ENGINE

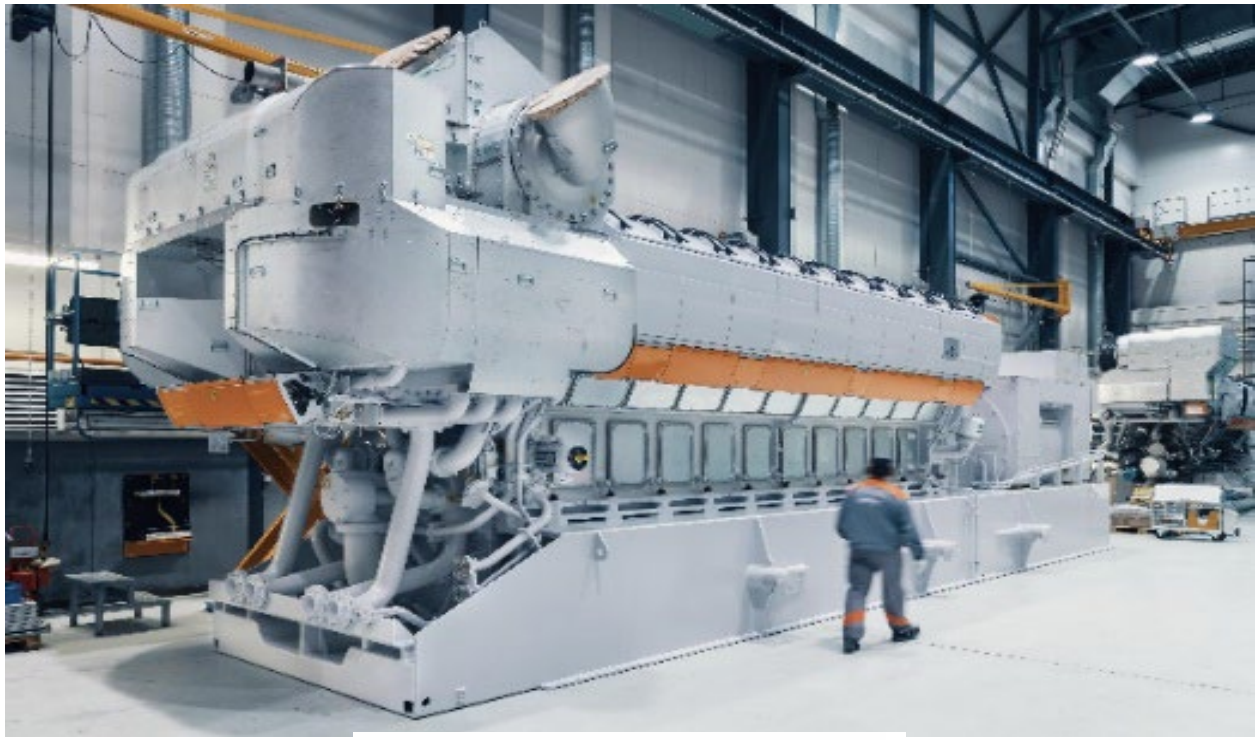
ZERO-DEFECT MANUFACTURING FOR GREEN TRANSITION IN EUROPE

HORIZON-CL4-2021-TWIN-TRANSITION-01-02

Co-funded by the European Union

The Manufacturing Partnership Day

Marzuk Kamal
AeonX AI, Paris



The challenge

The **manufacturing process of different metal products, such as valves and engines of heavy industry, is energy-intensive** and requires substantial amounts of natural and financial resources. Moreover, **defective components and engines cannot be easily reworked or recycled** without significant effort. *Decarbonisation goals via the use of sustainable fuels can only be met by new technical solutions implementing zero-defect and first-time-right manufacturing.*

The objectives

The overall goal of the ENGINE project is to **reduce the environmental impact and improve competitiveness of metal product manufacturers** by developing a novel metal product design and manufacturing system, which integrates life-cycle analysis and business decisions, reduces defects, waste, and shrinks product time-to-market.

The project will develop a first-time-right and zero-defect metal product design and manufacturing system, which **will be applied on marine engine supply chain.**

1. Create and demonstrate a novel metal product design and manufacturing system
2. Develop computational modelling toolbox for product and process design, non-destructive diagnostic tools for production monitoring, and data solution for seamless integration of the whole supply-chain
3. Research methodologies for first-time-right and zero-defect manufacturing
4. Investigate life-cycle analysis and life-cycle cost methods for design and business decisions
5. Present strategy for employee skills development
6. Transform innovations into promising business cases

The project

ENGINE system

The metal product design and manufacturing system that integrates the separate modules to enable sustainable-by-design product development and first-time-right and zero-defect manufacturing.

ENGINE exchange

Data management solution for industrial data storage, sharing and seamless, multiple-location integration of software and hardware tools.

