Toward virtual forming and design:

Thermomechanical characterization of advanced high strength steels through full-field measurements and a single designed test

Metal Plasticity Seminar

A. Andrade-Campos, University of Aveiro

KU Leuven, 19th November 2024

VForm-xSteels

This project has received funding from the Research Fund for Coal and Steel under grant agreement No 888153

Outline

- Introduction
- Introduction to the Vform-xSteels project
- Overview
- The Vform-xSteels database

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Decades
ago…

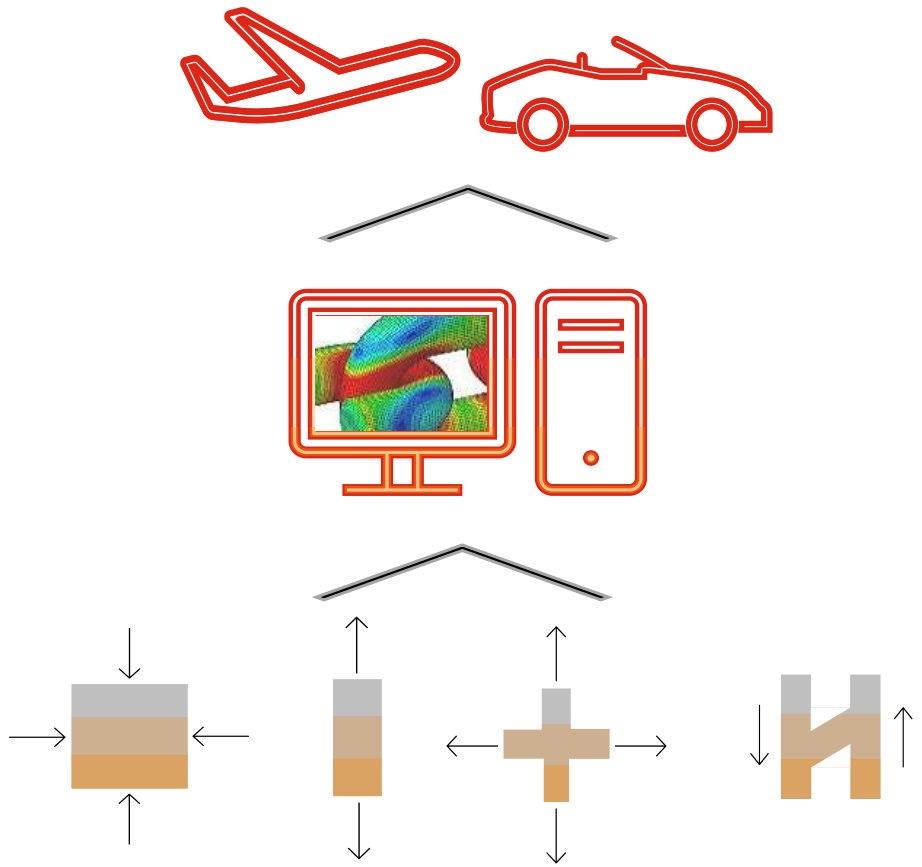

Today…

Problem and need

Faster and accurate development & production

Realistic simulations and material behavior reproduction

Increase information & **reduce time** in material testing



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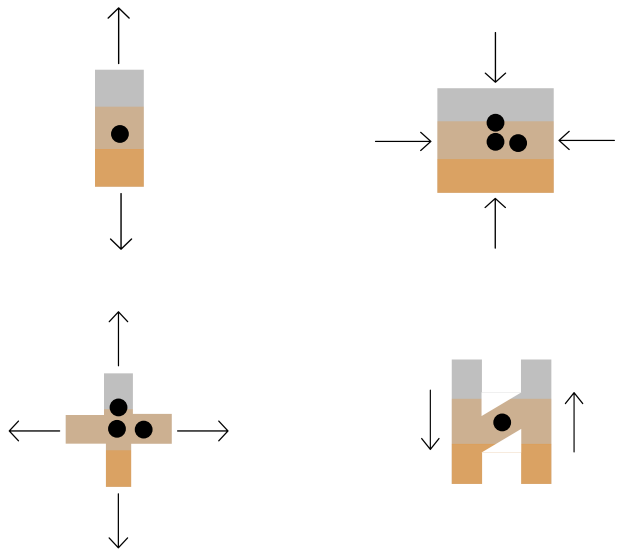
Problem

Limited quality and amount of data



*"The data we have is provided by suppliers. In some cases it is **limited**."*

André Ferreira
Designer Projectist @ OLI Oliveira e Irmãos

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Problem

Error in material behavior virtual predictions

"It would be important to have a service that could identify and provide these data to companies in due time."

