Advanced Laser-Based Manufacturing

Multiphysics Modelling and Interoperability with VMAP Standards

Aerobase Innovations AB

ALABAMA RESTORE GEAR-UP

Funded by the European Union

Company Profile

Highlights

Spin-off from Luleå University of Technology

Gestamp, RISE, Swerim, GKN, Vicura/AVL, NIBE, FEV

We have >70y combined experience

- Computational Material Science
- Simulation of Manufacturing Processes

Kronan H4, Luleå
Innovatum, Trollhättan

Bijish Babu, Ph.D.
Metals: Welding, AM, Forming, Rolling

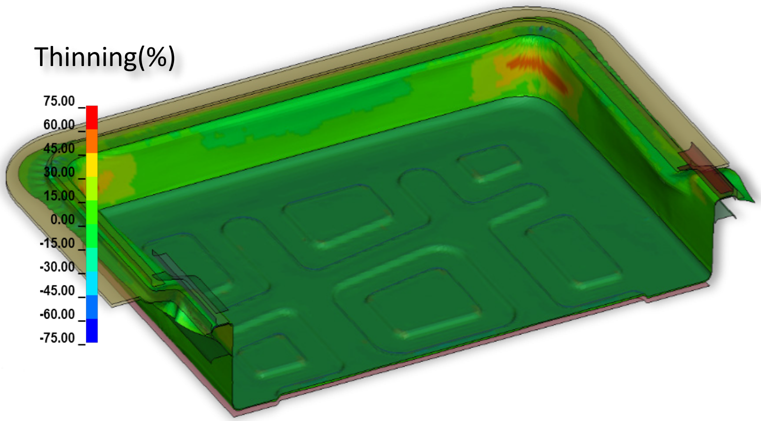
Daniel Berglund, Ph.D.
Metals & Composites: Forming, Crash, Welding

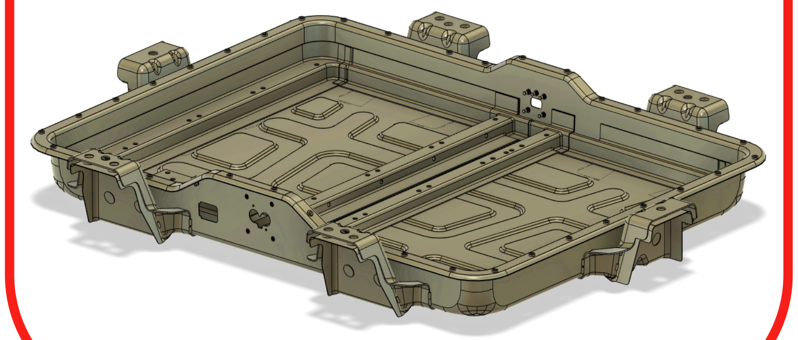
Henrik Tersing, Ph.D.
Metals: Forming, Crash, Welding, HT, AM, Transmission

Lakshmi Narasimhan, MSc.
Material modeling (composites)

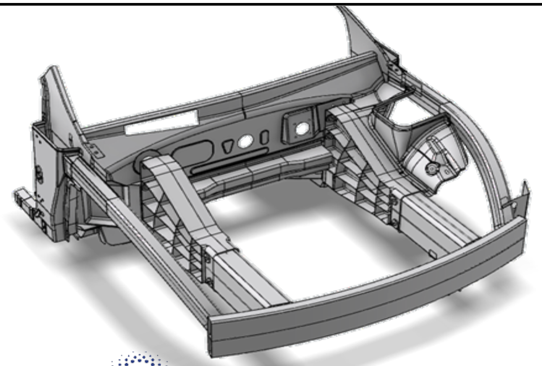
aerobase

Hot forming





Crash simulations



STELLANTIS

FEA SaaS

aerobase

What we offer

We make material models accessible to simulation engineers

Software for prediction of Failure & Post-buckling

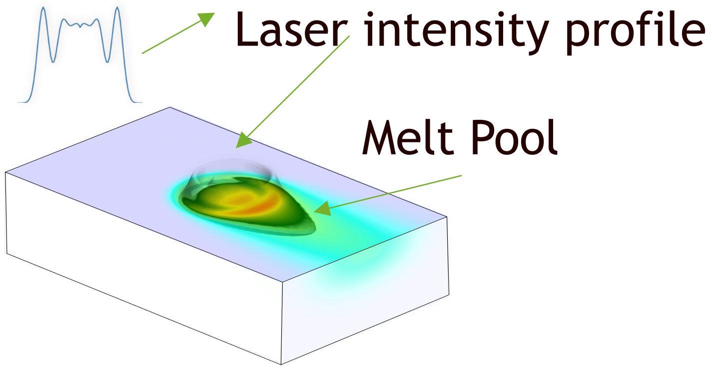
Software for prediction of Phase Evolution

