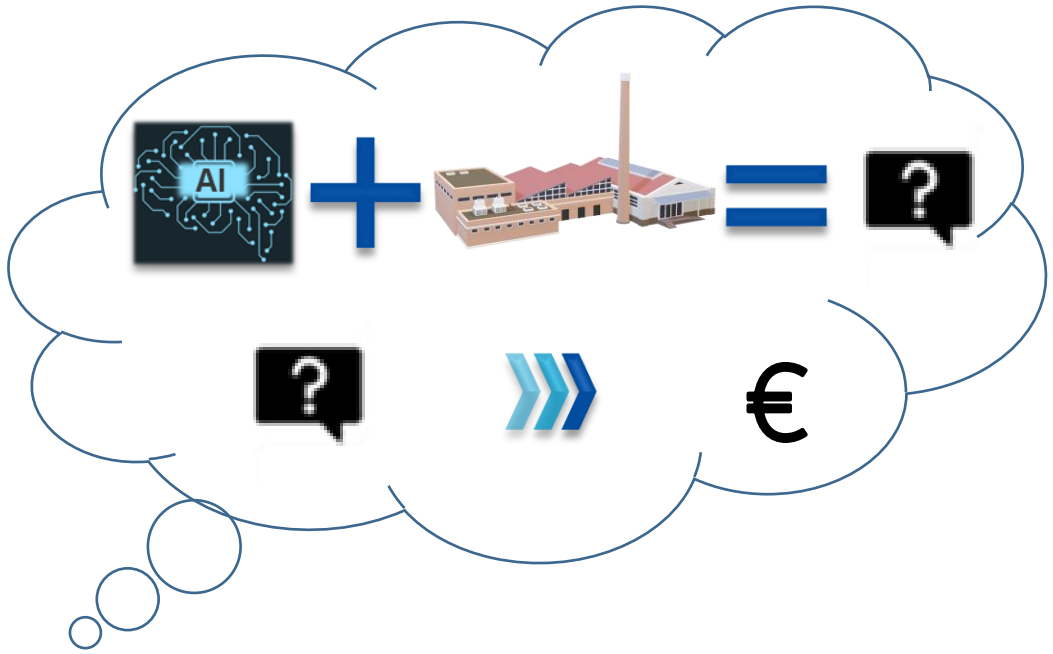
AIM-NET motivation

- **Manufacturing** as a “user of AI” point of **view** is **missing**



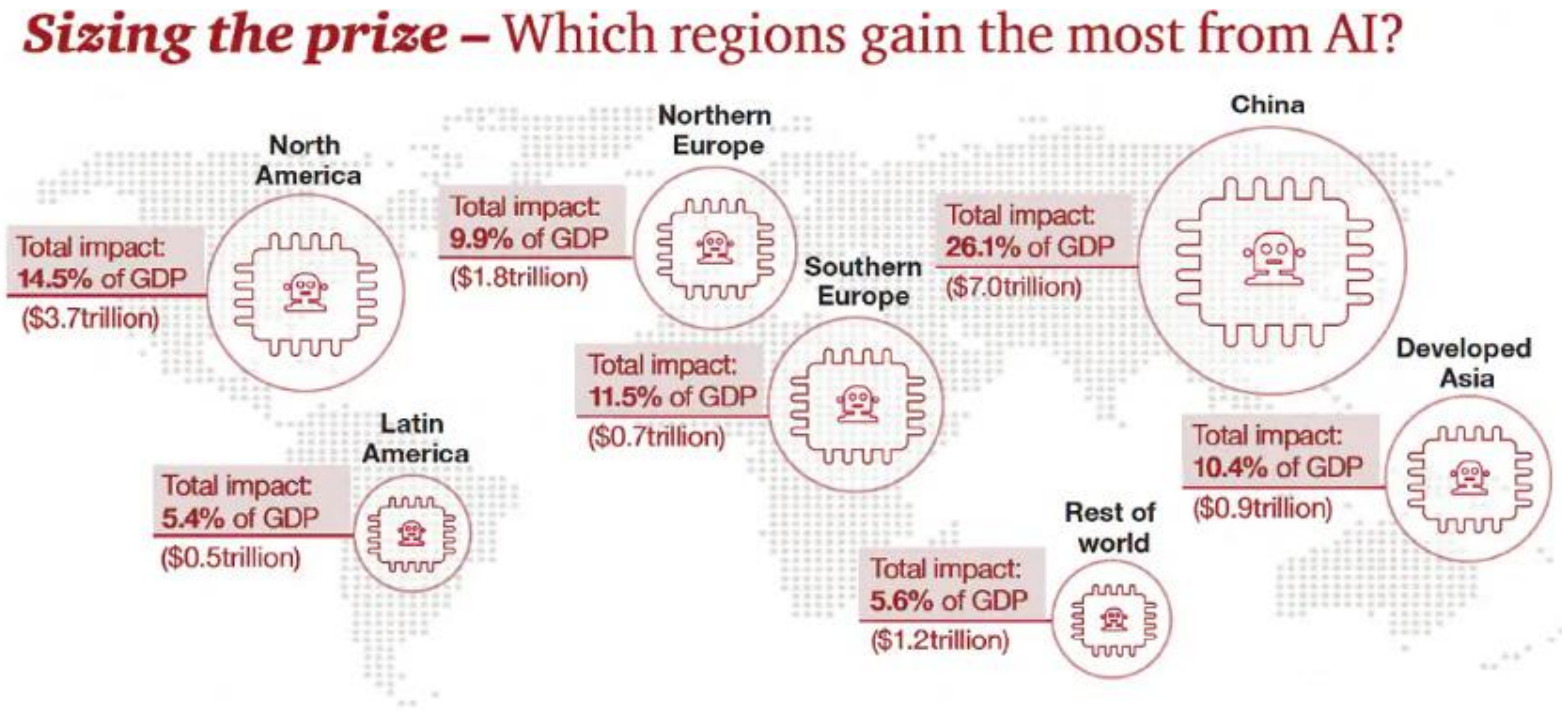
- A **coordinated effort** is needed
  - scale up from lab to Factory
  - align AI strategy and business goals
  - leverage engagement of AI talent and training
  - ensuring adoption and value creation

Factory Management

AI Impact on Manufacturing

https://www.mckinsey.com/business-functions/operations/our-insights/transforming-advanced-manufacturing-through-industry-4-0

AI business value



https://www.pwc.com/gx/en/issues/data-and-analytics/publications/artificial-intelligence-study.html

How industry can benefit from AI adoption

- AI transform **productivity** and GDP potential of the global economy.
- Labour productivity improvements will drive initial GDP gains - "**augment**" the productivity of labour
- product enhancements, stimulating consumer demand. Drive greater product **variety**, **personalisation**, **attractiveness** and **affordability**.