Mário Marques
Country Manager Iberia @ Autoform

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Project goal

Nowadays, the use of numerical simulation in general and particularly finite element analysis (FEA) has become a mandatory step (…) However, todays methods to characterize the materials through constitutive models, including damage, and their parameters are expensive and not robust.

The main goal of the project VForm-XSteels is to develop an efficient and accurate **methodology for material characterization and determining the material parameters of thermomechanical models,** from a dedicated single test that involve non-homogeneous temperature and strain fields**.**

Indeed, (…) A database and online library with calibrated material constitutive models, particularly for AHSS, is also developed.

The benefits of the proposed methodology and consequent implemented numerical tool developed within this project are (…) cost and time reduction in the overall development process are also benefits of this proposal.

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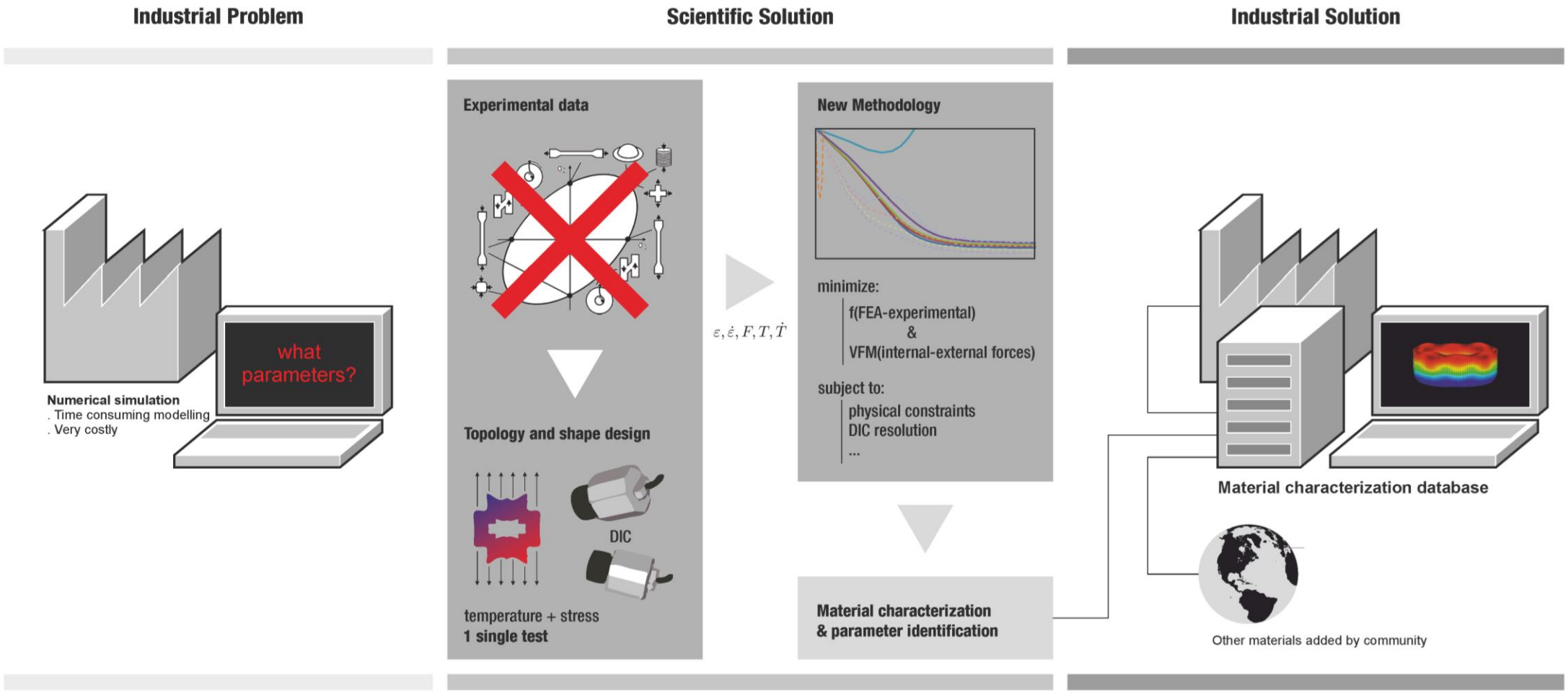
Project goal



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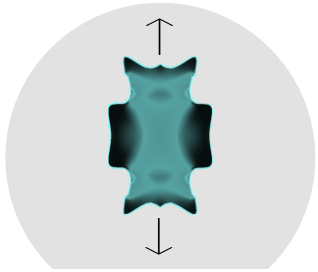
Project goal and technology