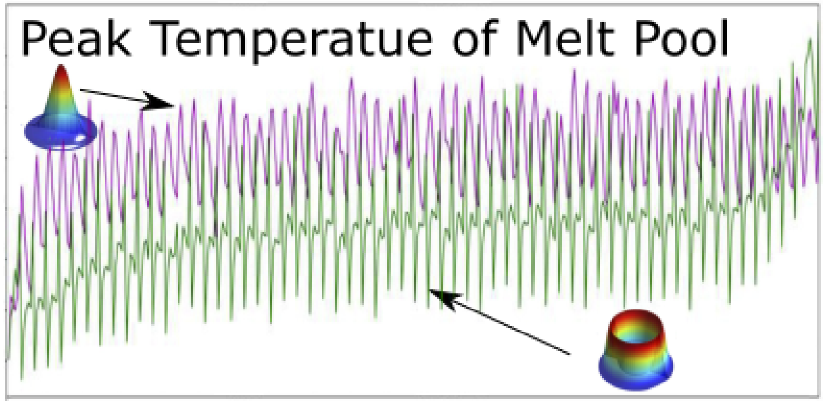
Cloud-based FEM package

Testing & Calibration of Models

Modeling & Implementation Support

Laser-DED (AM): Fluid (Melt pool)





ALABAMA RESTORE GEAR-UP

Funded by the European Union

1. Which melt pool geometry is desirable?

Objective: *Minimize defects & tailor microstructure*
Depends on: *Material, Process parameters, & Geometry*
Informed by: *DOE based coupon testing, Analysis & Simulations*

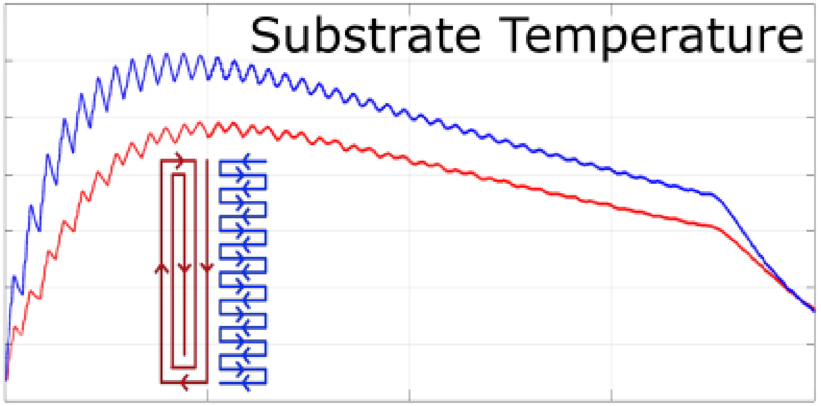
2. Which intensity profile → desired melt pool?

Objective: *Define the inverse problem*
Depends on: *Tailored heating & cooling, material, geometry & BC*
Informed by: *Error minimization*

