ALICIA – Assembly Lines in Circulation

Smart digital tools for the sustainable, human-centric, and resilient use of production resources

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08.05.24., Brussels

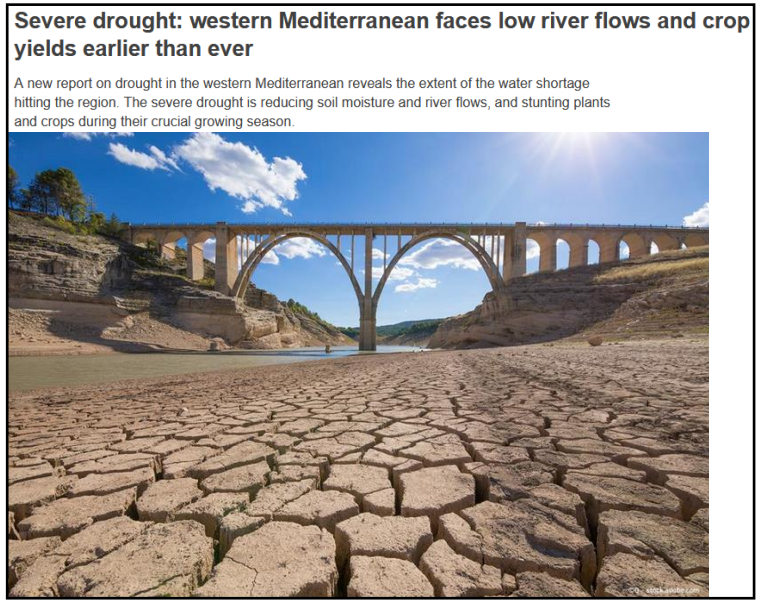
alicia – assembly lines in circulation

Climate change and resource shortages are not a risk for the future but threaten us now.

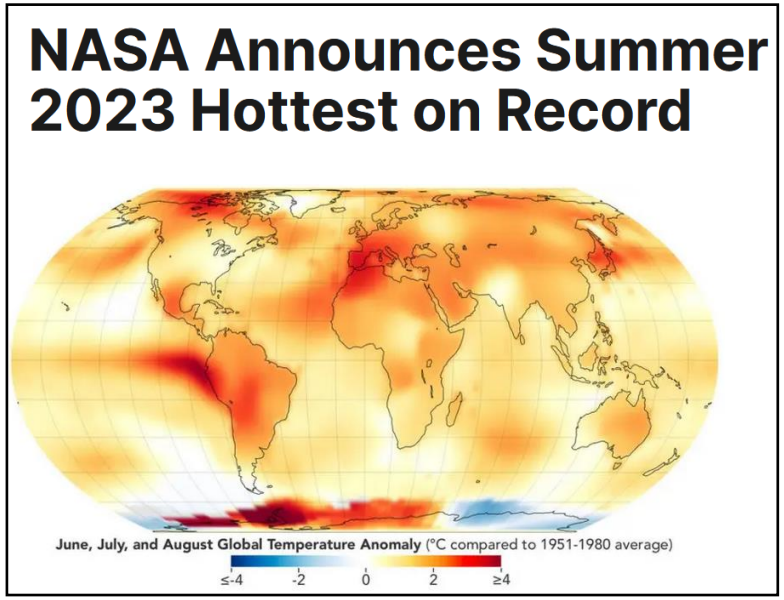
Current challenges for society and the economy

Quote: "Circularity can play an important role in maintaining secure access to strategic materials in the EU."

https://joint-research-centre.ec.europa.eu/jrc-news-and-updates/solutions-resilient-eu-raw-materials-supply-chain-2023-03-16_en



https://joint-research-centre.ec.europa.eu/jrc-news-and-updates/severe-drought-western-mediterranean-faces-low-river-flows-and-crop-yields-earlier-ever-2023-06-13_en



https://www.nasa.gov/news-release/nasa-announces-summer-2023-hottest-on-record/

Sustainability in production technology makes economic sense and is increasingly expected by society.

