

DIGI4CIRCULAR

DIGITAL PLATFORM FOR DATA-DRIVEN AND PHYSICS-BASED PRODUCT DEVELOPMENT ENABLING A CIRCULAR ECONOMY

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“Driving Circularity through Digital Innovation”

Why Circularity Matters?

Tackling Environmental Impact in Manufacturing

The transition from a linear to a circular economy is crucial for reducing environmental impact, optimizing resource use, and minimizing waste. In the automotive sector, recycling scrap materials can cut CO₂ emissions by up to 85%, but achieving this requires innovative tools and materials designed for circularity.

United for Innovation

A Multidisciplinary European Partnership



Our Vision & Approach

Enabling Circular Product Development through Digital Innovation

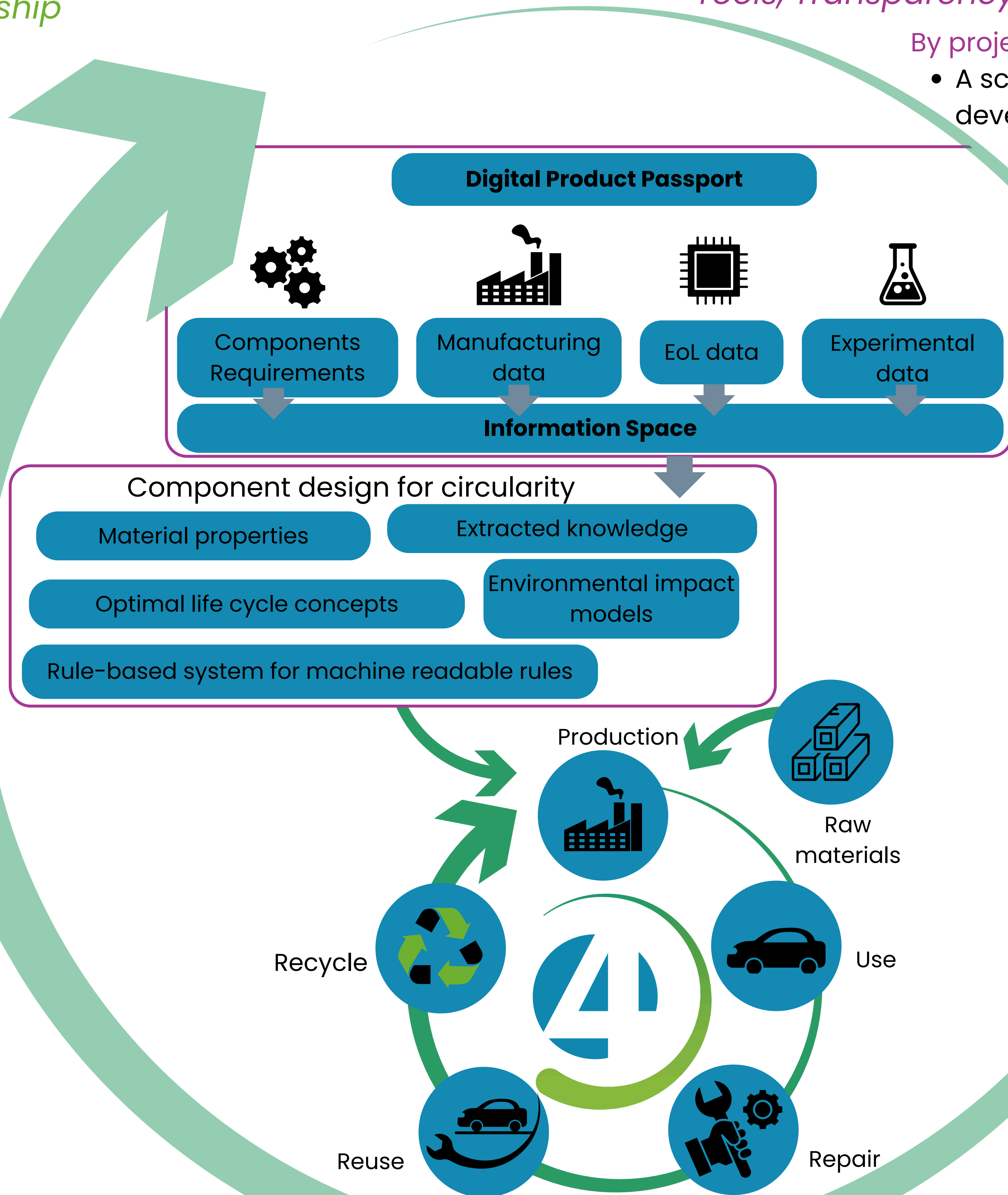
Digi4Circular develops a robust digital workflow integrated into the Synera platform. It combines automated workflows, AI-supported algorithms, and physics-based modelling to generate circular product designs based on environmental impact assessments.

