From Scrap to Circular Component

Manufacturing Partnership Days 2026

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Organisation: Paderborn University

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Place: SILO, Brussels, Belgium

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Agenda

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Challenge

Why recycled aluminium is often downcycled

2

Structure

Product life cycle and product development

3

Platform

One engineering chain and the tools behind it

4

Demonstrator

From scrap to a structural part

5

Progress & impact

Where we are and why it matters

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The challenge: impure scrap

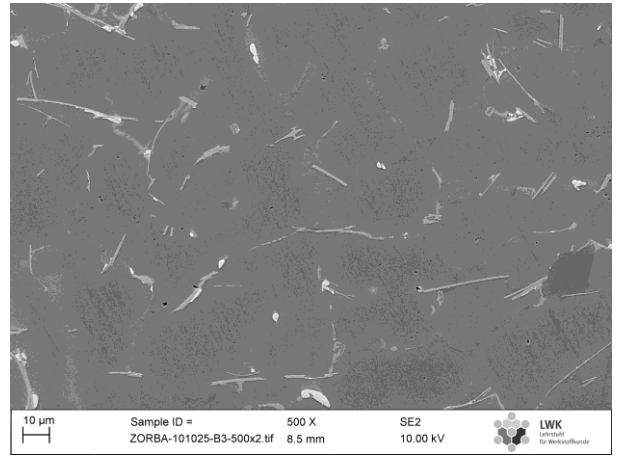
85 %

less CO_2 when aluminium is made from scrap



But scrap is impure

Elements such as iron reduce ductility. Today, scrap is usually diluted with primary aluminium – or downcycled into less demanding products.



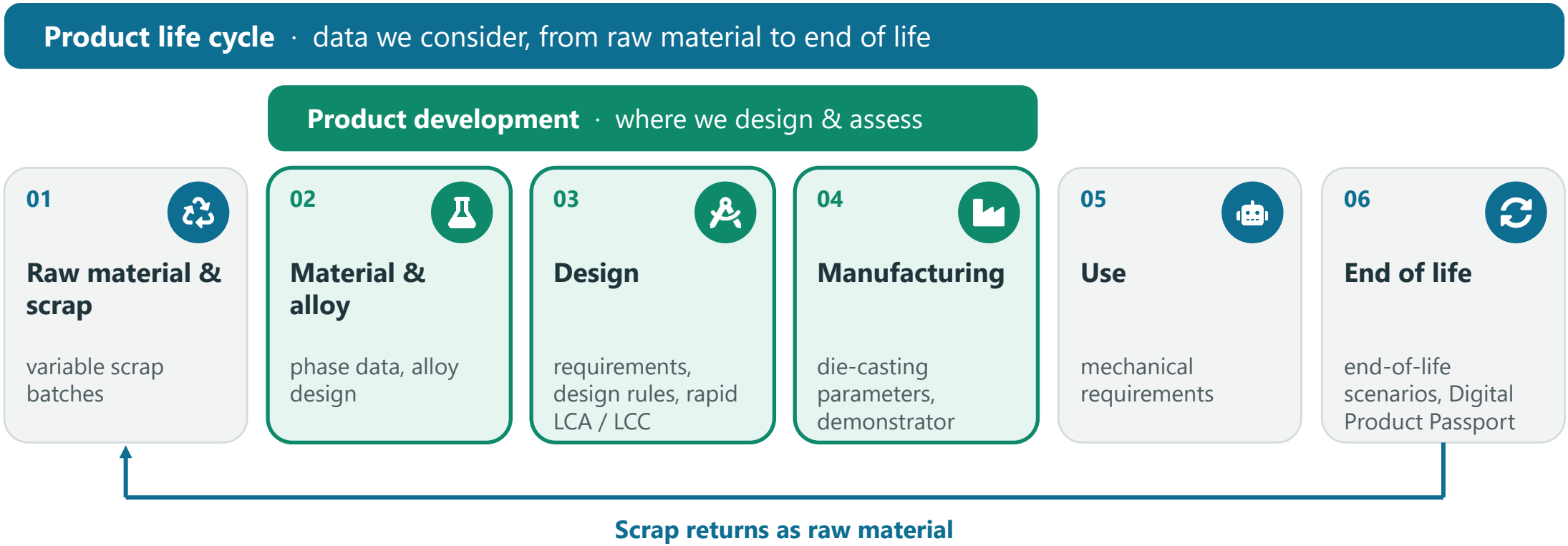
As cast ZORBA-scrap: bright needles are typical iron-rich phases (SEM-Image, 500x)

Our challenge: use as much recycled aluminium as the component's requirements allow in the Automotive Industry – target ≥ 50 %

Sources: CORDIS fact sheet Digi4Circular (GA 101177586); aluminium is a critical and strategic raw material under Regulation (EU) 2024/1252