VForm-xSteels

Innovative experimental **test** (1 000+ points)



IP test

Optical technology

Advanced Data analytics to calibrate the material models

Optimization algorithms

Fast

Accurate

Robust

Flexible

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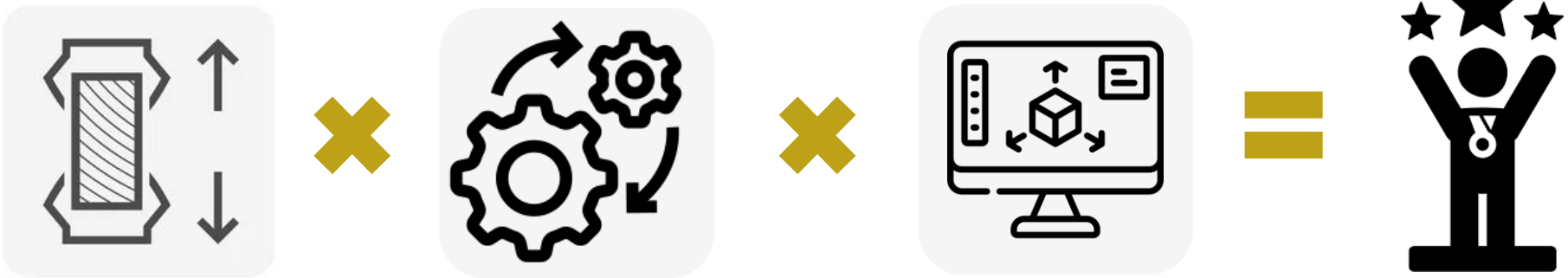
Project goal and technology

VForm-xSteels

Success of the material modelling

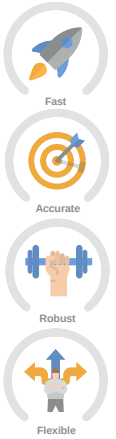


Quality/quantity of the reference
(observ. experimental)

Inverse methodology
(calibration process)

Constitutive model
(formulation)

Sucess



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Project goal to the deliverables

At the end of the project, it is expected to obtain:

(i) **numerical methodologies** and tools able to efficiently and automatically represent the thermo-mechanical behaviour, including damage, of advanced high strength steels, through complex material constitutive equations and optimization of the large number of parameters;

Parameter Identification/ model calibration methodologies

- Thermomech models (WP2)
- Damage models (WP5)

(ii) a suitable temperature and strain heterogeneous **mechanical test**, able to provide the largest number of strain states and present complex thermal-strain fields such as the ones occurring in warm-metal-forming operations;

Tests/ Specimens design

- Sheet metals (WP3)
- Damage models (WP5)
- Large thickness specimens (WP6)

(ii) a **database of material constitutive equations and parameters** calibrated to a large number of AHSS.

Online Database design and development

- Models for FEA (WP4)
- Calibrated/identified Parameters (WP2, WP5, WP7)
- Experimental data (all WP)
- KPIs (WP2, WP5)