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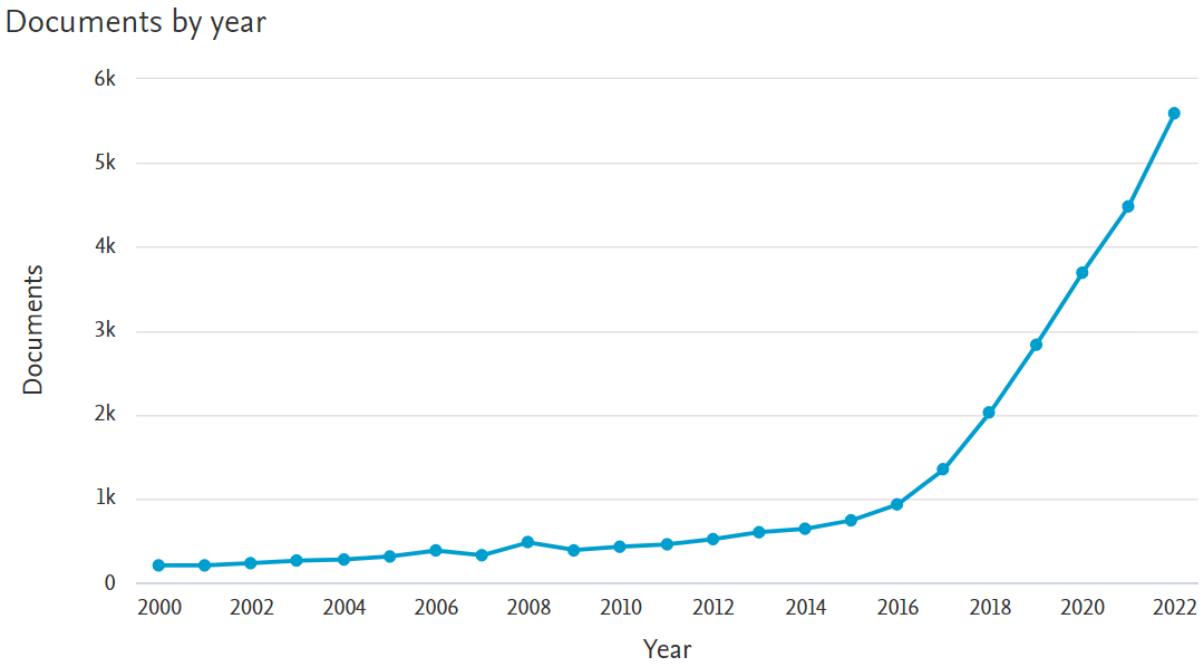
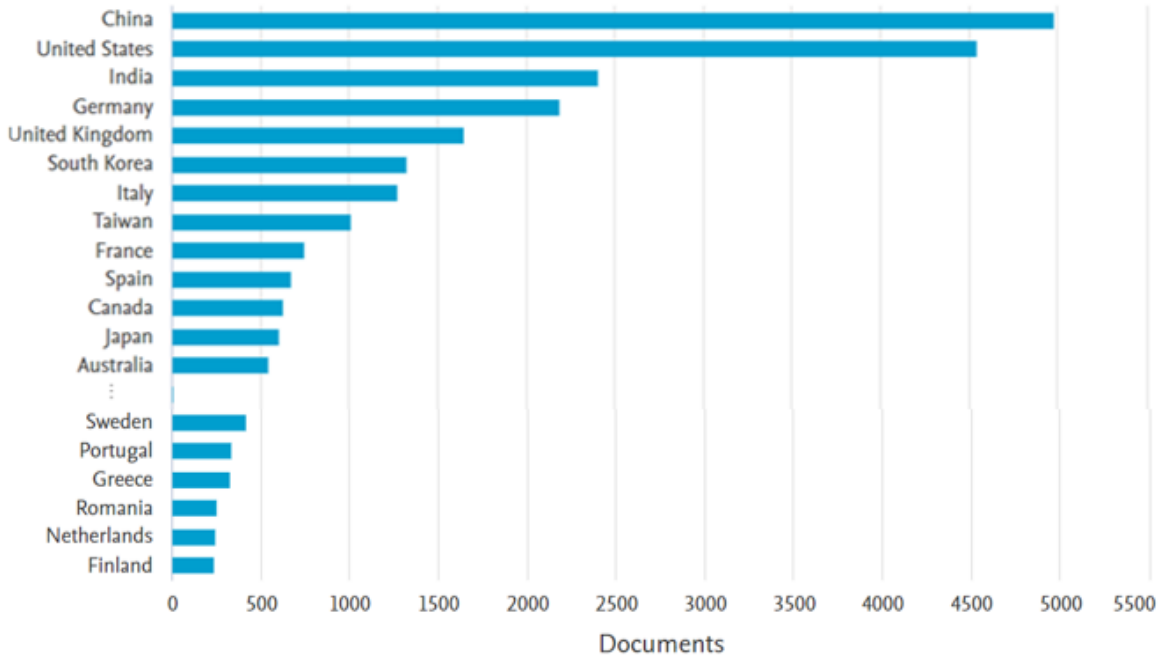
Research papers analytics

TITLE-ABS-
KEY ((**ai** AND **manufacturing**) OR (**ai** AND **industry AND 4.0**) OR (**ai** AND **industry4.0**) OR (**smart** AND **manufacturing**) OR (**neural** AND **networks** AND **manufacturing**) OR (**ai** AND **in** AND **manufacturing** AND **review**) OR (**deep** AND **learning** AND **manufacturing**) OR (**natural** AND **language** AND **processing** AND **manufacturing**)) AND PUBYEAR > 1999