- ✓ Tailored microstructure
- ✓ Fewer defects
- ✓ High Productivity

aerobase

AM Simulations: Scanning Strategy



AM Simulations: Thermal

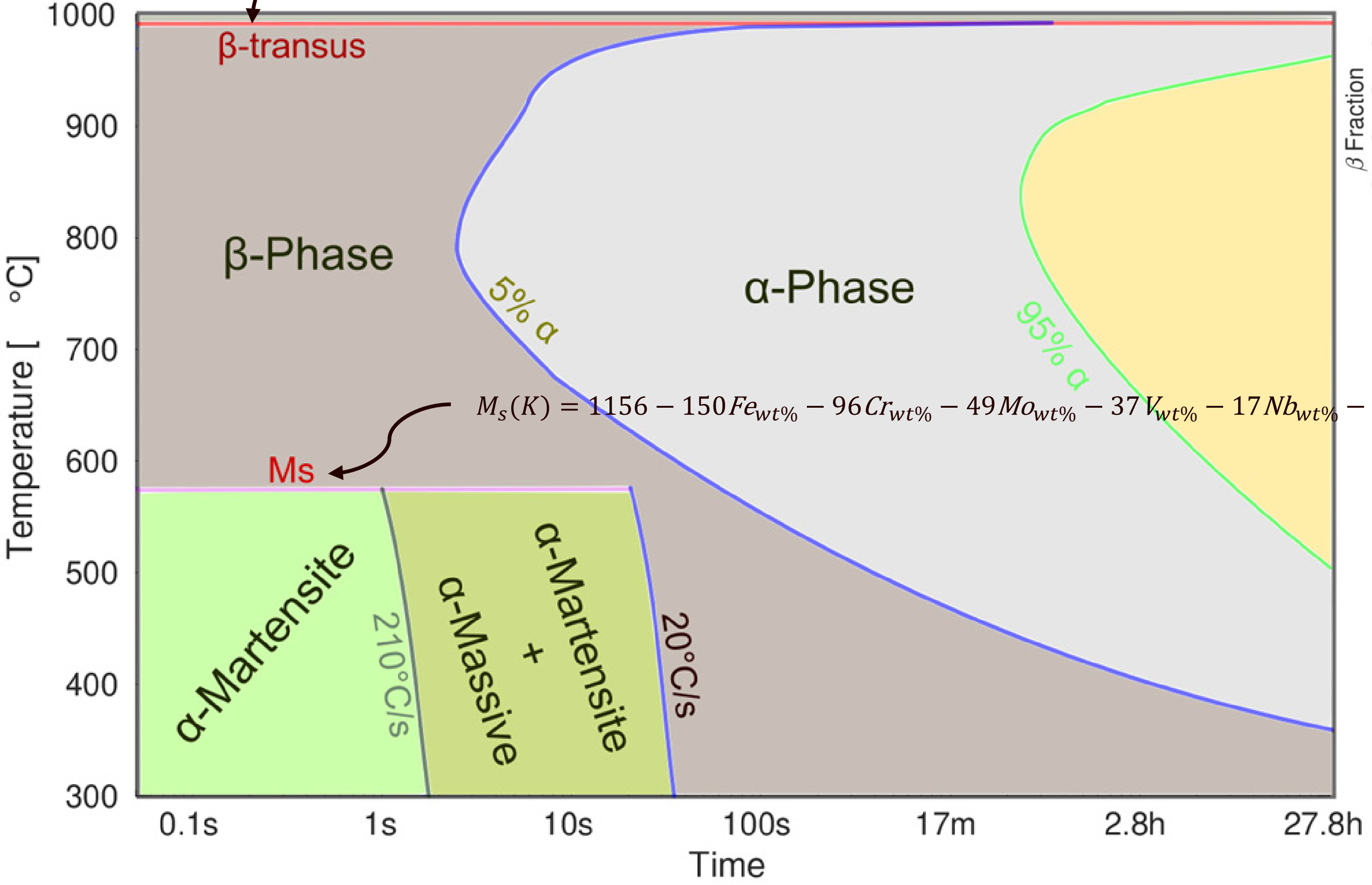
Total Layers	4
Total Beads	48
Total Elements	896
Total Dwell Moves	94
Active Distance (mm)	1120.00
Travel Distance (mm)	713.41
Total Time (s)	1883.41

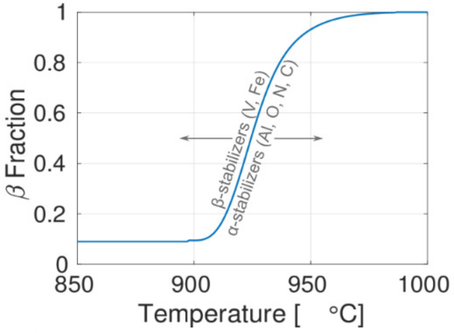
Total Layers	4
Total Beads	12
Total Elements	896
Total Dwell Moves	22
Active Distance (mm)	2201.45
Travel Distance (mm)	390.64
Total Time (s)	2606.10