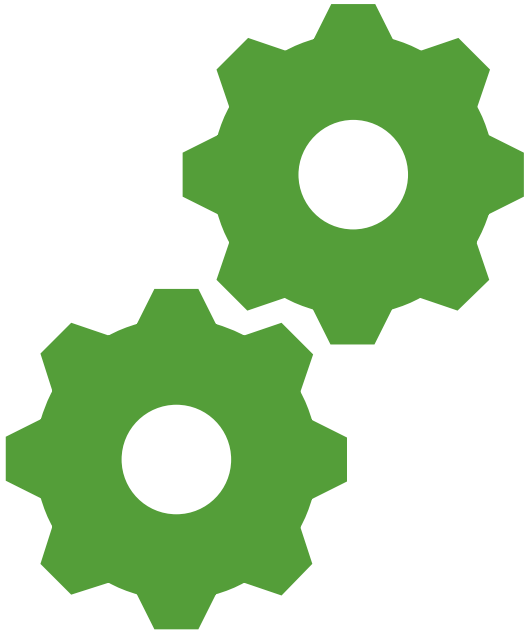
ENGINE toolbox

Software suite for sustainable-by-design product development and first-time-right manufacturing.

ENGINE production

Production control, diagnostics, and monitoring solution enabling zero-defect manufacturing.

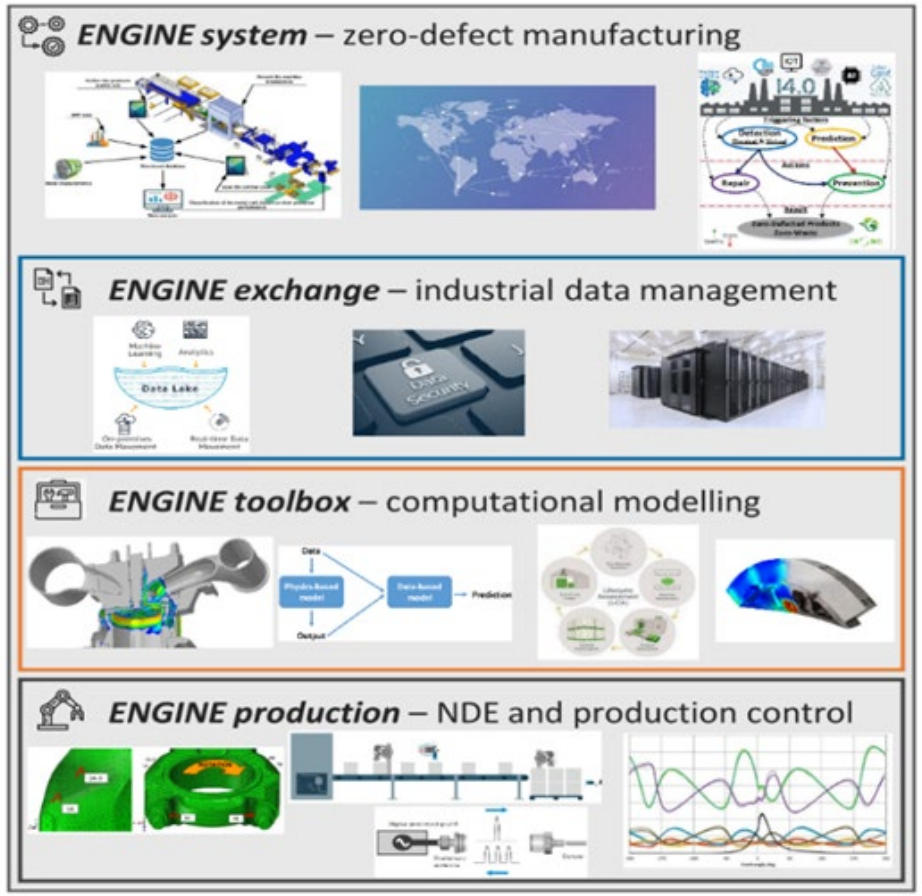
Showcase the developed technologies on marine engines