How to achieve sustainability in production technology?

alicia – assembly lines in circulation

Initial Situation

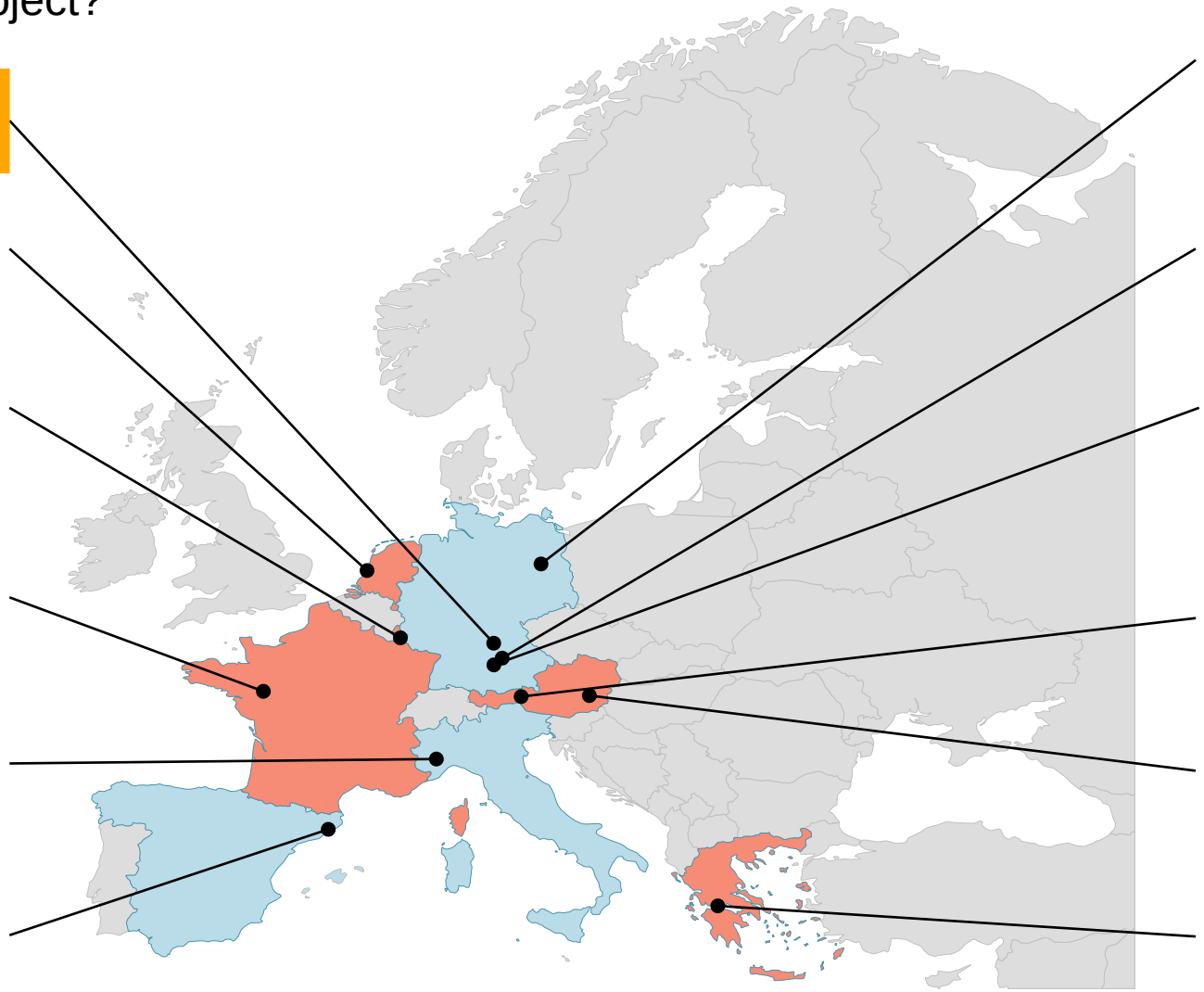
- Today‘s assembly lines do not reach their maximum lifetime, resulting in premature obsolescence and wasted resources.
- Disruptions in global supply chains and resulting product shortages challenge companies worldwide.
- Reuse of production resources is difficult due to the lack of a technical solution enabling interoperability of lines consisting of second-hand resources.

Goals

- Engineering a Circular Manufacturing Ecosystem (CME) for production lines and demonstrating the CME in two industrial use cases
- Using 70–80 % less material and energy for second-hand production lines, reusing up to 100 % of production assets
- Enabling to design, deploy, run, de-commission and recirculate secondhand production lines 40 % faster

Project Partners

Who is involved in the project?