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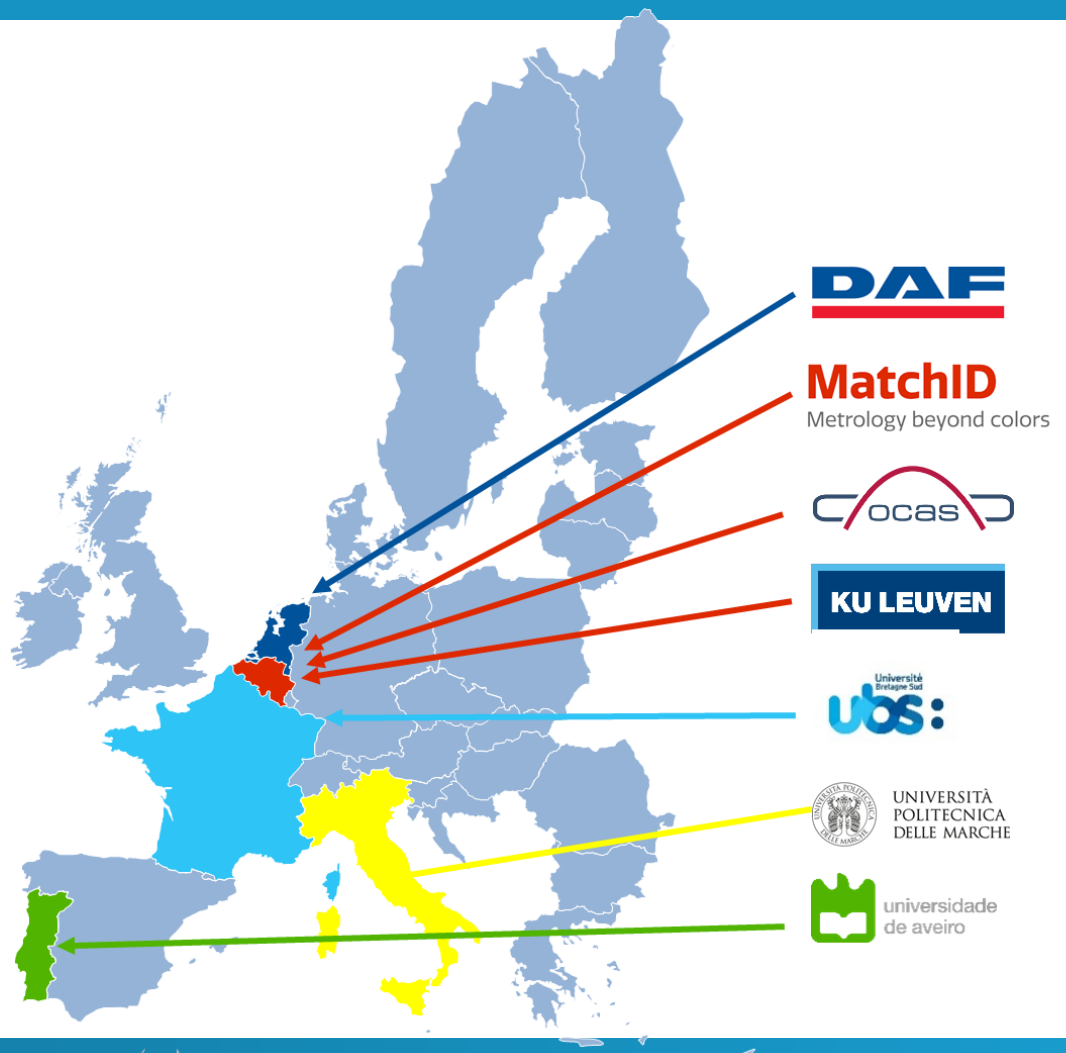
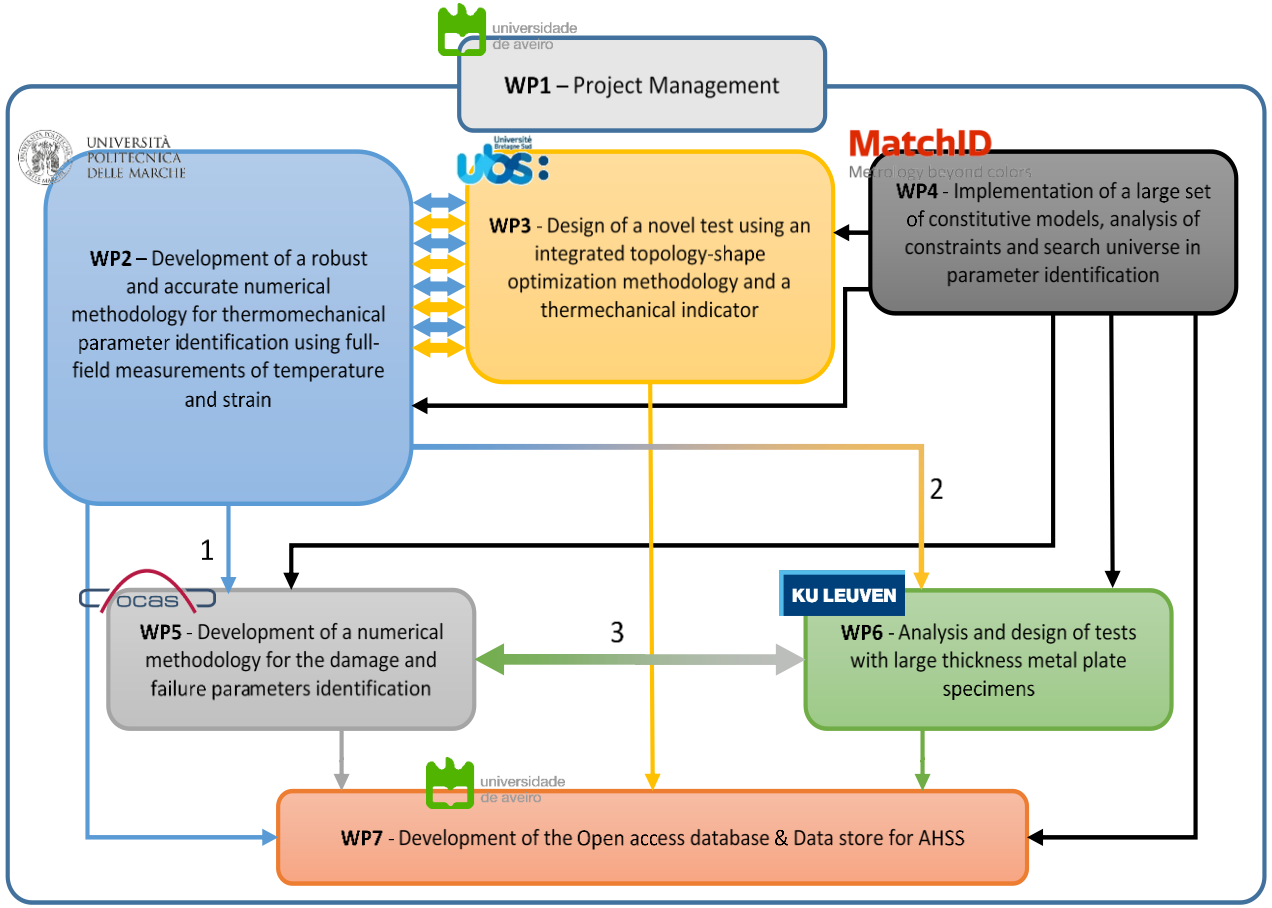
The consortium