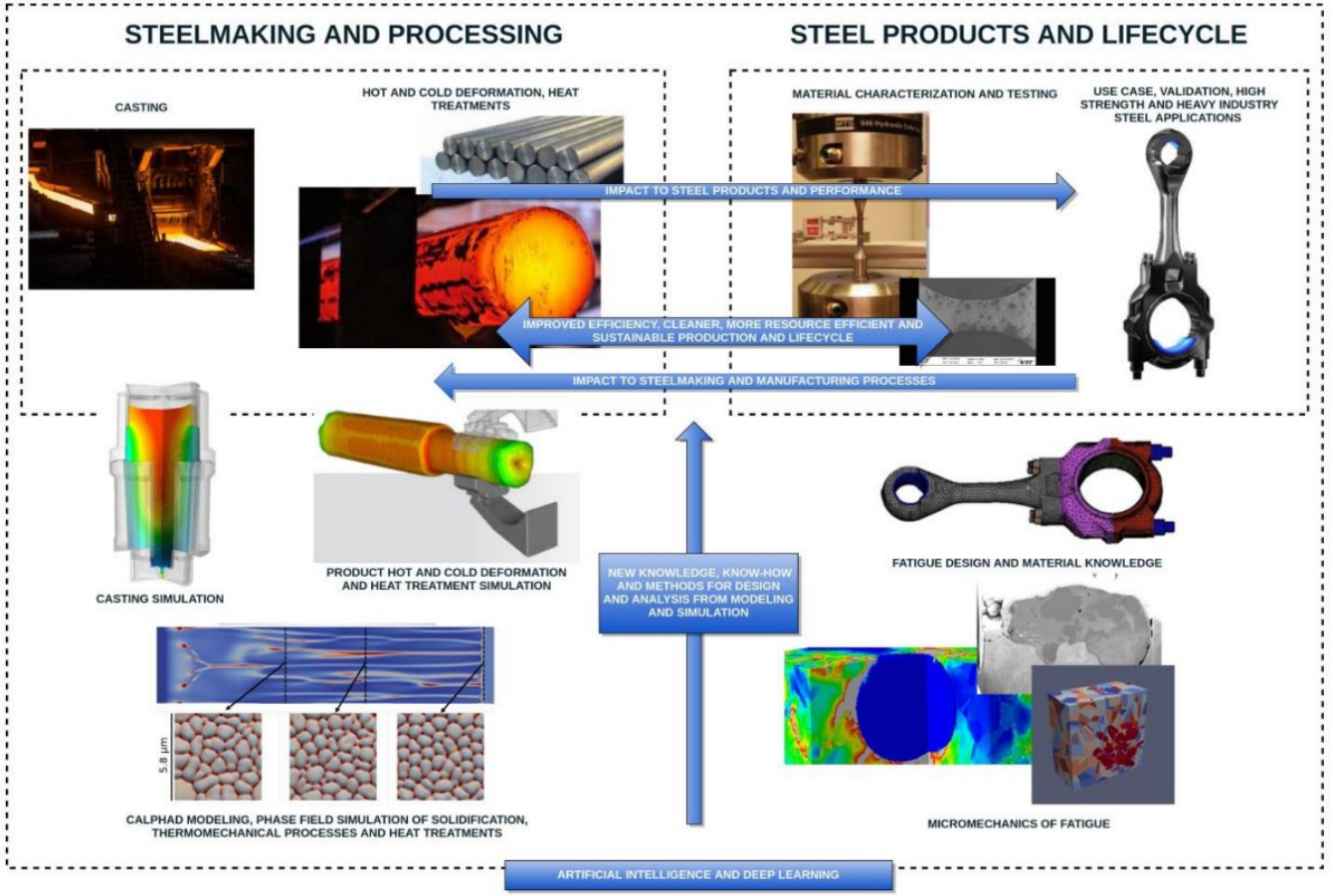


Key Exploitable Results

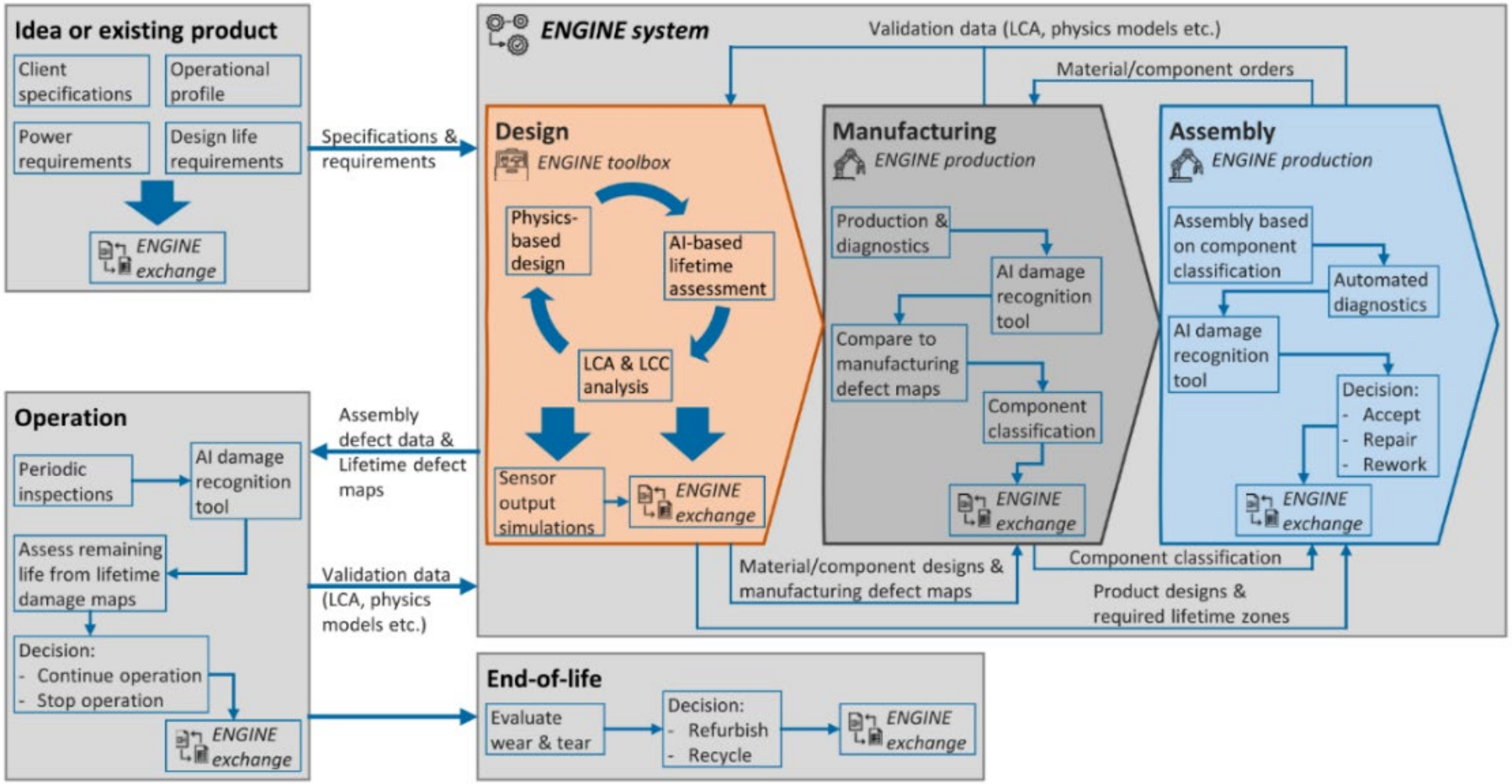
1. ENGINE system
2. ENGINE exchange
3. ENGINE toolbox
4. ENGINE production
5. AI, data analytics tools & Homomorphic AI Platform
6. Post-Quantum End-to-End Encrypted Data security tools
7. LCA model, sustainability data and digital LCA tool
8. Sensors, and respective NDE techniques
9. NDE methods supported by AI-modeling
10. Methodologies
11. Experimental testing
12. Repair and refurbishment strategies
13. Skills development materials and website
14. Standardization materials
15. Publications