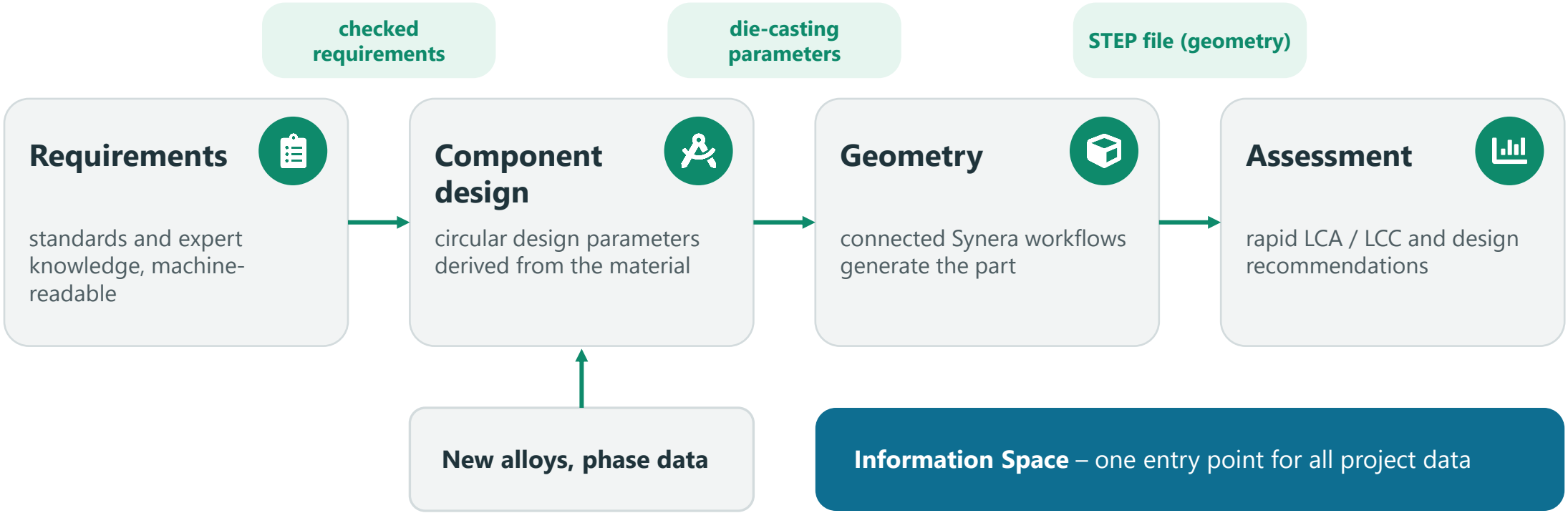
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Life cycle and product development



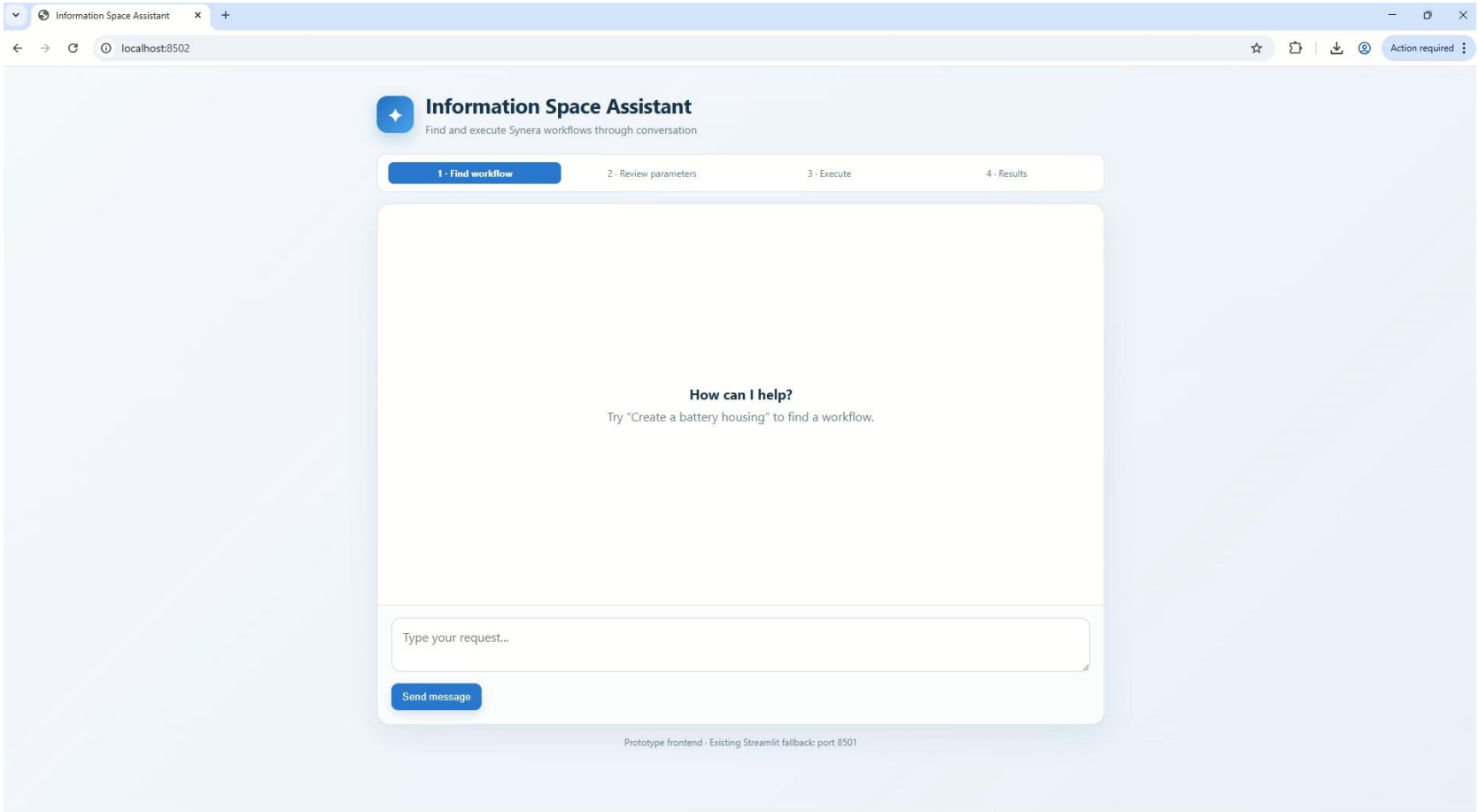
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One engineering chain, one platform