Continental

YAGHMA

netcompany

intrasoft

IMT Atlantique
Bretagne-Pays de la Loire
École Mines-Télécom

COMAU

surplex

DIN

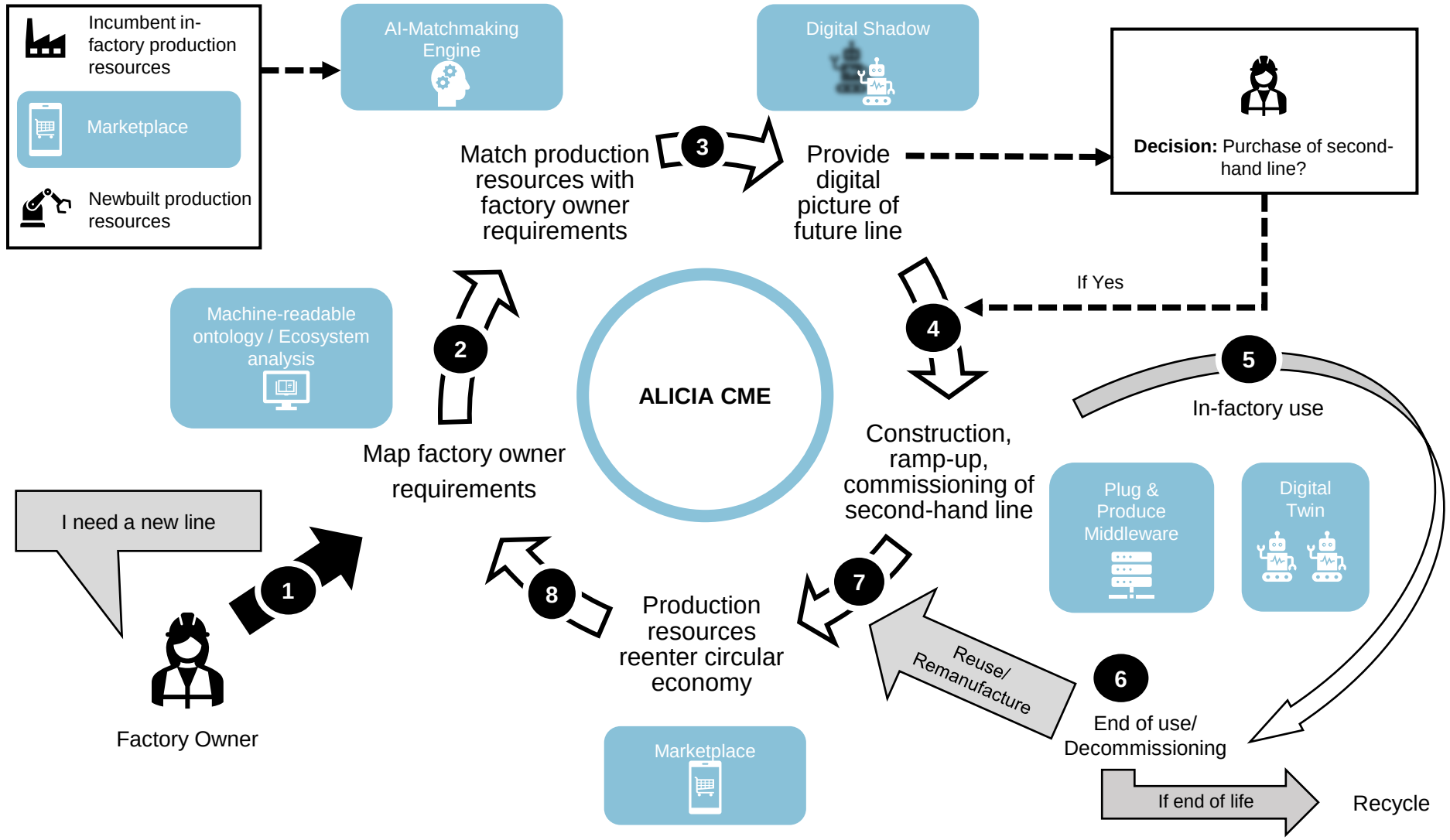
mts Consulting & Engineering GmbH

ECI MECHATRONICS

TU Graz

LMS
Laboratory for Manufacturing Systems & Automation

The ALICIA Circular Manufacturing Ecosystem