The ENGINE concept

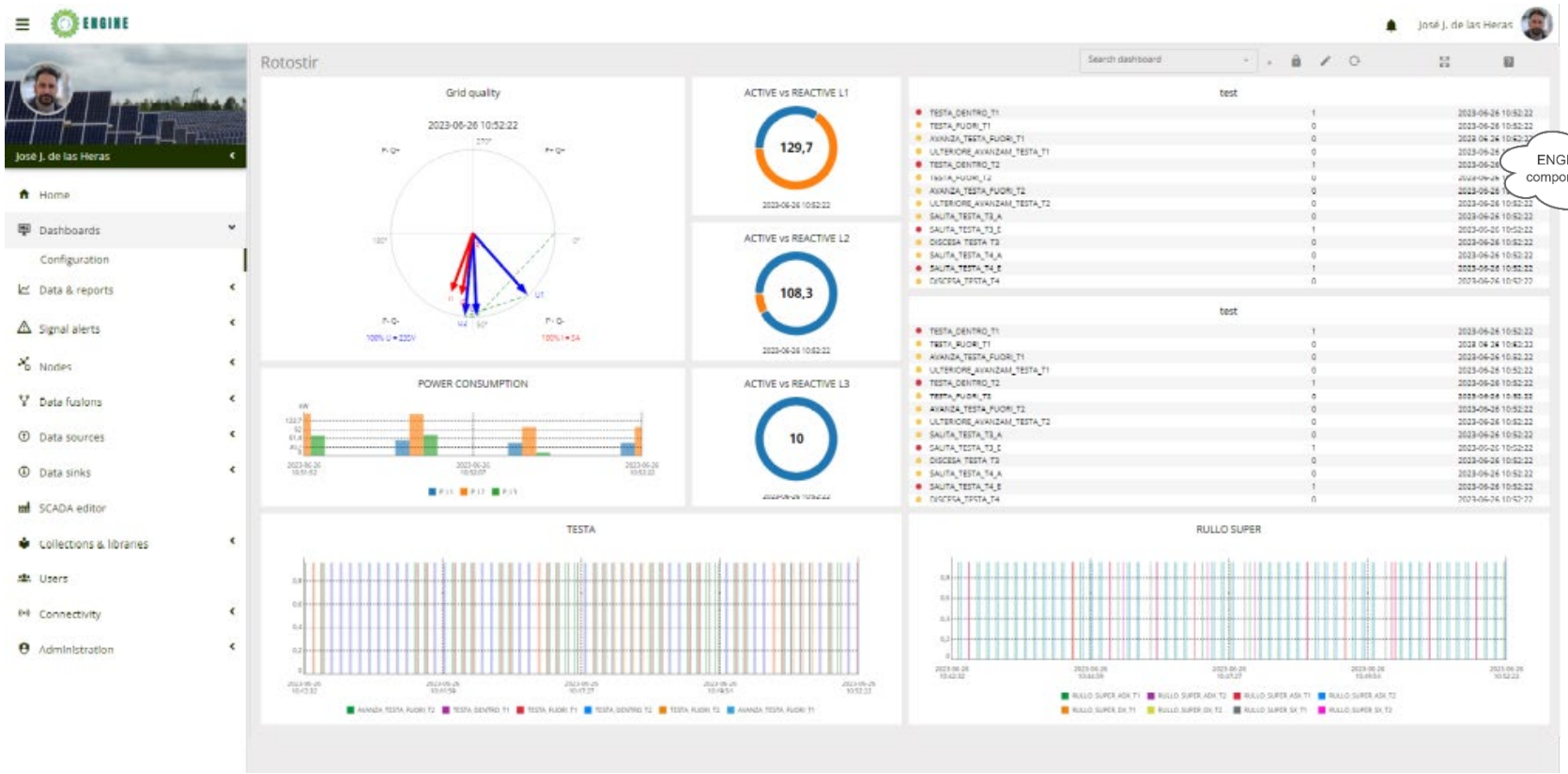


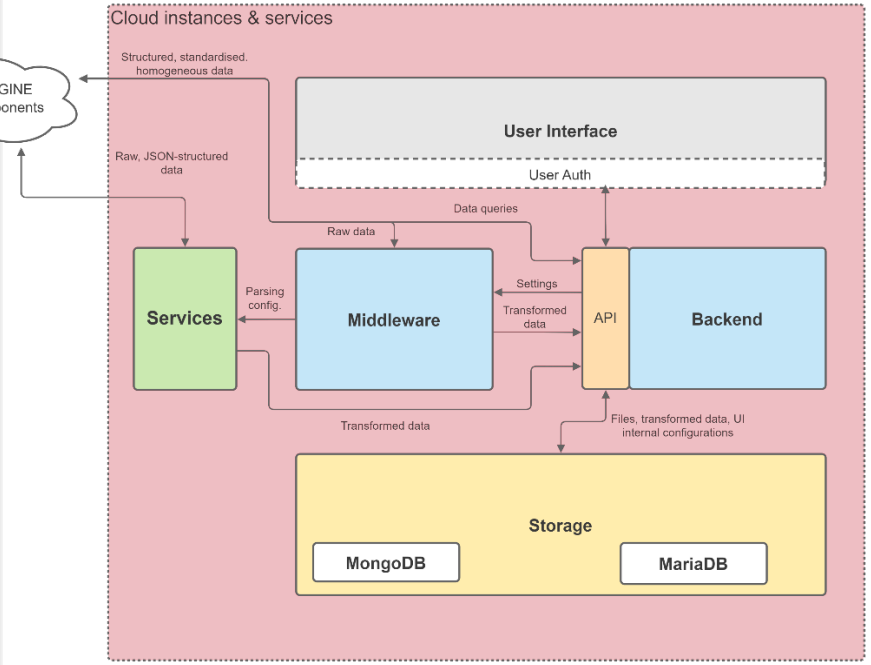


Novel metal product design and manufacturing system



Example of results: The ENGINE exchange



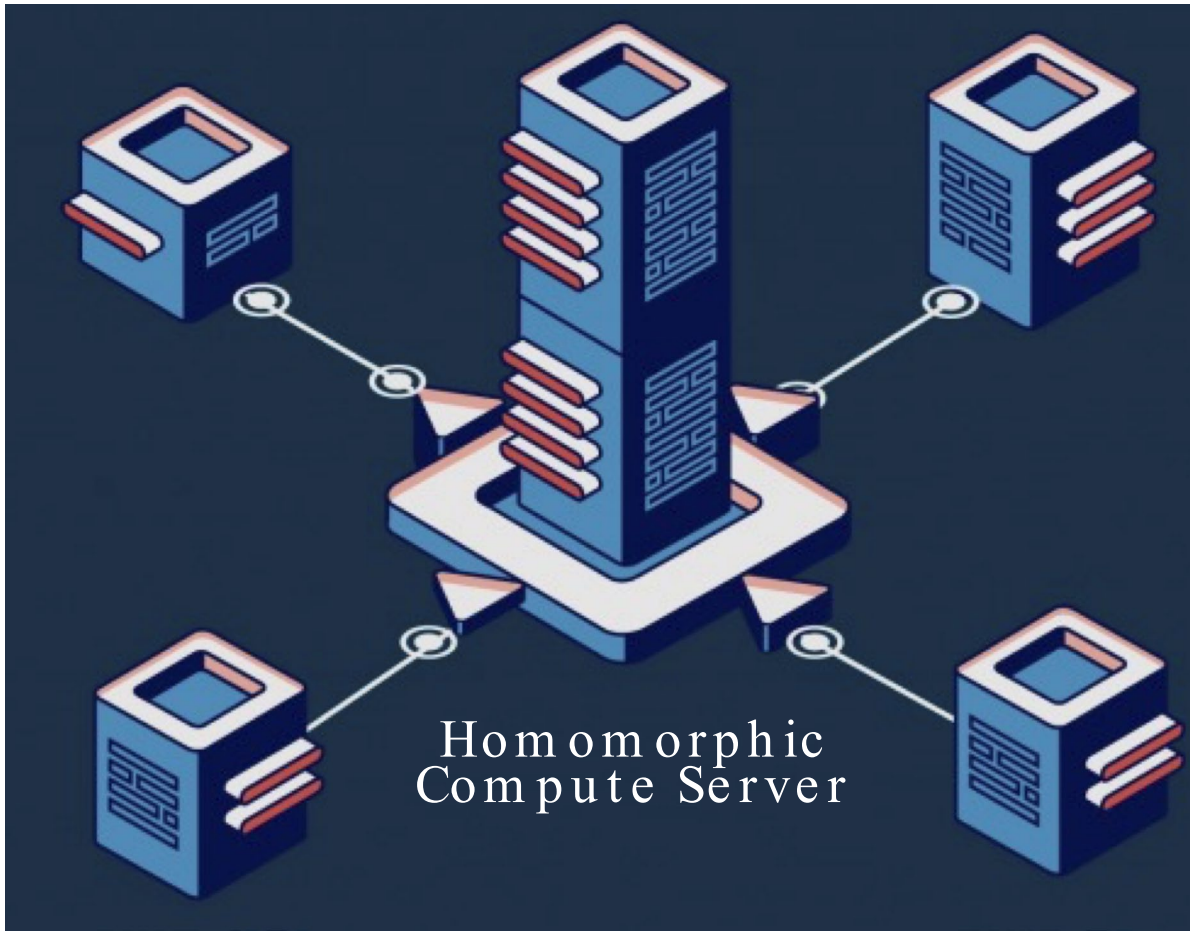


Results: Federated Homomorphic AI Platform