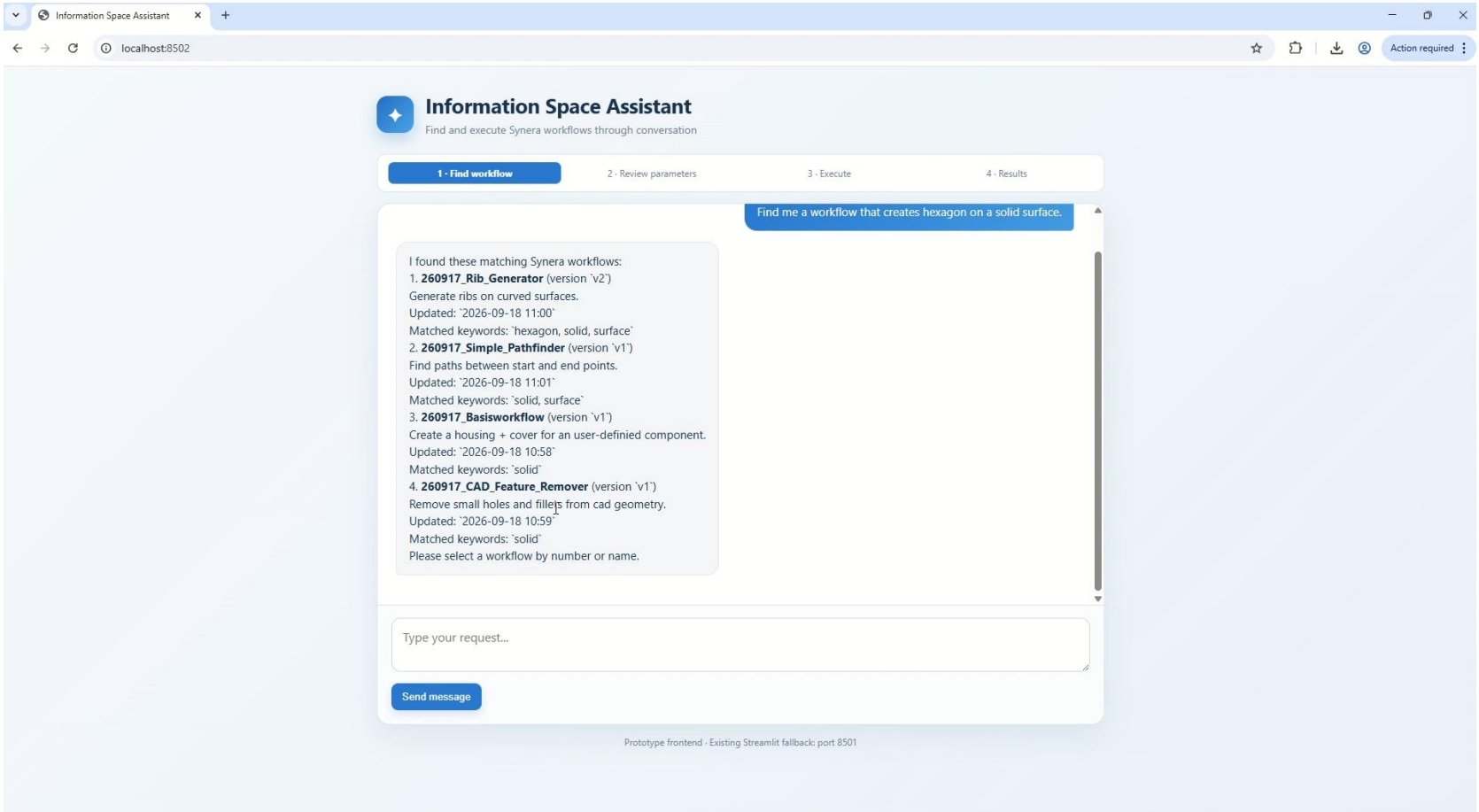
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One platform, one engineering chain