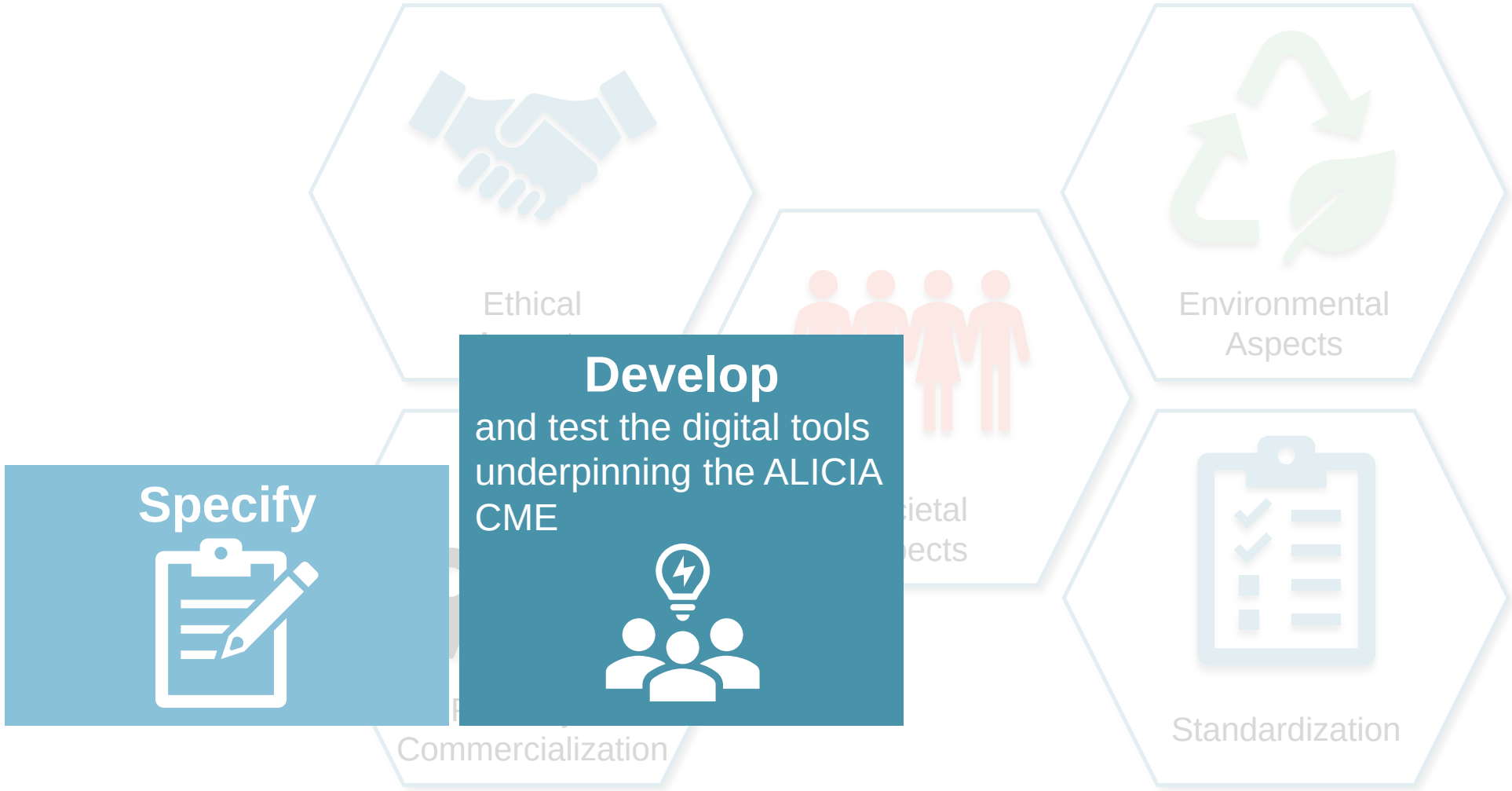


Methodology – Specify

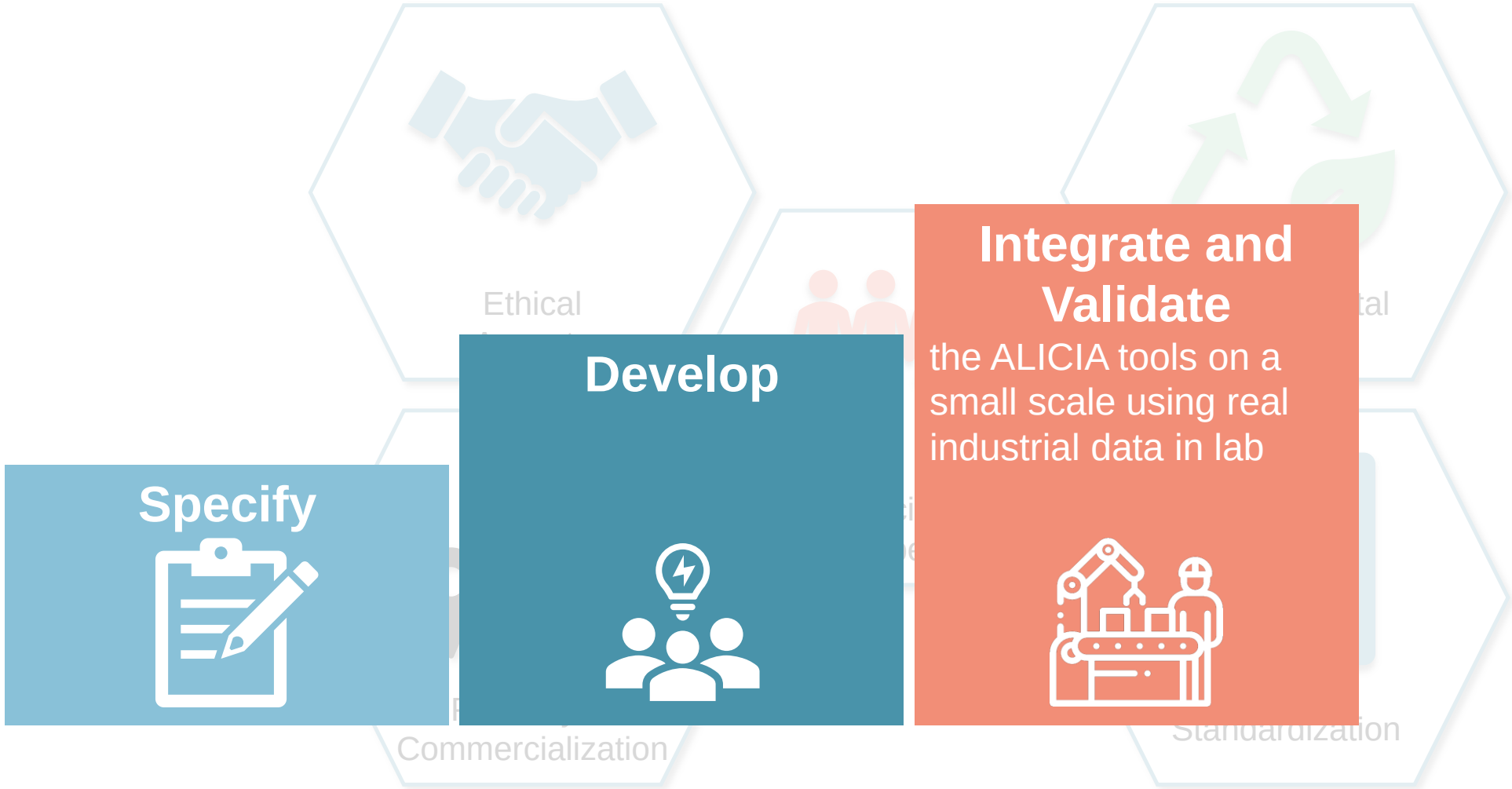
Specify

Functional specification of the ALICIA CME and system architecture definition

Methodology – Develop



Methodology – Integrate and Validate

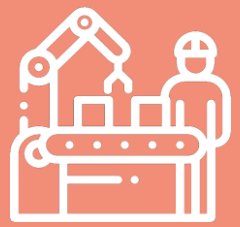