ENGINE

ORGANIZATION 1

ORGANIZATION 2

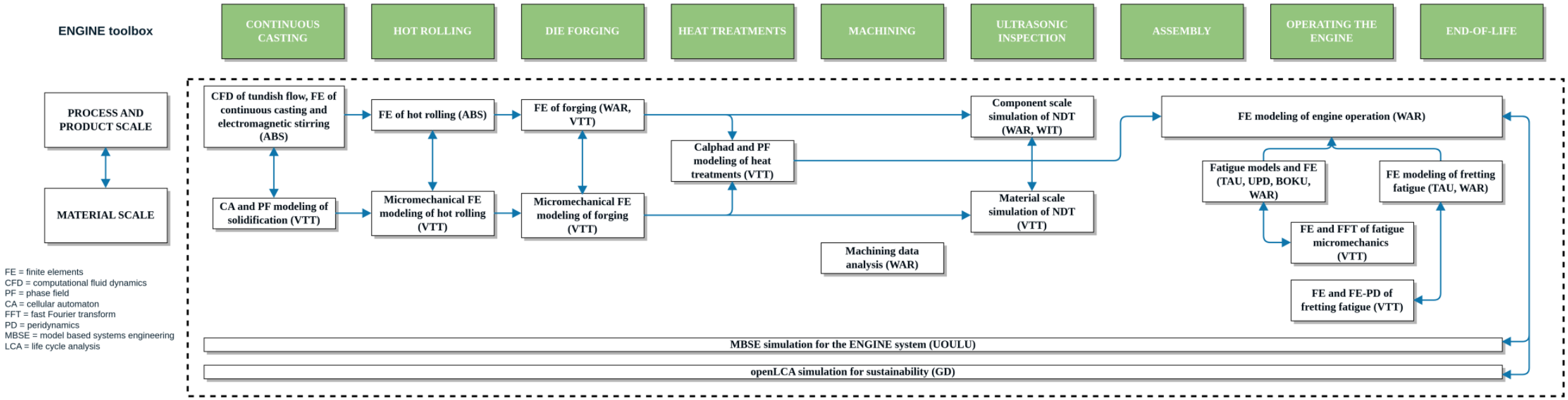


ORGANIZATION 4

ORGANIZATION 3

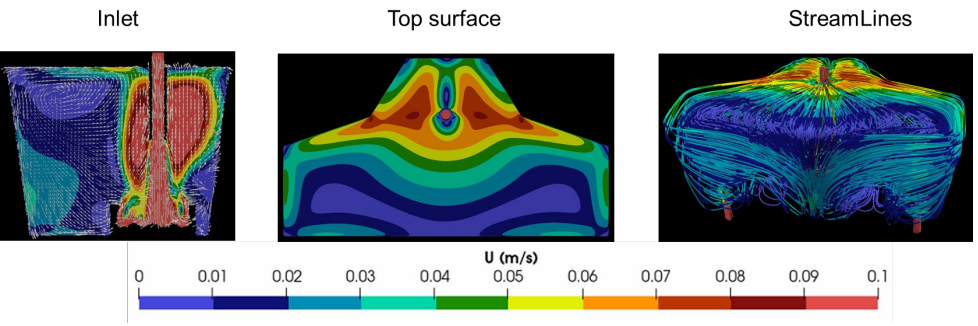
- **Data never leaves the organization**
- Only encrypted ML models from each organization are synchronized at every few iterations
- Models are Encrypted before leaving organization ML server
- ML models are updated by homomorphic computation engine in the server

Example of results: The ENGINE toolbox

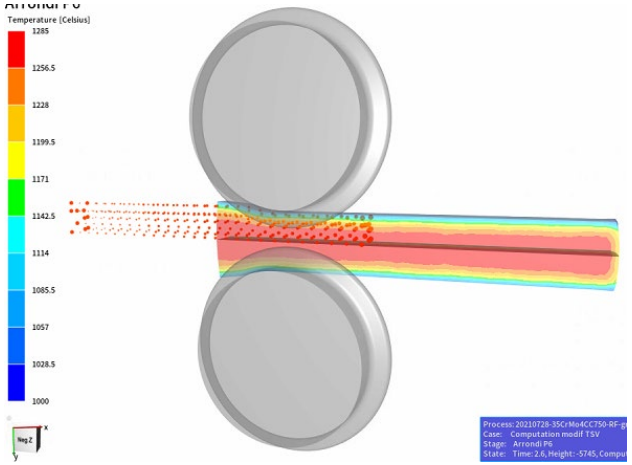


Example of results: The ENGINE toolbox (select)