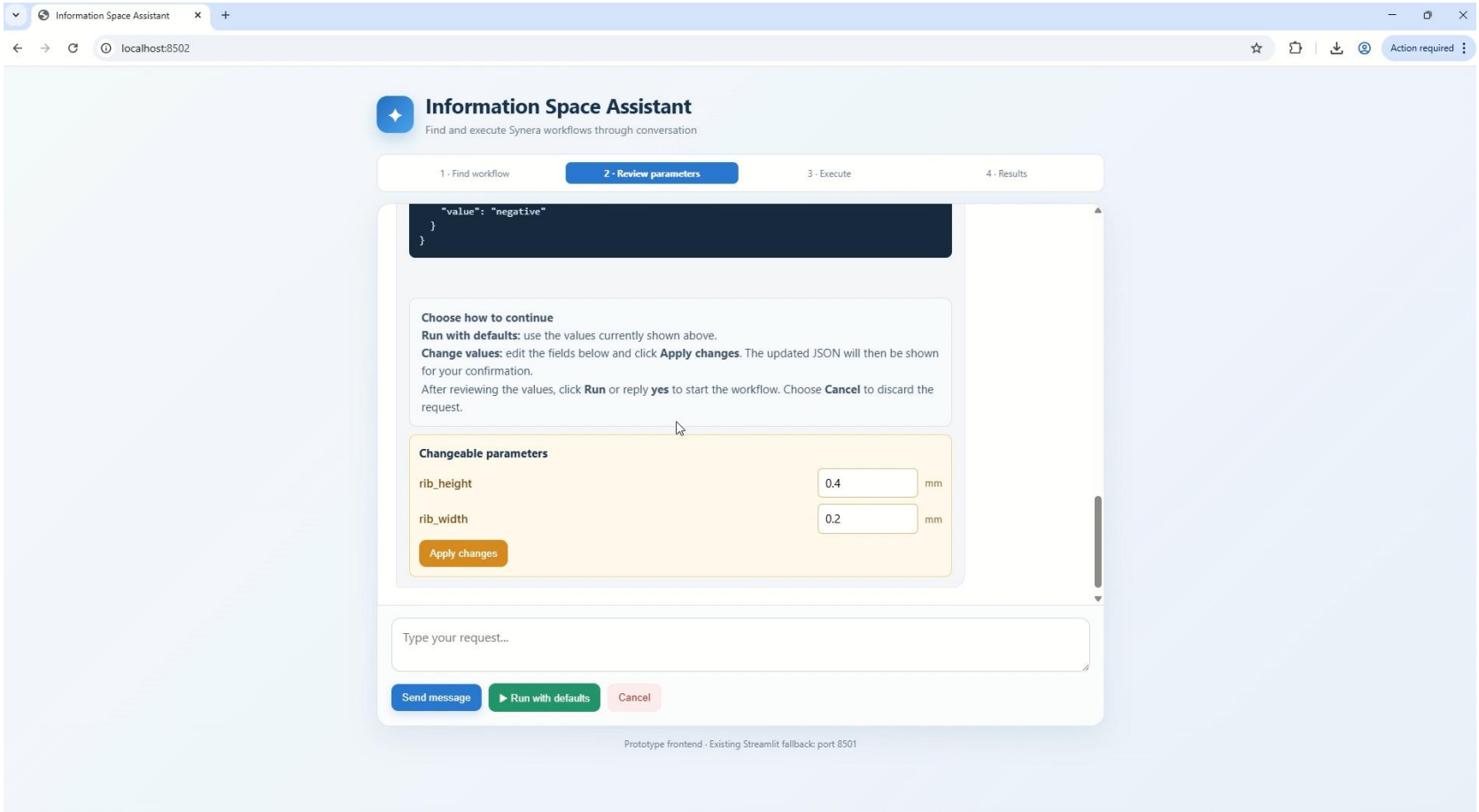
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One platform, one engineering chain