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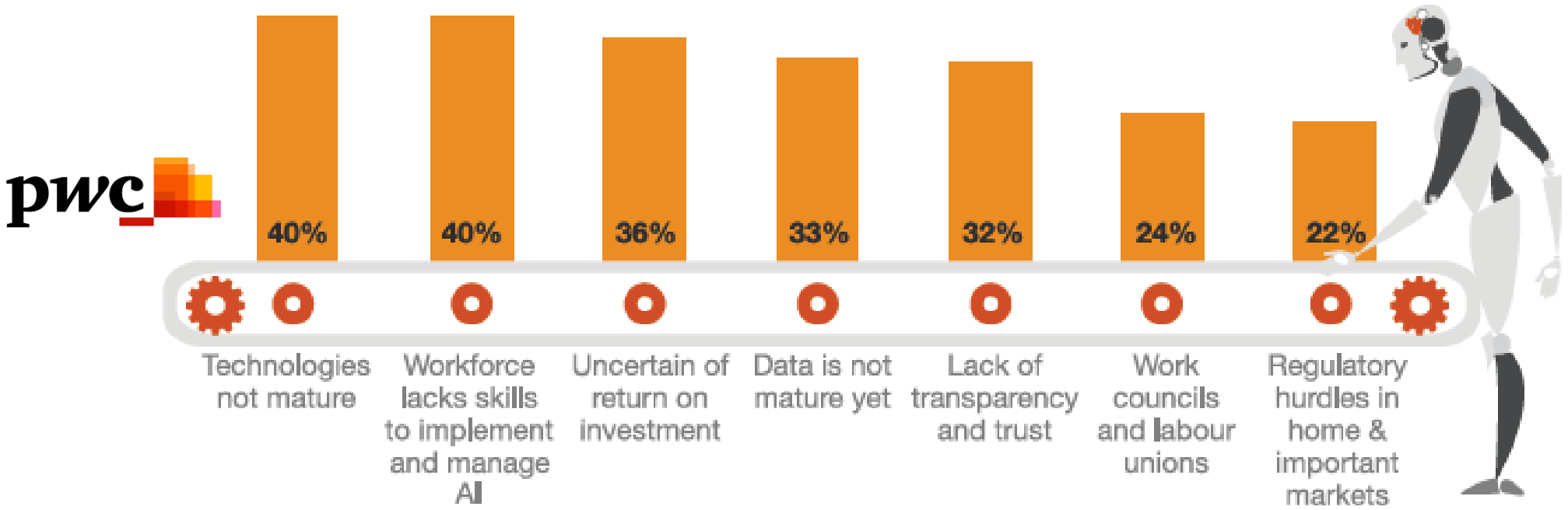
AI adoption main barriers

AIM-NET industry feedback

AI tools far from ready → Amount & quality of data → Integration challenge → Lack of AI expertise → ROI not evident



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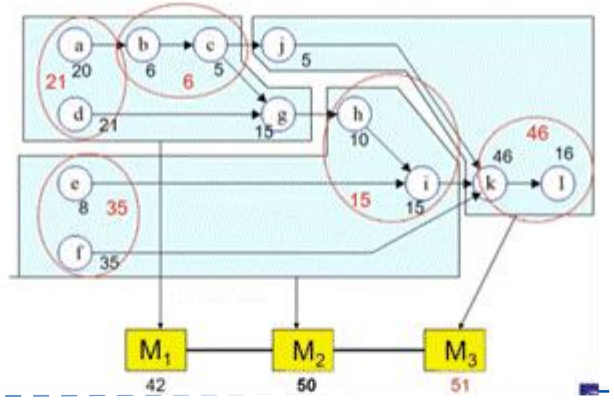
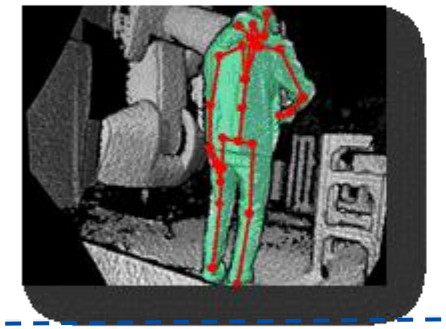
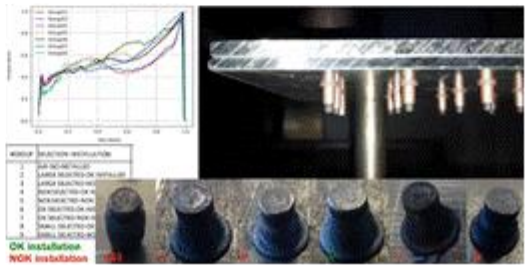
AI across the factory







Systems level

Supply/ Value chain

Production planning

Workstation level

Safe Human Robot Collaboration

Motion Planning

Process level

Process & quality monitoring

Tool wear prediction

Adaptive control

Cross-cutting aspects

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Industry requirements

Systems level

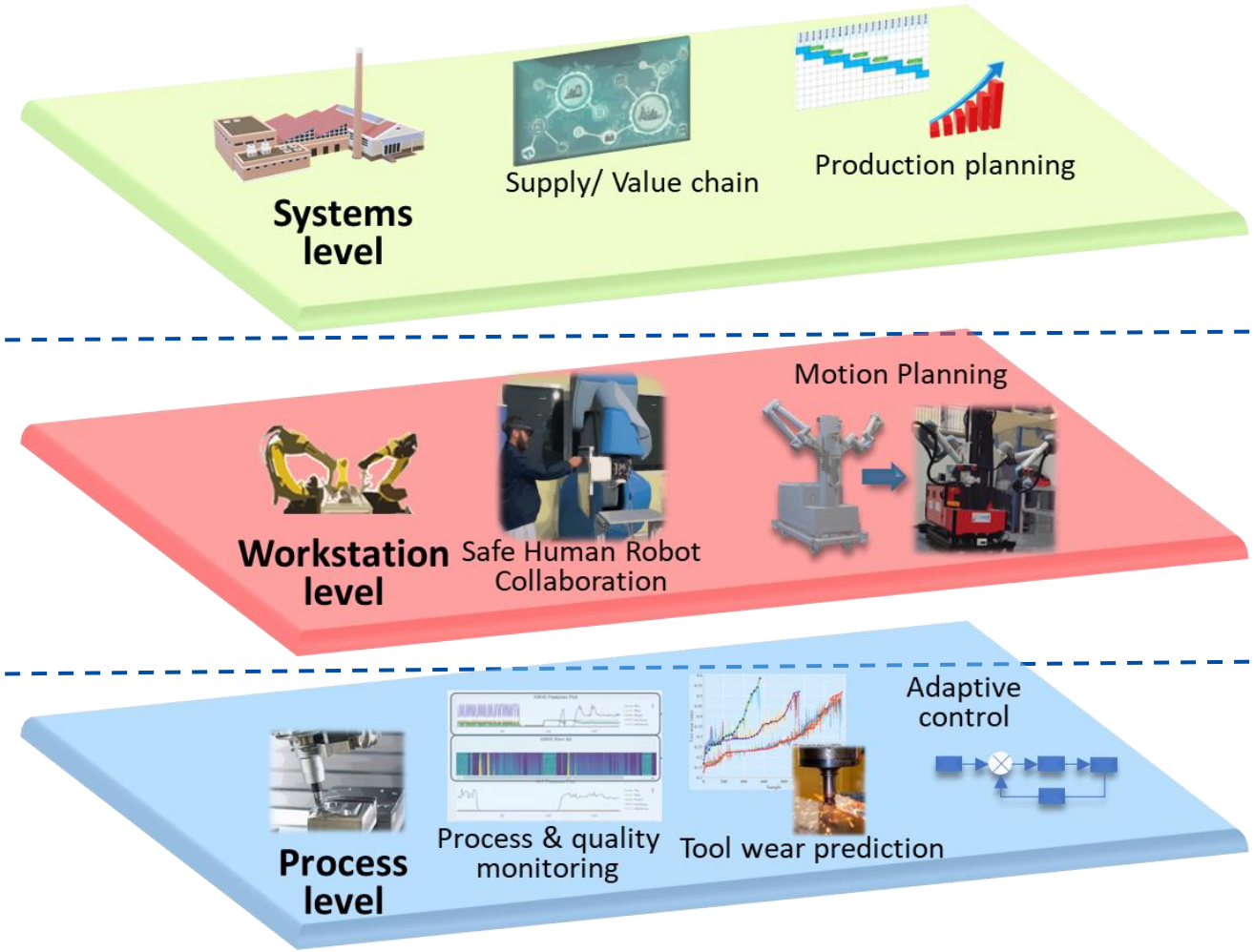
- Design Resilient production systems
- Efficient logistics and material flow
- Optimized resource utilization