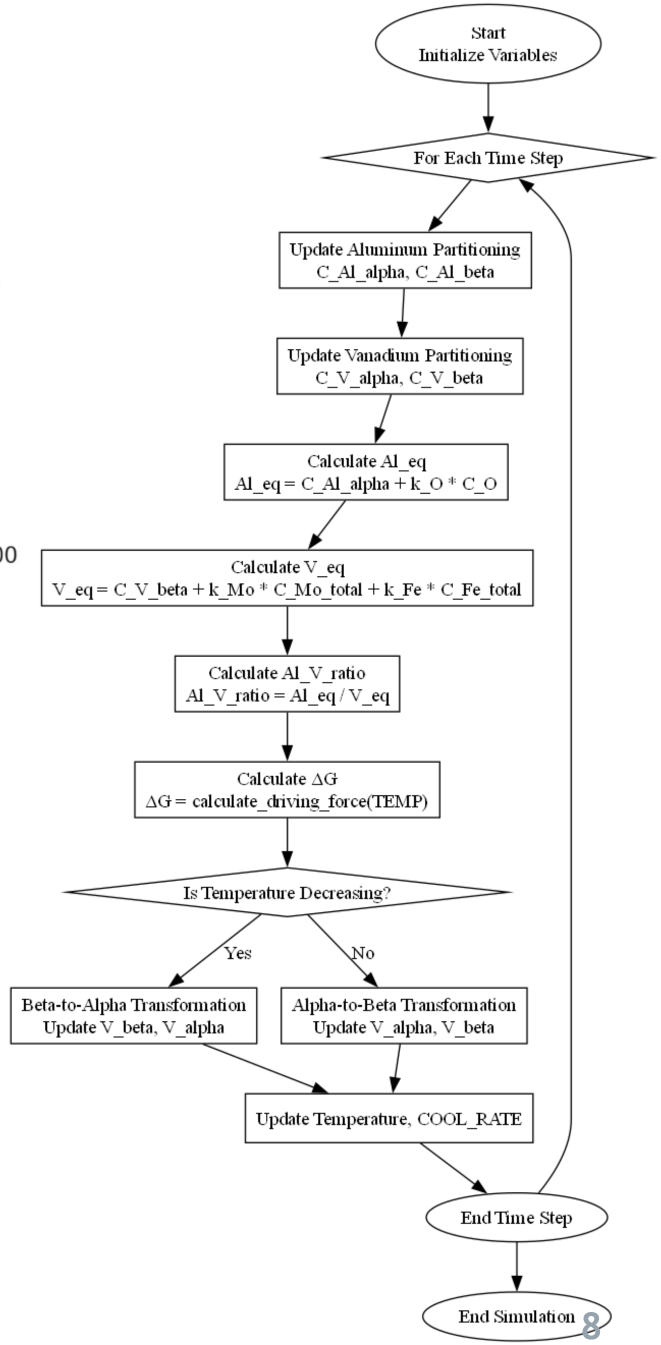
AM Simulations: Metallurgy

$$X_\beta^{eq} = 1 - 0.89e^{-\left(\frac{T^*+1.83}{1.73}\right)^2} - 0.28e^{-\left(\frac{T^*+0.59}{0.67}\right)^2}, \text{ where } T^* = (T - T_{chem})/24$$

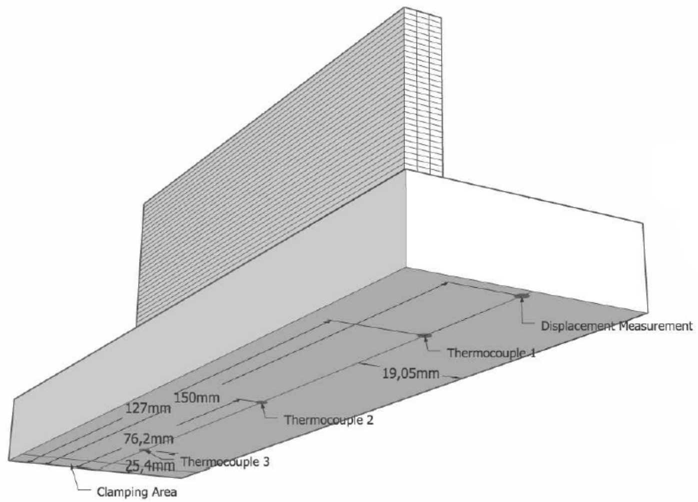
$$M_s(K) = 1156 - 150Fe_{wt\%} - 96Cr_{wt\%} - 49Mo_{wt\%} - 37V_{wt\%} - 17Nb_{wt\%} - 7Zr_{wt\%} + 15Al_{wt\%}$$