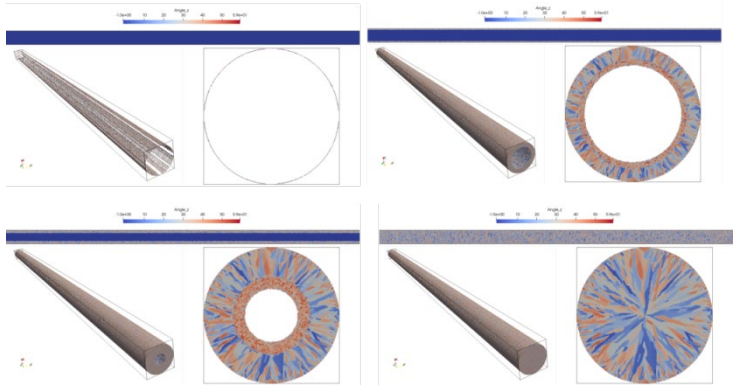
Steelmaking



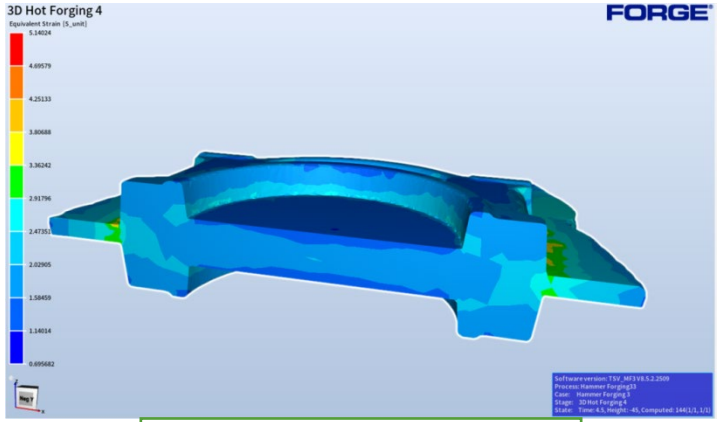
Hot rolling



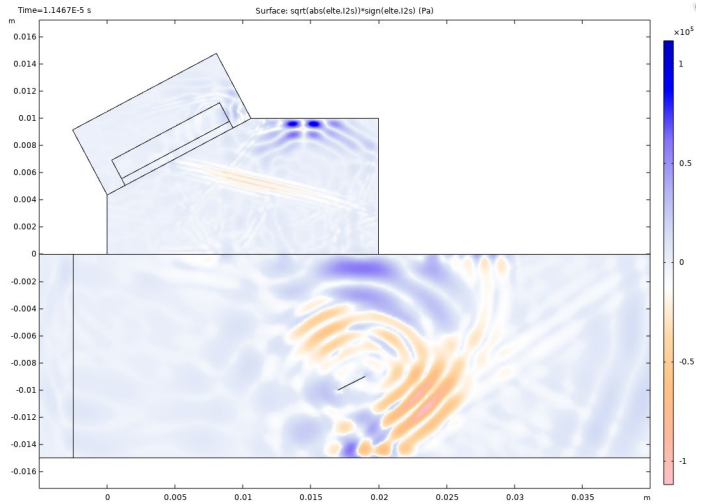
Defect generation during solidification



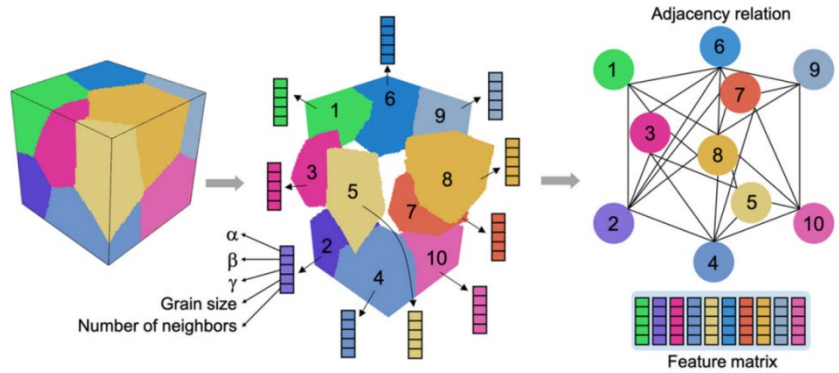
Forging



Simulation of inspection



AI for modeling the effect of defects on lifetime



Gaps being addressed and future challenges (select)

Gaps

- **Establishing the complete ENGINE workflow,** from steelmaking to product manufacturing, product operation, end-of-life and sustainability does truly provide the industry novel capabilities and future business opportunities all around.
- The methods established to rapidly generate on-the-fly AI training data and deploy the respective solutions are proving to significantly **accelerate the adoption of AI to a range of new scopes, the hybrid approach tackling a gap typical for AI.**
- Filling the gap in LCA/LCC interacting with technical design provides a more complete implementation and abilities for circular design and ensuring sustainability interacts with the whole product process. Also, extending LCA to areas previously poorly covered or lacking in data extends our analysis ability.
- **Integration of online measurements, sensoring and non-destructive evaluation** and inspection to real-time support for decision-making is one of the most impactful gaps we are covering. The role of AI and system scale integration is paramount.
- **The role of high quality validation data from experimental and production activities** is proving itself highly valuable for establishing the types of predictive ability we require to pursue defect free manufacturing and linking the work to daily and product specific business needs.
- **Dissemination activities and skills uptake required** to make use of modern AI solutions require particular attention to make the best out of the results, methods and methodologies being developed.

Future challenges

- **Integrating system, product, manufacturing and material** level modeling and production demonstrators of defect generating processes and integration to decision-making is critical for ensuring industry uptake and exploitability of the project key exploitable results **(ENGINE system = exchange + toolbox + production).**
- **Optimization and inference across disciplines using AI to identify sustainable and defect free manufacturing** opportunities requires tight integration and in-depth capabilities from the ENGINE system and digital tools.
- **Training and education and generating the respective material** is and will be a continuous challenge, as the level of complexity in the provided solutions increases and this must not become a barrier for adoption and exploitation. Relates also to ensuring links to standardization, maintaining and support and extensibility.
- We are seeing **several opportunities arising** from the interactions between manufacturing, production and operation and the respective workflows (our KERs), simply from being **able to provide new viewpoints and exploit data and digitalization beyond what has been done in the past.** Ensuring we identify and develop based on the respective findings and feedback is critical for realizing the project impact on zero defect manufacturing and sustainability.

ENGINE

ZERO-DEFECT MANUFACTURING FOR
GREEN TRANSITION IN EUROPE

Thank you for your attention

More information:

www.theengineproject.eu

www.twitter.com/ENGINEProjectEU

https://www.linkedin.com/showcase/engineproject

Co-funded by the European Union

Grant Agreement No. 101058179

Funded by the European Union. Views and opinions expressed are however of those of the author(s) only and do not necessarily reflect those of the European Union or the European Health and Digital Executive Agency. Neither the European Union nor the granting authority can be held responsible for them.