Machine level

- Reduce programming and setup efforts
- Efficient and Safe workplaces
- Simplify visualization and interaction with AI

Process level

- High energy efficiency
- Inprocess Quality Inspection & Control
- Zero Defects Manufacturing



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AI technology available

Systems level

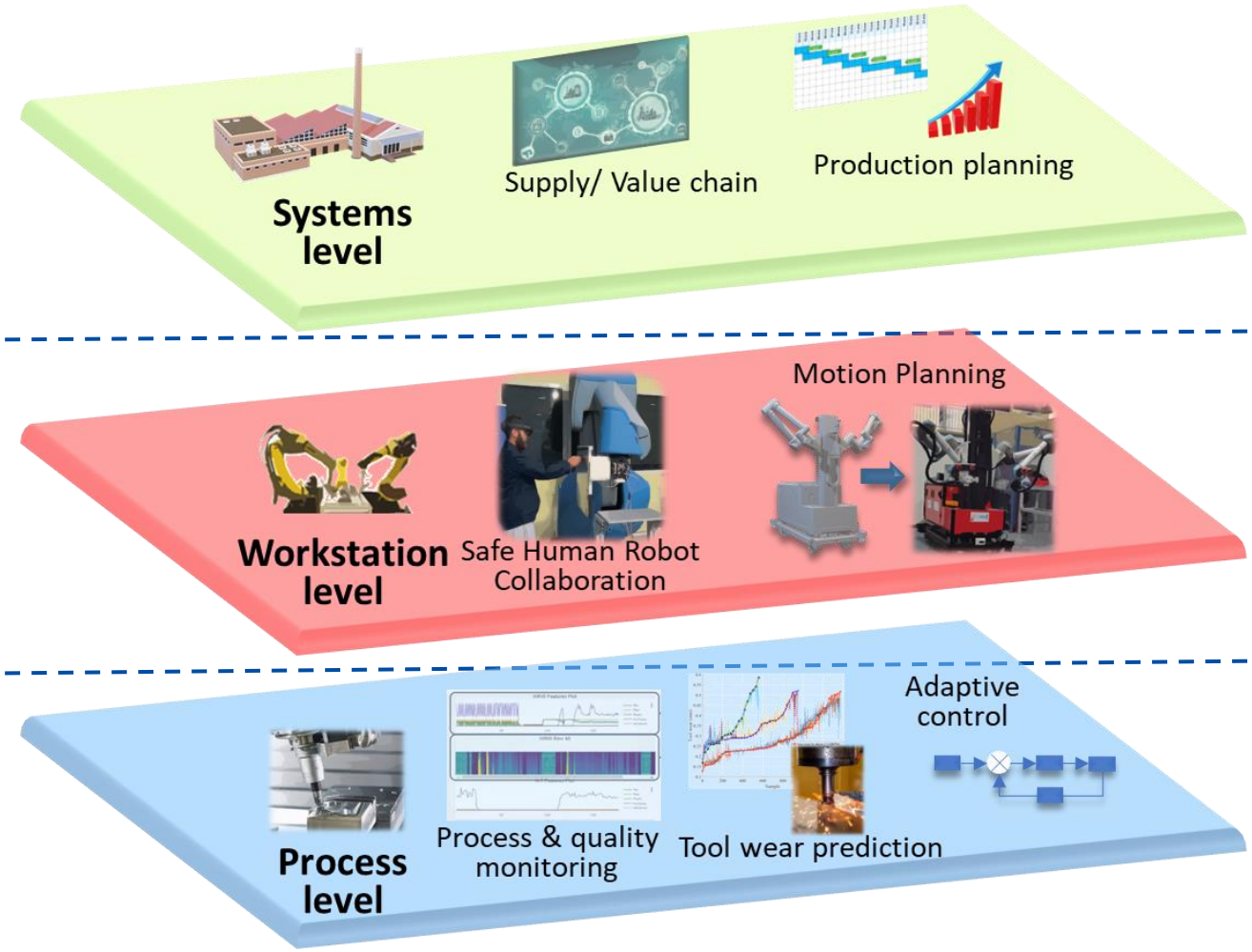
- AI to generate production line design
- AI to generate production plans and schedules
- AI to automate business processes

Machine level

- AI for automated workstation layout design
- AI for dynamic task planning & coordination in HRC
- AI for co-manipulation of compliant parts

Process level

- AI enabled quality assessment / inspection
- AI to optimize process parameters
- AI to generate new product designs