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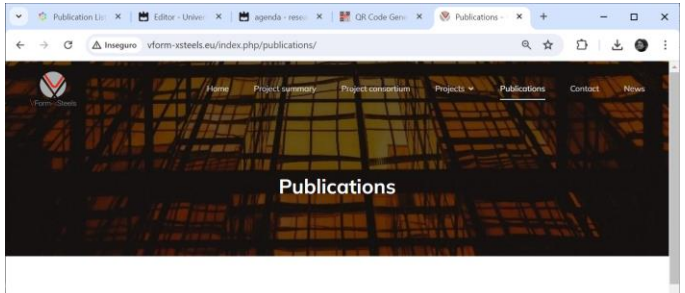
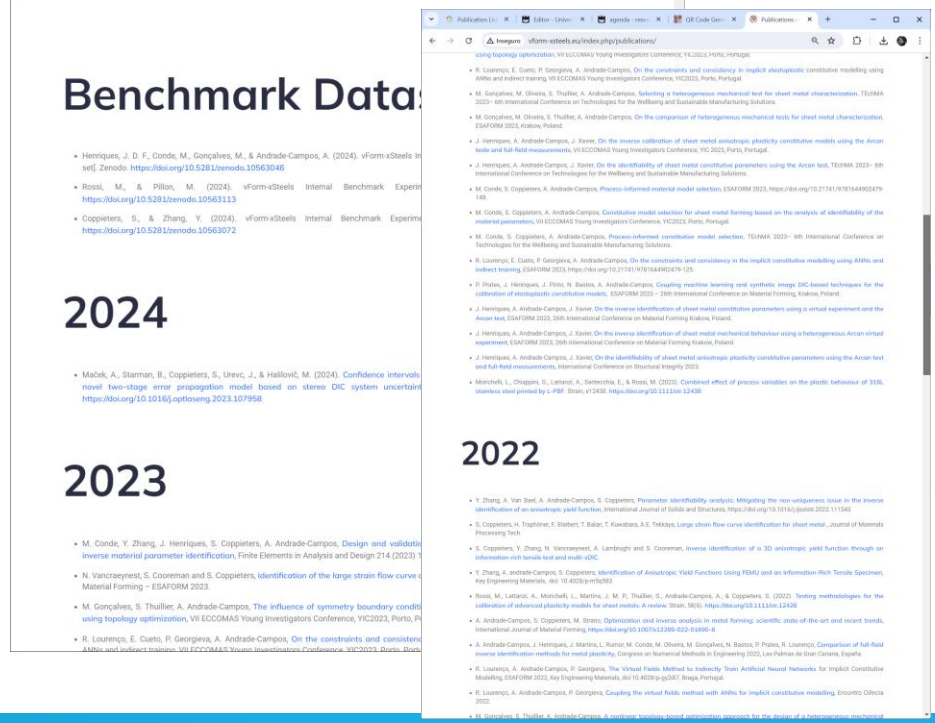
Project results

- > 25 journal papers and > 40 conference papers;
- several software codes;
- More than 7 events organized (seminars and symposiums);
- Created several advanced trainings (online videos) and courses;
- 9 PhD students;
- …
- An online material database and front end.





http://www.vform-xsteels.eu

http://www.vform-xsteels.eu/index.php/publications/

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The Vform-xSteels Database

Implementation

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