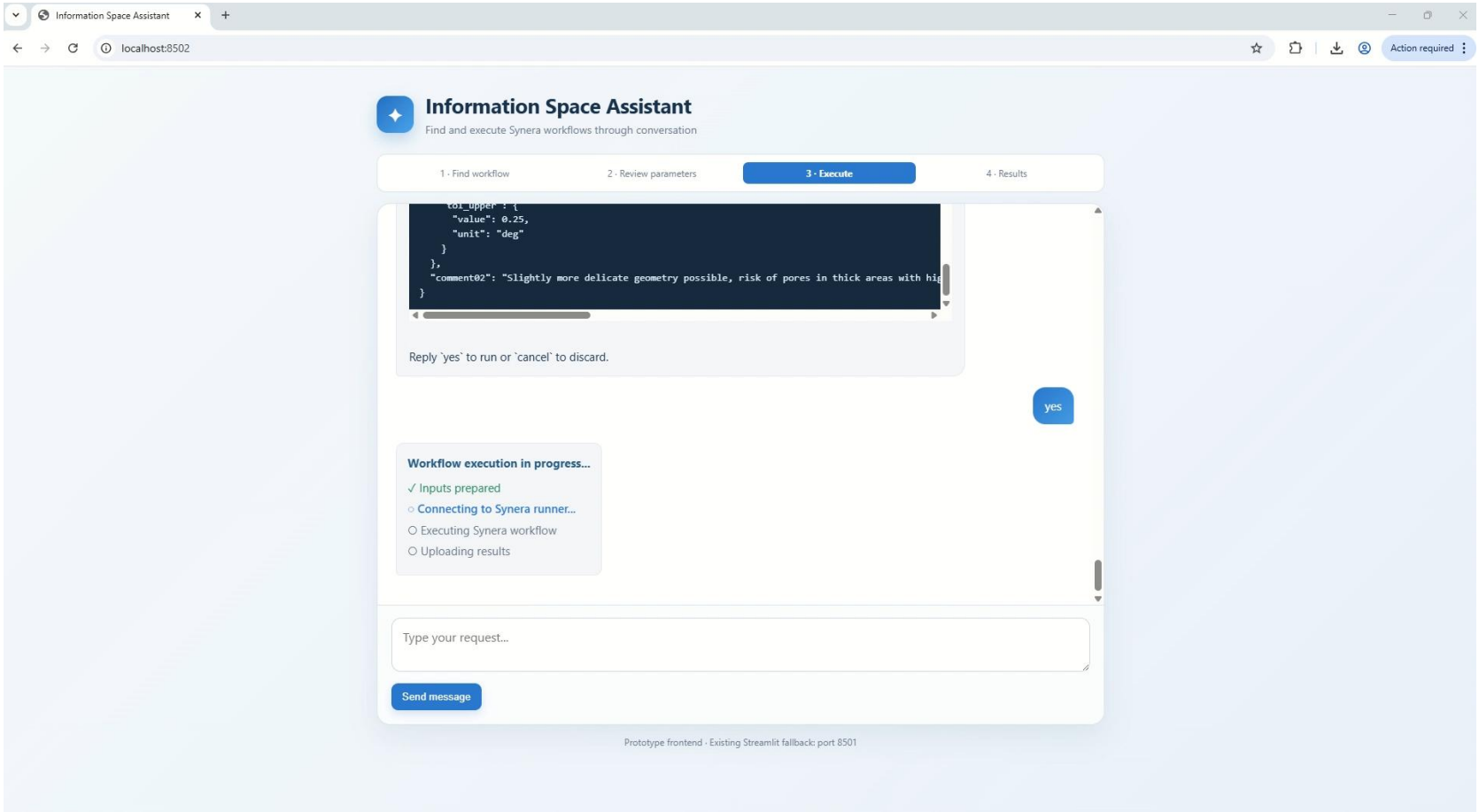
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One platform, one engineering chain



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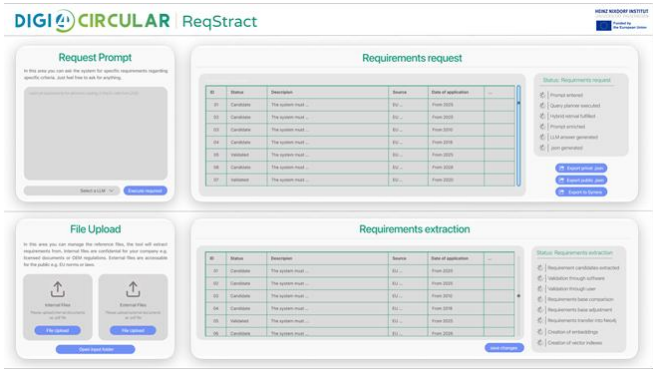
One platform, one engineering chain



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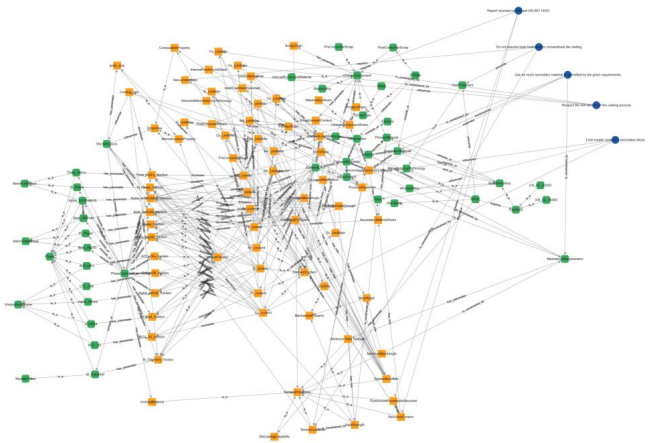
A look inside: first working tools