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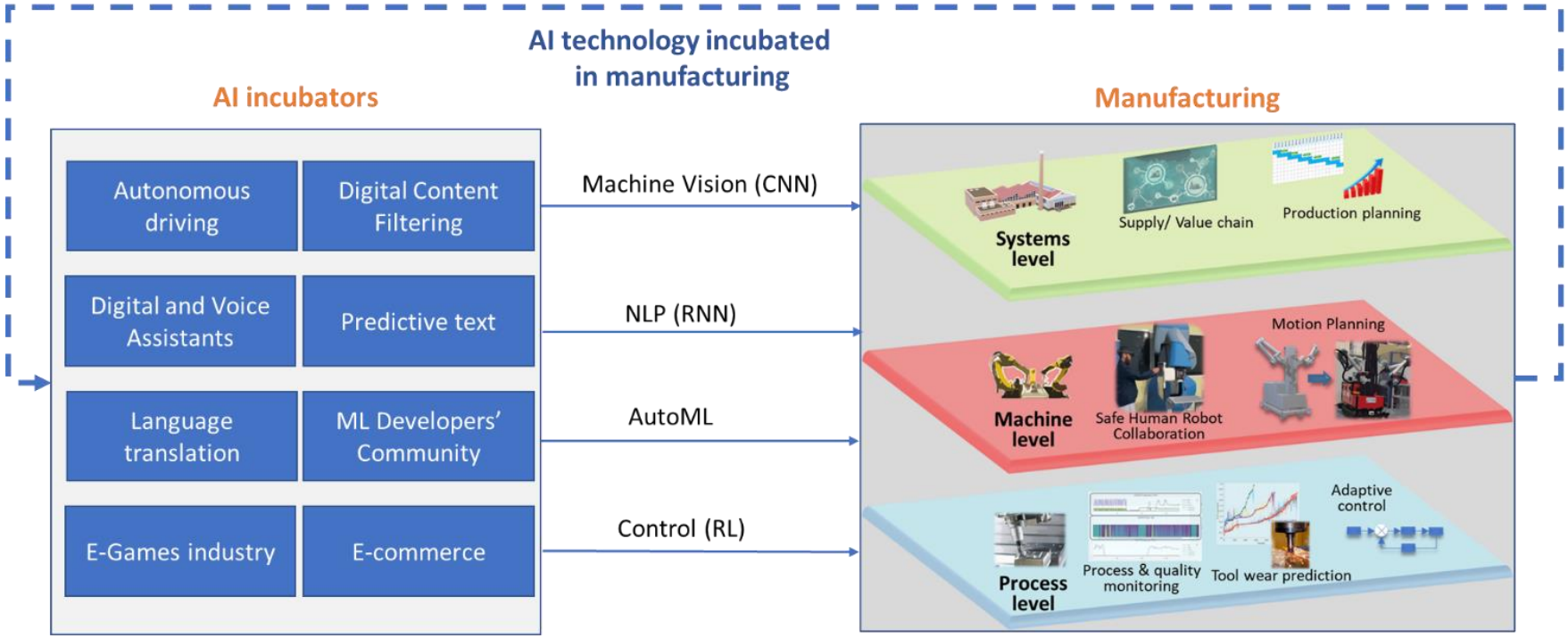
AI technology and manufacturing - close the loop

- new AI technologies will be developed as a result of working on **unique** problems relevant for manufacturers
- AI technologies to be developed for Manufacturing will help '**mature**' AI technology further – to 'export' to other industries and bring a wider benefit outside the boundaries of manufacturing



AI technology used by manufacturing

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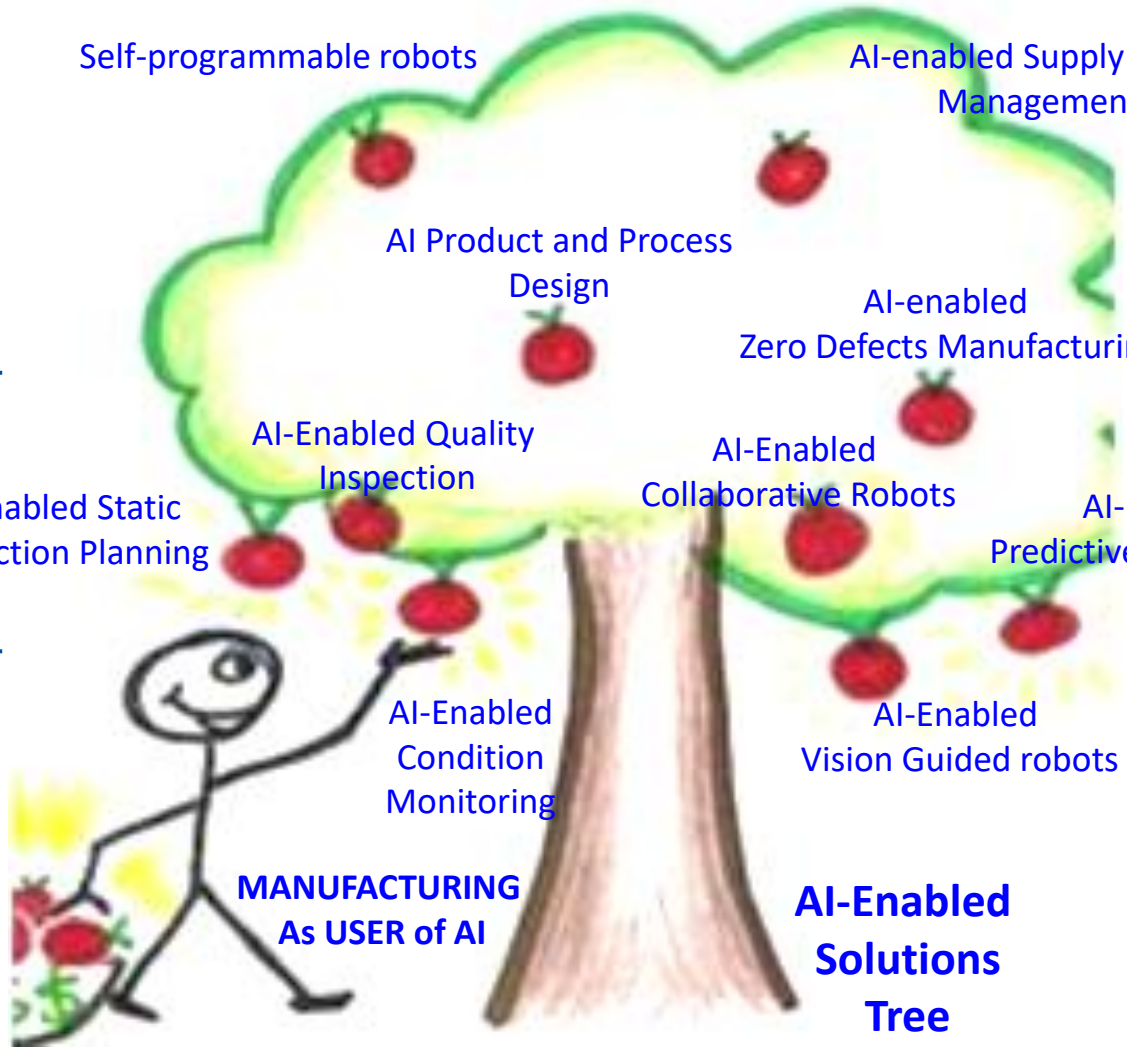
The lowest hanging AI fruits