What We Deliver

Tools, Transparency, and Transformation

By project end, Digi4Circular will deliver:

- A scalable platform for circular product development
 - Validated aluminium casting use case in automotive
 - Digital Product Passport for traceability and compliance
 - Training packages for workforce upskilling
- Benefits:**
- Up to 85% CO₂ reduction
 - Faster, greener product development
 - Support for EU regulations and strategic autonomy
 - Alignment with European Green Deal and UN SDGs



What We're Working On

Key Tasks and Current Progress

- promising aluminium alloy found
- casting tests are done
- potential first component designed for alloy
- begun the rule based system

WP1 Development of IS and data acquisition

- Definition of the functional and non-functional requirements for the Information Space
- Design and development of the Minimum Viable Product (MVP) version of the Information Space
- Design of the data acquisition, connection, and storage architectures

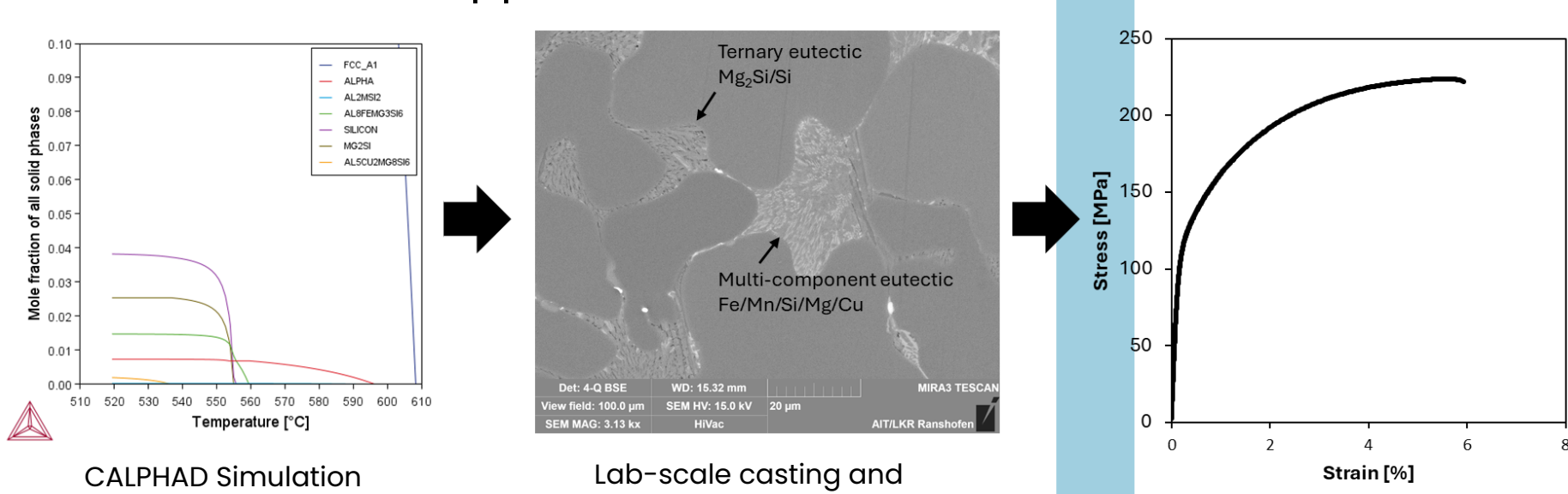
Methodology for individual nodes

WP2 Circular material design

Goal: Successful alloy development attaining suitable mechanical properties to enable the replacement of the currently used steel components in CityBot with a weight reduction of around 50 %.

Key developments:

- Topological adjustments were made to suit the new material.
- A high-strength cast alloy is being developed with ≥40% recycled content and ~5% ductility.
- Current alloy shows 220 MPa tensile strength and 5.5% ductility, achieved by incorporating impurities into multi-component eutectic structures.
- A new approach is underway to further increase the recycling content.
- The alloy is being tested for mechanical performance and suitability for future circular applications.



WP3 Circular product life cycle and environmental impact scenarios

Goal: Define lifecycle and end-of-life (EoL) scenarios, and develop tools and standards to support circular product design and Digital Product Passport (DPP) implementation.

Key developments:

- Lifecycle scenarios and process archetypes defined; hotspot identification and literature review ongoing
- RapidLCA-LCC tool architecture and database customization initiated using Ecoinvent; API integration with Synera planned
- Definition of mandatory and optional product data parameters for the DPP
- Design of user-interface mockups and architecture for the Digital Product Passport; complemented by product development process diagrams
- Collaborative data sharing and integration setup via Digi4Circular platforms (OwnCloud, Mira); distinction between public DPP and restricted Information Space clarified

WP4 Knowledge extraction from technical docs and experts

Goal: Enable AI-driven extraction of expert and regulatory knowledge to support early, circularity-conscious engineering decisions through machine-readable design rules.

Key Developments:

- a method for AI-supported extraction of knowledge from technical documents
- a method for AI-supported extraction of tacit knowledge
- a questionnaire for extracting tacit knowledge.
- a performance evaluation of different Large Language Models (LLMs) in knowledge extraction.
- a regulation database.
- the definition of a machine-readable solution artefact in the form of requirements (ReqIF) with relevant attributes.
- ethics and legal framework (GDPR-compliant) developed for responsible data processing

WP5 Circular component design

Goal: Design components that enable circular products, extend lifetime, and keep materials in closed loops.

WP5 focuses on shifting from linear to circular design by developing components that last longer and retain value.

When designing, we consider:

- Function and stresses
- Manufacturing and assembly – suitable for disassembly, repair, and reuse
- Connections and interfaces – separation, modularity, and exchangeability
- Circular strategies – reuse, repair, refurbishment, remanufacturing, and finally recycling

WP6 Integration and validation within Synera platform

Goal: Integrate and validate digital engineering nodes within the Synera platform to support circularity through connected data workflows and real-environment testing.

Key Developments:

- Identification and structuring of key material parameters
- Specifications and logic workflows for node integration defined
- Transfer of material properties, digital product passport, and design rules for circular economy into machine-readable data
- Synera training and pilot component design initiated
- Implementation of a conceptual Synera workflow demonstrating the data handling
- Establishment of a foundation for harmonized input/output definitions and unified information flow across partners

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Funded by the European Union



The highlighted part from the CityBot is to be replaced by a new aluminium alloy