Methodology – Demonstrate

Specify

Develop

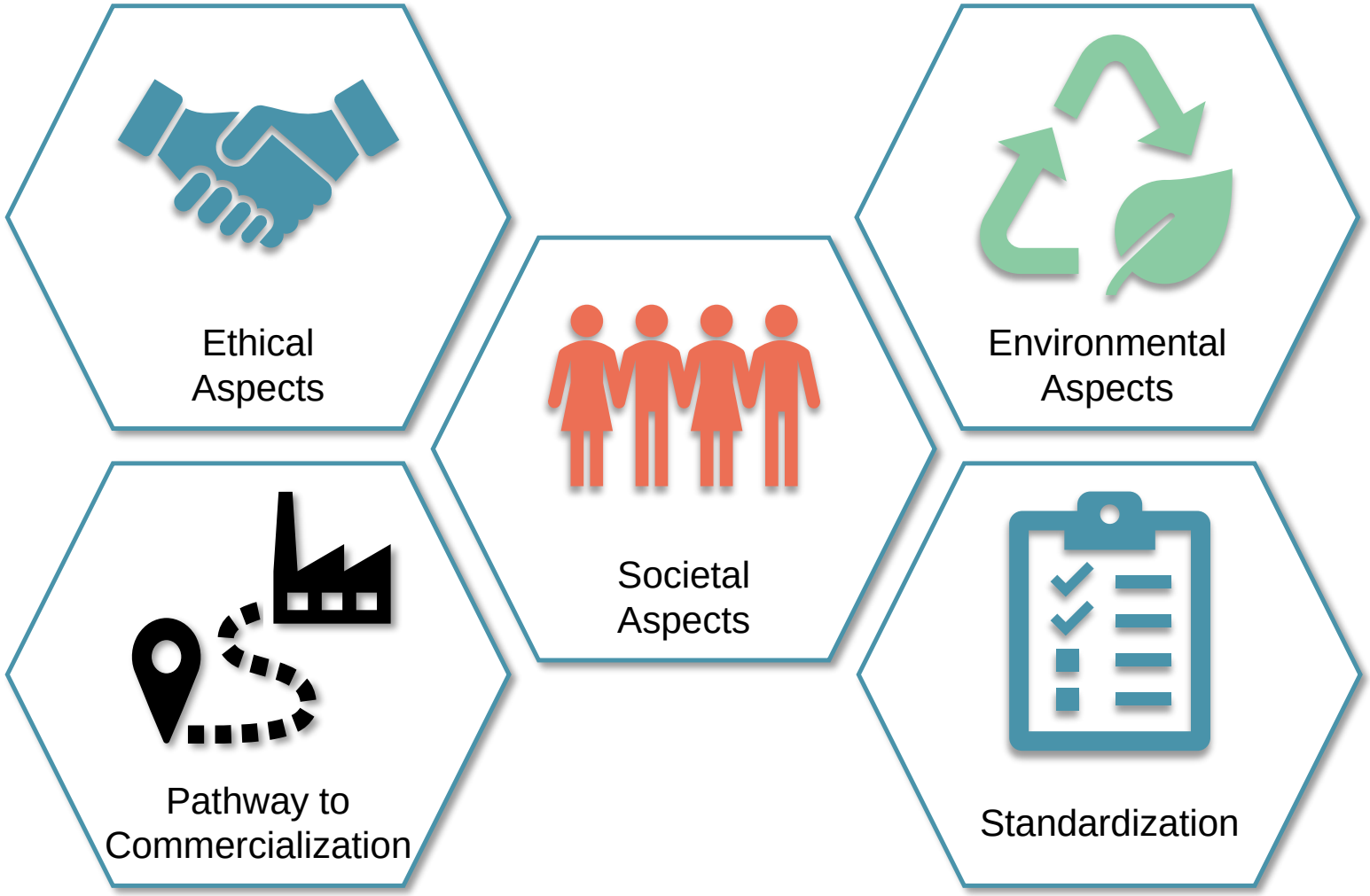
Integrate and Validate



Demonstrate

the ALICIA CME in two real-life industrial set-ups

Methodology – Framework Conditions



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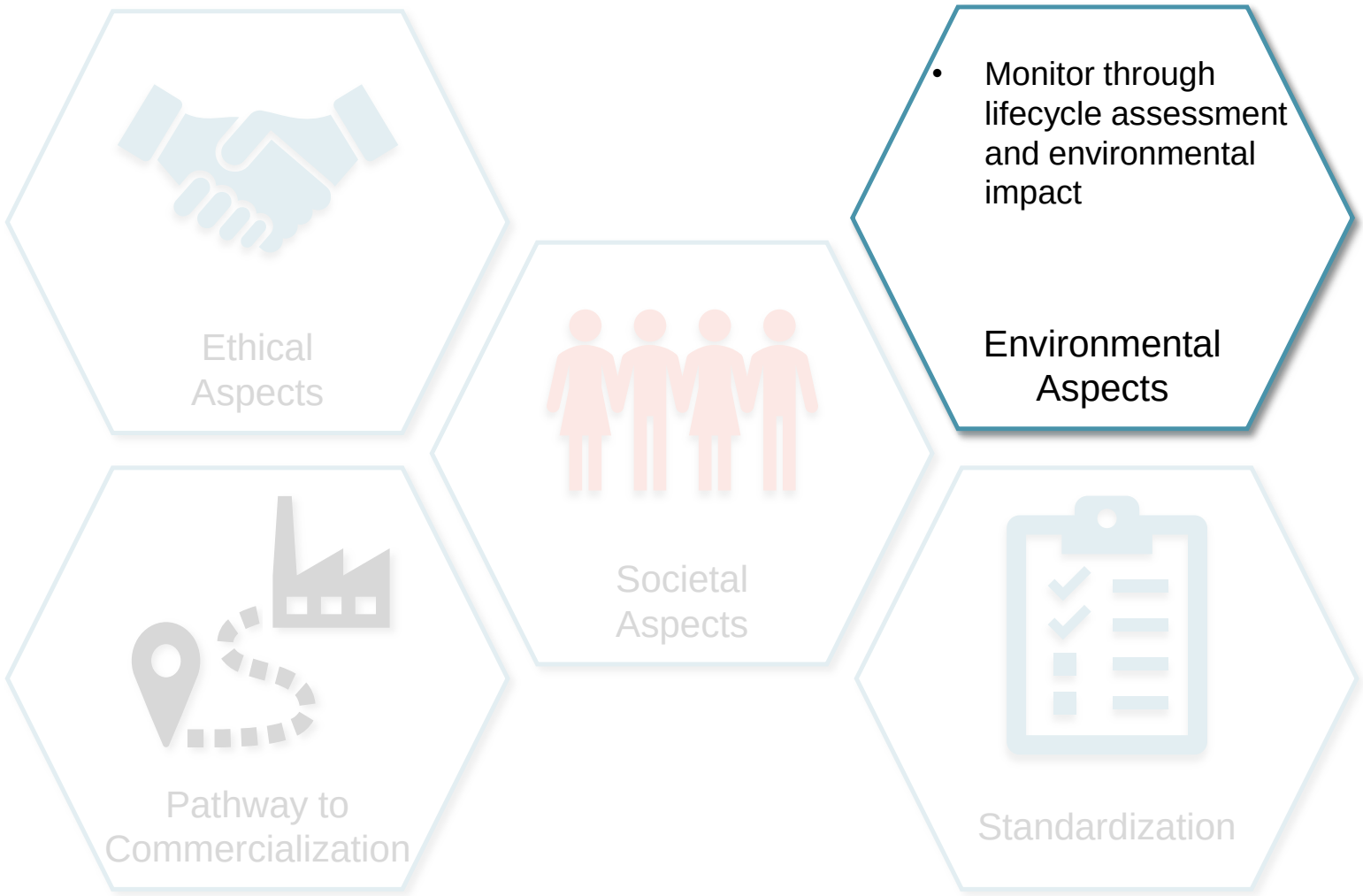

Methodology – Framework Conditions

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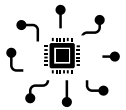
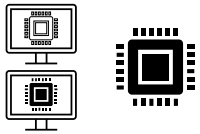
Methodology – Framework Conditions

Novel Digital Tools to enable the CME

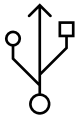
Machine-readable Ontology and Ecosystem Analysis Tool



AI Matchmaking Engine



Digital Shadow / Digital Twin

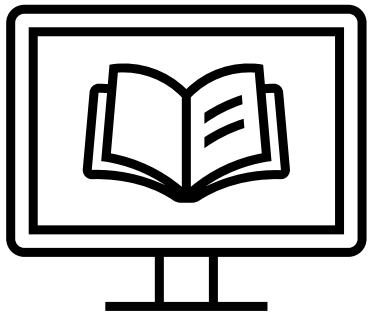


Plug & Produce Middleware

Online Marketplace for Trading Second-Hand Production Resources

Novel Digital Tools to enable the CME

Machine-readable Ontology and Ecosystem Analysis Tool



State of the Art (SoA)