ReqStract



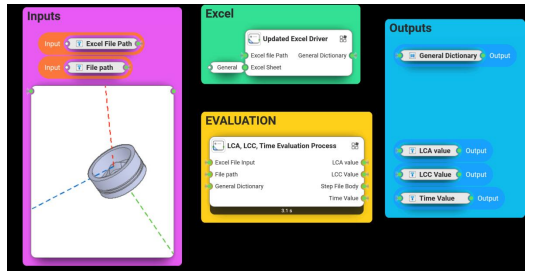
Extracts requirements from standards and expert knowledge

Knowledge graph (example)



One of our three knowledge graphs: links scrap, composition, phases and requirements

Synera workflow

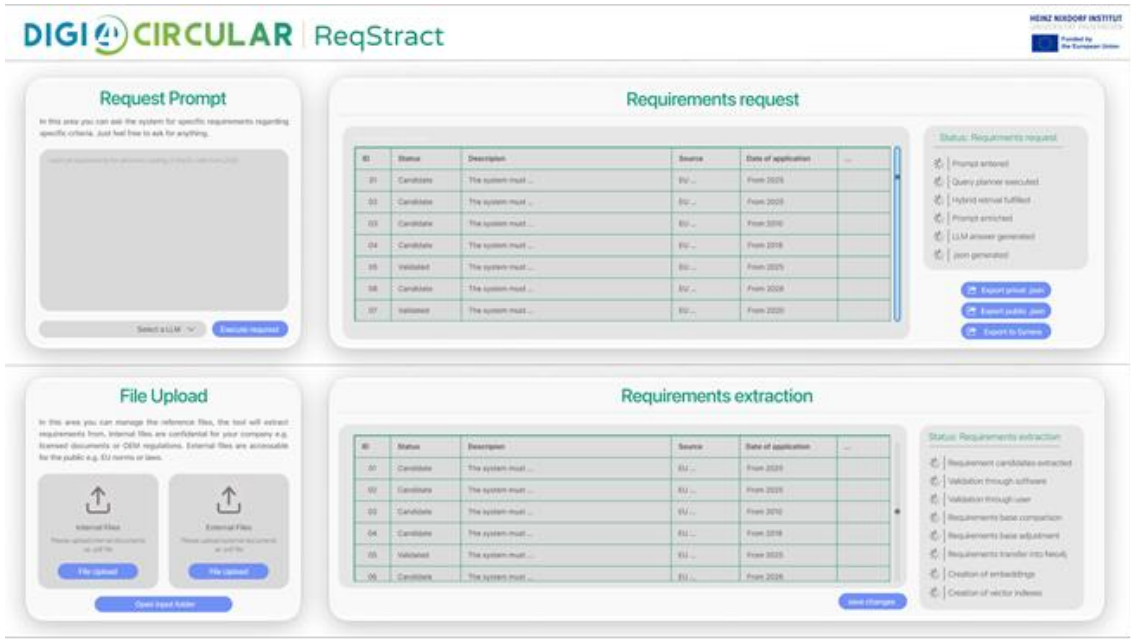


STEP file in – LCA and LCC out, during design

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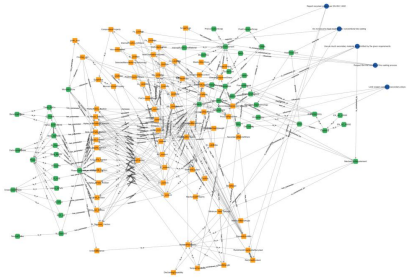
A look inside: first working tools

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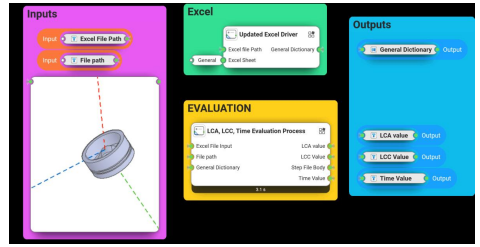


ReqStract extracts requirements from standards and expert knowledge – and makes them machine-readable.