LONG-TERM
Hyper-agile cognitive industry
Green Deal

MID-TERM
Agile factory
Fit for 55
Industry 5.0

SHORT-TERM
Modern factory
Industry 4.0
Digitalised production

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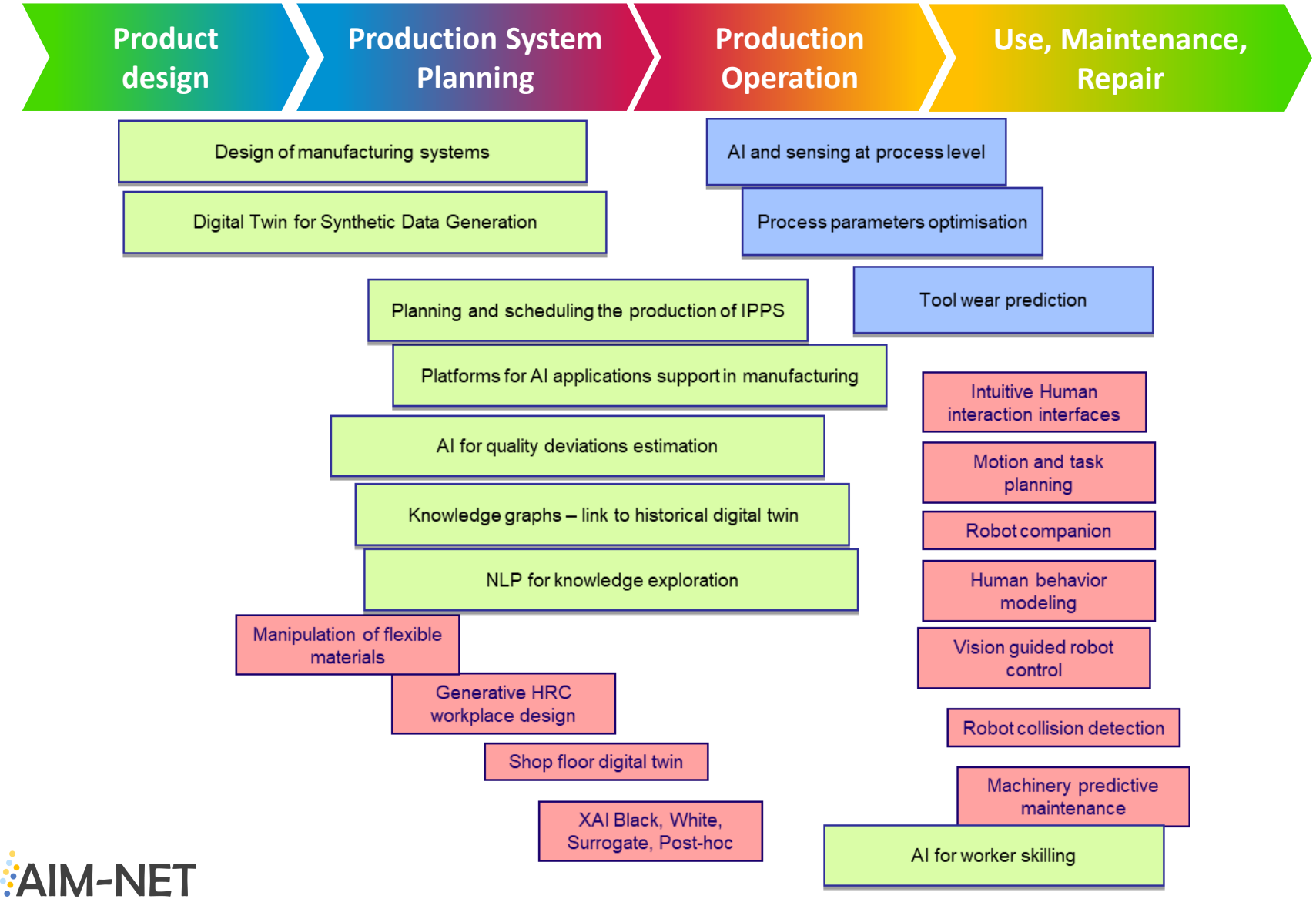
AI solutions of today



- Today's most popular AI cases in manufacturing focus in 'narrow' tasks
  - Deep Learning for **quality inspection**
  - ANN among the most popular classifiers for applications such as **fault diagnosis and predictive maintenance**

- Explore AI in manufacturing at large being a **'wide' area of complex systems and sub-systems that are interconnected** with myriads of dynamic connections