- Machine-readable ontologies (e.g., MaRCO) create a meta-language for machines
- Analytical tools for capturing economic, environmental, or social aspects exist
- No comprehensive and systemic approach to combine all

ALICIA‘s progress beyond SoA

- Create a **unified knowledge base** based on MaRCO
- Develop a **human-centric** and resilient analysis tool
- Integrate perspectives on dynamics and cross-domain relations

AI Matchmaking Engine

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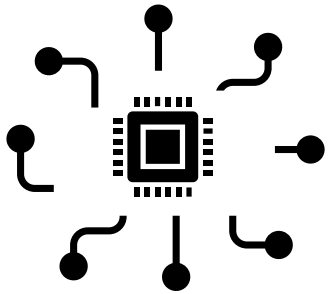


SoA

- Difficulties in manual matching of appropriate production resources with production lines
- Challenge in ensuring flexibility while avoiding line balancing problems
- SoA approaches ignore production resource lifecycle aspects.

ALICIA‘s progress beyond SoA

An AI tool to support the designer by executing complex matchmaking while

- combining multiple variables related to individual production resources’ characteristics
- joining them into a **production line set-up**
- **maximizing the reuse** of production resources

Digital Shadow / Digital Twin

Plug & Produce Middleware

Online Marketplace for Trading Second-Hand Production Resources

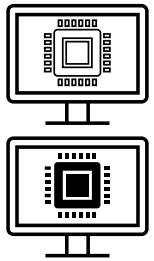
SoA: State of the Art, AI: Artificial Intelligence

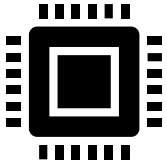
Novel Digital Tools to enable the CME

Machine-readable Ontology and Ecosystem Analysis Tool

AI Matchmaking Engine

Digital Shadow (DS) / Digital Twin (DT)





SoA

- DS and DT technologies are being deployed in manufacturing
- The research field is still in its infancy
  - DT models are still **developed manually**
  - **no given real time data integration** between physical and digital objects

ALICIA's progress beyond SoA

A "semi-automatic" DS combining:

- data on available production resources fed automatically from the marketplace
- manually fed CAD model data.

The DS will then evolve into a DT once the physical second-hand line has been built

Plug & Produce Middleware

Online Marketplace for Trading Second-Hand Production Resources

SoA: State of the Art, CAD: Computer Aided Manufacturing

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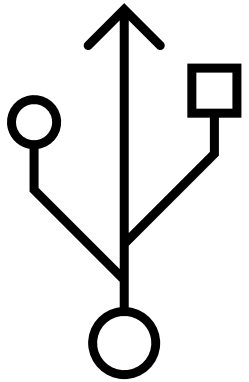
AI Matchmaking Engine

Digital Shadow / Digital Twin

Plug & Produce Middleware



SoA

- Administration shells contain semantically unambiguous machine property descriptions
- Allow heterogenous machines to communicate with each other without further action
- Focus exclusively on new equipment neglecting the possibility to integrate legacy equipment.

ALICIA‘s progress beyond SoA

- ALICIA’s Plug & Produce middleware to **connect to legacy production resources** with software adaptors
- Interoperability optimized by complying with **AAS/RAMI 4.0 standard**
- Combination of **heterogeneous production resources** from different OEMs to maximize second-hand resource reuse

Online Marketplace for Trading Second-Hand Production Resources

SoA: State of the Art, OEM: Original Equipment Manufacturer

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Online Marketplace for Trading Second-Hand Production Resources

SoA

- Online marketplaces for industrial equipment lack sophisticated functionalities
- Online marketplaces such as **Market4.0** and the **Dome 4.0** have been developed
- No focus on (second-hand) production resources.

ALICIA‘s progress beyond SoA

- **Expansion of Market4.0 platform** towards (second-hand) production resources.
- **Simplification through AI** matchmaking engine of (second-hand) production resource reuse
- Shared information between DS and DT via **International Data Spaces (IDS) data backbone**
- Support of buyers with **integrated apps** utilizing such data (e.g., by offering simulations)

Thank you for your attention!

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