Knowledge graph (example)



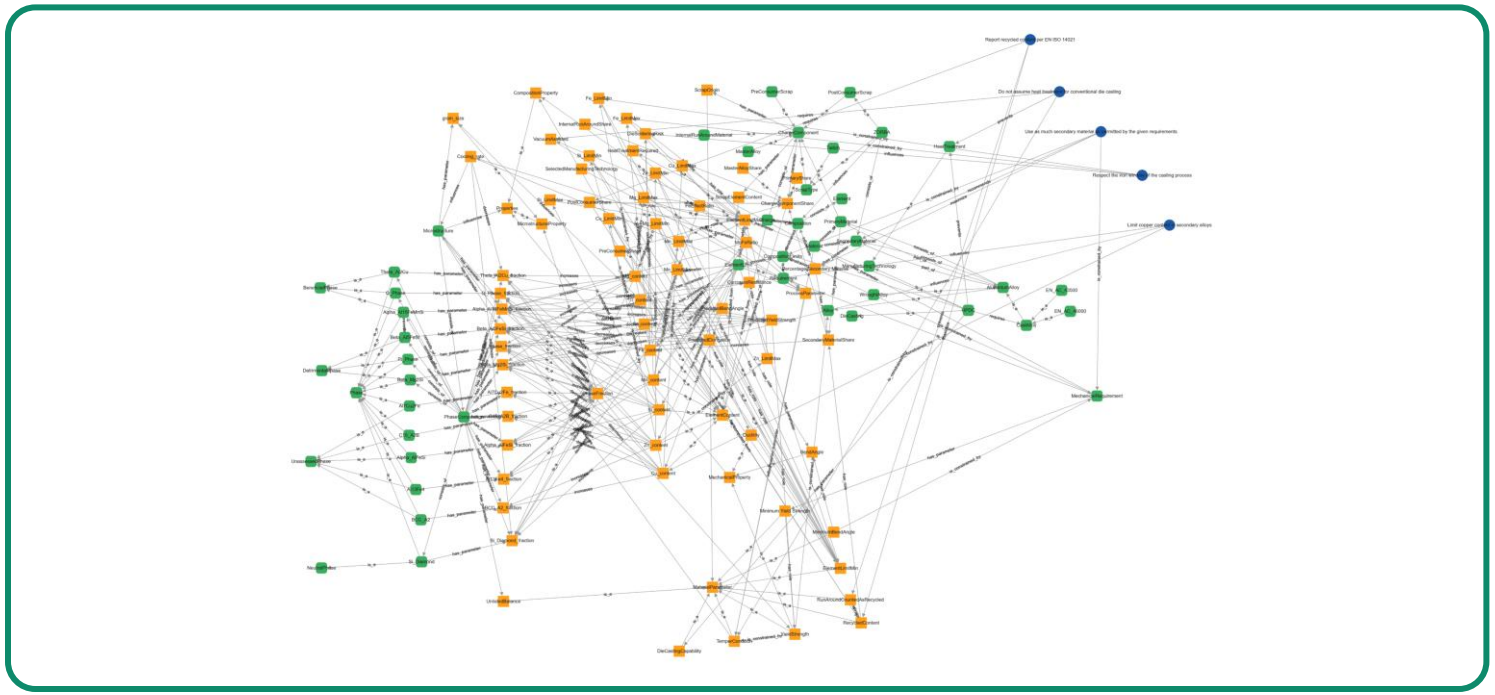
Synera workflow



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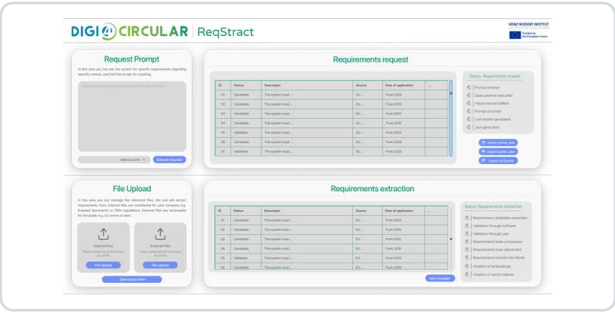
A look inside: first working tools

Knowledge graph (example)

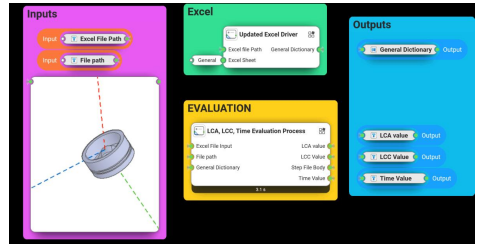


An example from our three knowledge graphs: it links scrap, composition, phases and requirements through rules.