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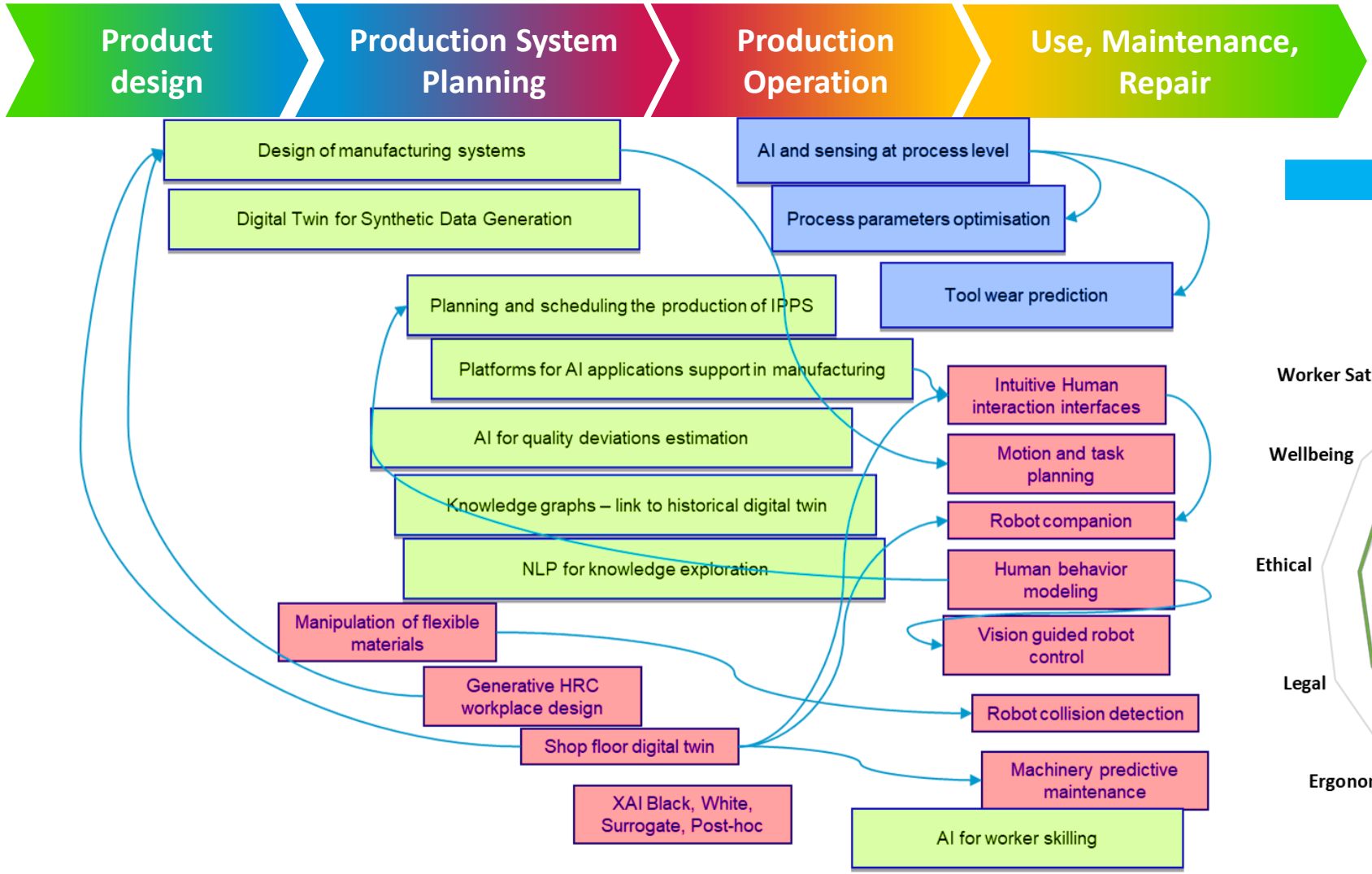
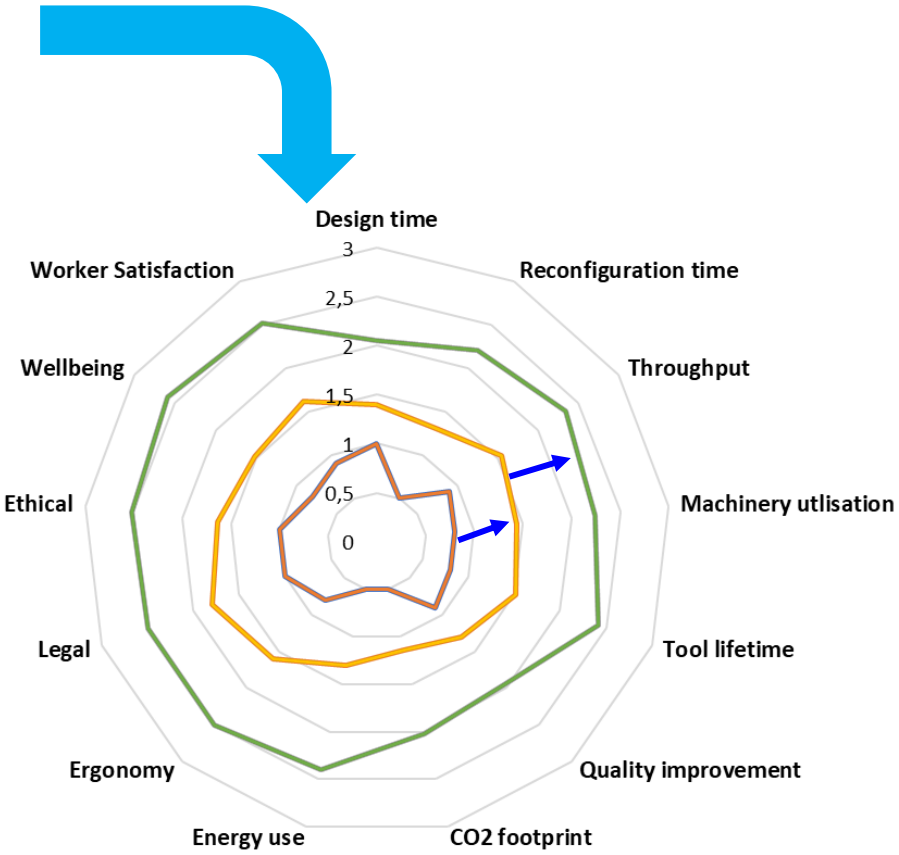
AI scale-up





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AIM-NET perspective on Regulatory aspects of AI

- Product safety embedding AI capabilities
- Prohibited artificial intelligence practices
- Risk management system
- Data and data governance
- Technical documentation and Record-keeping
- Transparency and provision of information to users
- Human oversight
- Accuracy, robustness and cybersecurity
- Obligations of providers of high-risk AI systems
- Quality management system
- Obligation to draw up technical documentation
- Automatically generated logs
- Corrective actions
- Duty of information
- Obligations of users of high-risk AI systems