ReqStract



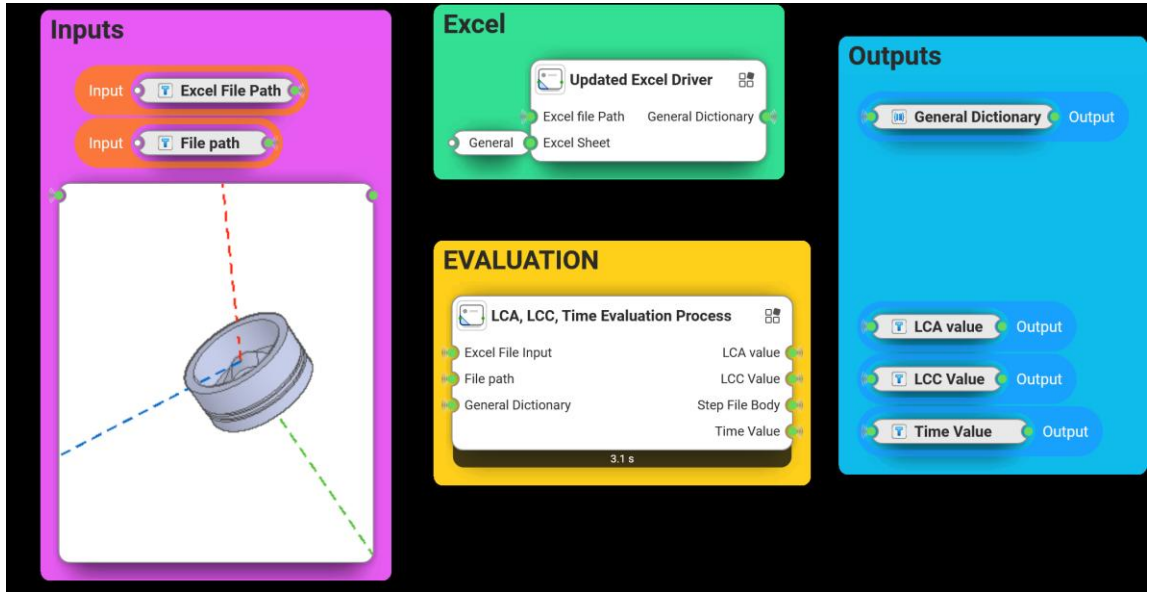
Synera workflow



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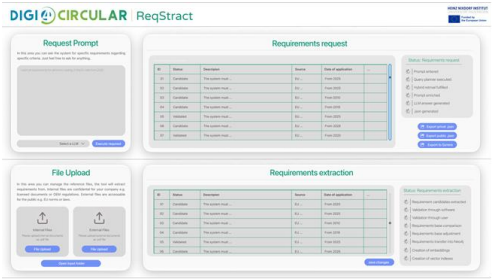
A look inside: first working tools

Synera workflow

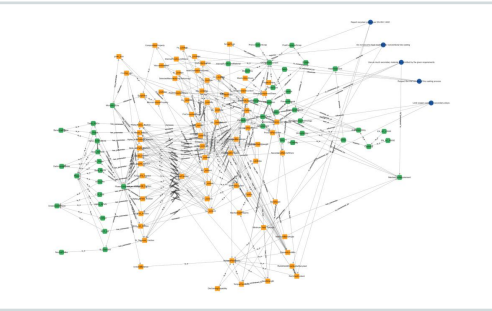


A Synera workflow: the STEP file goes in, LCA and LCC values come out – during design.

ReqStract



Knowledge graph (example)



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Material and geometry together

TODAY

Scrap → **Downcycling** or **Structural parts** → **Mostly primary aluminium**

WITH DIGI4CIRCULAR – FOR A STRUCTURAL PART

Variable scrap batch → **Tuned alloy** meets the requirements → **Matching geometry** designed for this alloy → **Structural part** ready for die casting

Each scrap batch gets its own recipe – and the component gets the geometry that fits it, ready for die casting.

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Demonstrator: the CityBot coupling



Steel assembly
12 parts, welded

→

One aluminium part
high-pressure die-cast

designed automatically through the Digi4Circular chain

≥ 50 %
recycled content (target)

≥ 50 %
lighter than the steel part

STATUS

Design adapted | **Casting tool ordered** | **First castings**

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Where we are at mid-term

11/2024 — We are here · 11/2026 — 04/2028

WP4 Requirements

Extraction methods validated; ReqStract prototype running

Next: ontology linking vocabulary

WP2 New alloys

Alloy ranges screened by simulation; casting tool ordered

Next: first castings

WP5 Component design

Knowledge graph with 3 domains and 33 rules for variable scrap

Next: loop with simulation

WP6 Integration

Modular Synera workflows; chatbot and metadata tool as proofs of concept

Next: join the building blocks

WP3 Assessment

Synera workflow running: STEP file in, LCA and LCC out

Next: database and DPP mock-ups

WP1 Information Space

First usable version and project repository in place

Next: integrate all components

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Why it matters

Environment

~205 kg

aluminium in an average European car – every kg from scrap saves up to 85 % CO_2

Industry

Less dilution with primary aluminium – alloying elements tuned to the required properties

Engineers

One connected workflow from requirements to alloy, geometry and LCA / LCC

Europe

Less dependence on primary aluminium; product data ready for the Digital Product Passport

Aluminium is a strategic raw material for Europe – making scrap fit for structural parts keeps more of it in use.

Sources: European Aluminium / Ducker Carlisle (EU and UK car production 2022); Regulation (EU) 2024/1252

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Designed in – not downcycled

€5.76 M

EU funding

11 partners

DE · AT · IT · PT · CZ · ES

2024 – 2028

11/2024 to 04/2028, coordinated by Paderborn University

Let's talk: katharina.rohde@uni-paderborn.de · digi4circular.eu

HORIZON-CL4-2024-TWIN-TRANSITION-01-05 · Made in Europe Partnership

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Thank you for your attention!

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