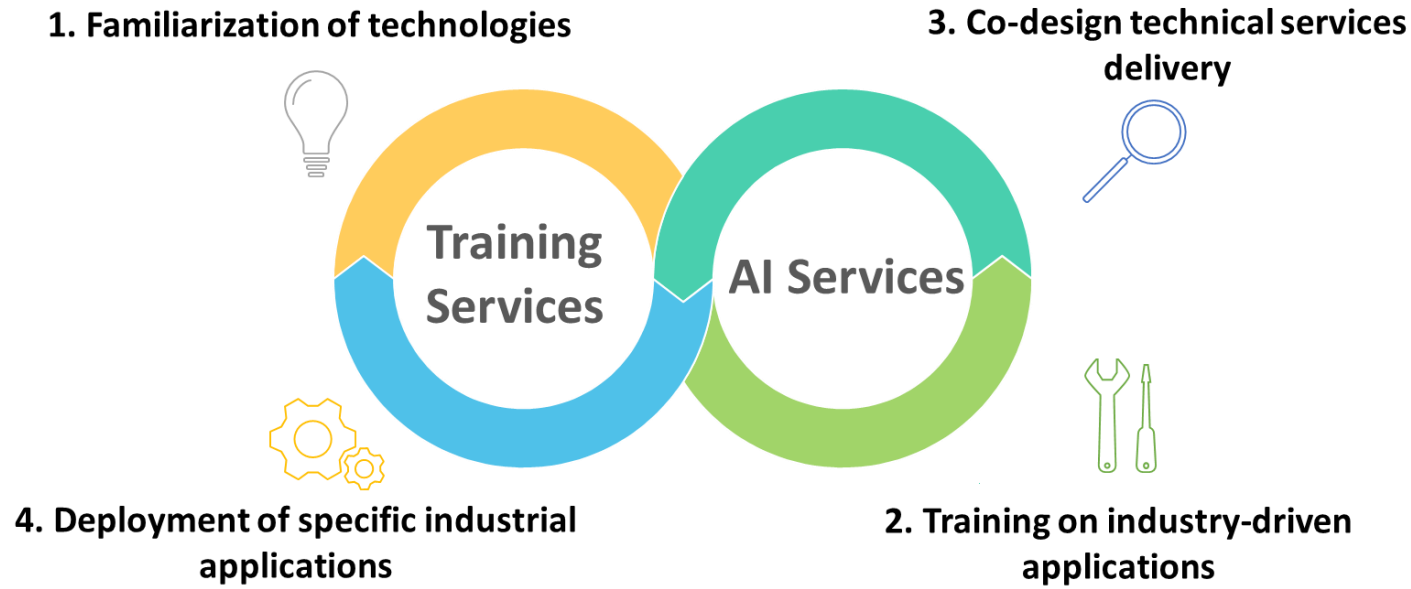
Identify research requirements for Manufacturing to comply to the AI regulations.

Help to de-risk the investment in AI.

How to help European Manufacturing take advantage of the AI Act

AIM-NET education and training aspects

- Continuous training – training approaches
  - ICT technologies
  - Upskilling, reskilling etc.
- Training and education services structuring – AI focus, new disciplines, skills
- Networks of Training centers on AI in Manufacturing
- Teaching factory concept
- Competence centers engagement



Messages to take-away

- The **three-layers approach** can prove very useful when studying the impact of AI in manufacturing and developing roadmap for the future
- AI **impact to manufacturing** has been demonstrated in several industrial cases however its full potential remains unexploited
  - So far, only the **low-hanging fruits** have been collected
  - Today's most popular AI cases in manufacturing focus in '**narrow**' tasks
- **Explore AI** in manufacturing at large, being a '**wide**' area of **complex interconnected systems** and **sub-systems**
  - Bring **substantial impact** not only to manufacturing but other sectors as well
  - AI in Manufacturing can then be an **incubator** for AI at large
- Need to accelerate / increase the effort for AI exploration

Artificial Intelligence in Manufacturing – White paper

https://www.aim-net.eu

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ARTIFICIAL INTELLIGENCE IN MANUFACTURING

White paper

Executive summary

This white paper entitled "Artificial Intelligence in Manufacturing" reports the use of Artificial Intelligence (AI) in European manufacturing, and its potential to enhance competitiveness and technological leadership in the future. The paper is based on research conducted by the Artificial Intelligence in Manufacturing NETwork (AIM-NET), which represents the viewpoint of the manufacturing community on the achievements and challenges of AI solutions. The document covers topics such as AI in manufacturing processes, robots, machines, and operations support in manufacturing, and AI in manufacturing systems. It also includes discussions on cross-cutting aspects such as regulation, education, systems engineering, and data augmentation. The paper also presents the maturity achieved TRL levels of existing AI-based applications in manufacturing, typical KPIs used to assess performance, and barriers and limitations to wide adoption. It also provides a roadmap for future work on AI, with efforts needed in short-term and long-term time horizons. Overall, the paper provides a comprehensive overview of the current status and future vision of AI in manufacturing for policy makers, practitioners, and researchers.

Prepared by the Artificial Intelligence in Manufacturing Network – AIM-NET
info@aim-net.eu

- ✓ Provides a comprehensive overview of the current status and future vision of AI in manufacturing for policy makers, practitioners, and researchers
- ✓ Represents the viewpoint of the manufacturing community on the achievements and challenges of AI solutions
- ✓ 17 organizations have actively contributed
- ✓ Discusses:
  - AI in manufacturing processes
  - AI in manufacturing workstations
  - AI in manufacturing systems
  - Cross-cutting aspects of AI such as regulation, education, systems engineering, and data augmentation
  - Technology readiness, typical KPIs to assess performance
  - Barriers and limitations to wide adoption
  - Roadmap for future research and development on AI (short-term and long-term)

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1st European Symposium on Artificial Intelligence in Manufacturing

https://www.aim-net.eu/symposium2023

Timeline

Abstract submission	31 May 2023
Abstract acceptance notification	2 June 2023
Paper submission	30 June 2023
Paper review notification	15 July 2023
Final submission	15 August 2023
Conference date	19 September 2023

Author and Publication Information

Publish papers open access.
Author fee approximately 500€

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ESAIM'23 co-organised by DFKI and LMS
Scientific Topics:
– AI for process monitoring, optimization, and control
– AI for condition monitoring, diagnosis, and predictive maintenance
– AI for quality assessment and prediction
– AI for production planning, scheduling, and control of manufacturing systems and value chains
– AI for flexible and precise robotics
– AI for enhanced human-robot collaboration
– AI for the design of manufacturing systems, equipment, processes, and products
– Digital platforms, data spaces, and information technologies for AI applications in manufacturing systems
– Digital Twin to optimize process, equipment, and plant operations
– Data augmentation and synthetic data for developing AI applications
– Education and training for developing skills for AI in manufacturing
– Ethical and legal aspects of AI in manufacturing.

Location

The conference will take place at the
German Research Center for Artificial Intelligence
DFKI

Kaiserslautern, Germany

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