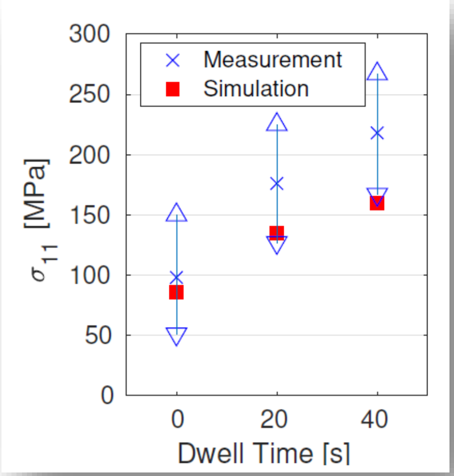


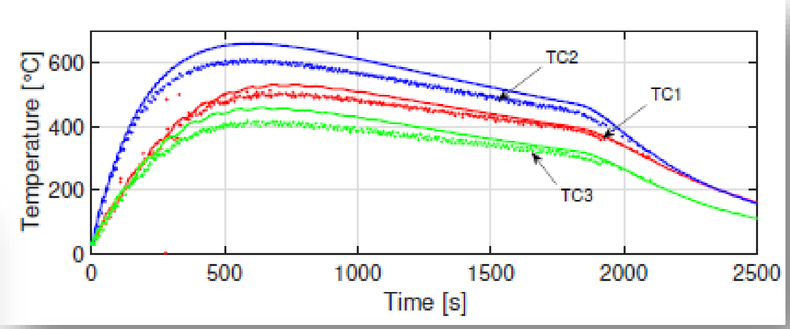


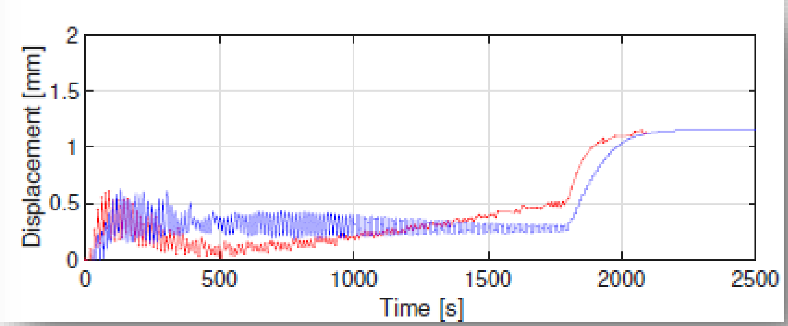


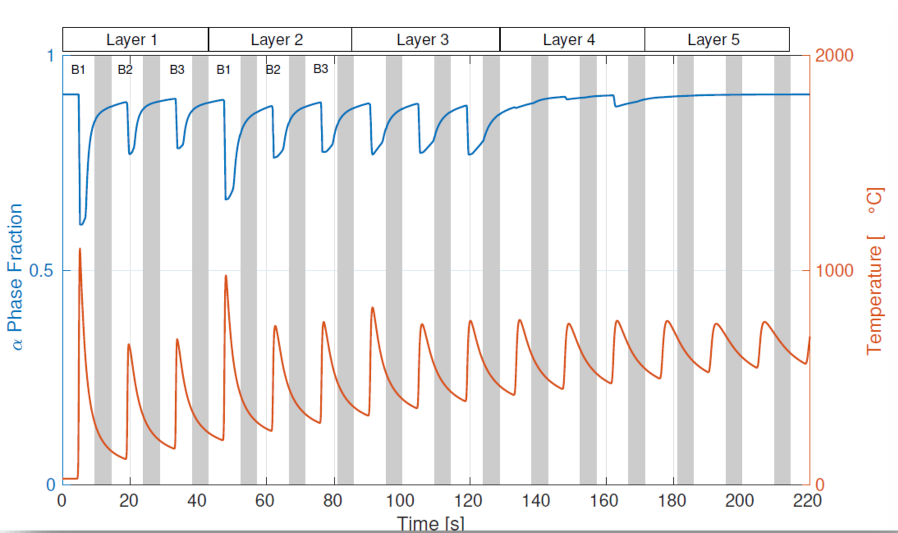
AM Simulations: Mechanical

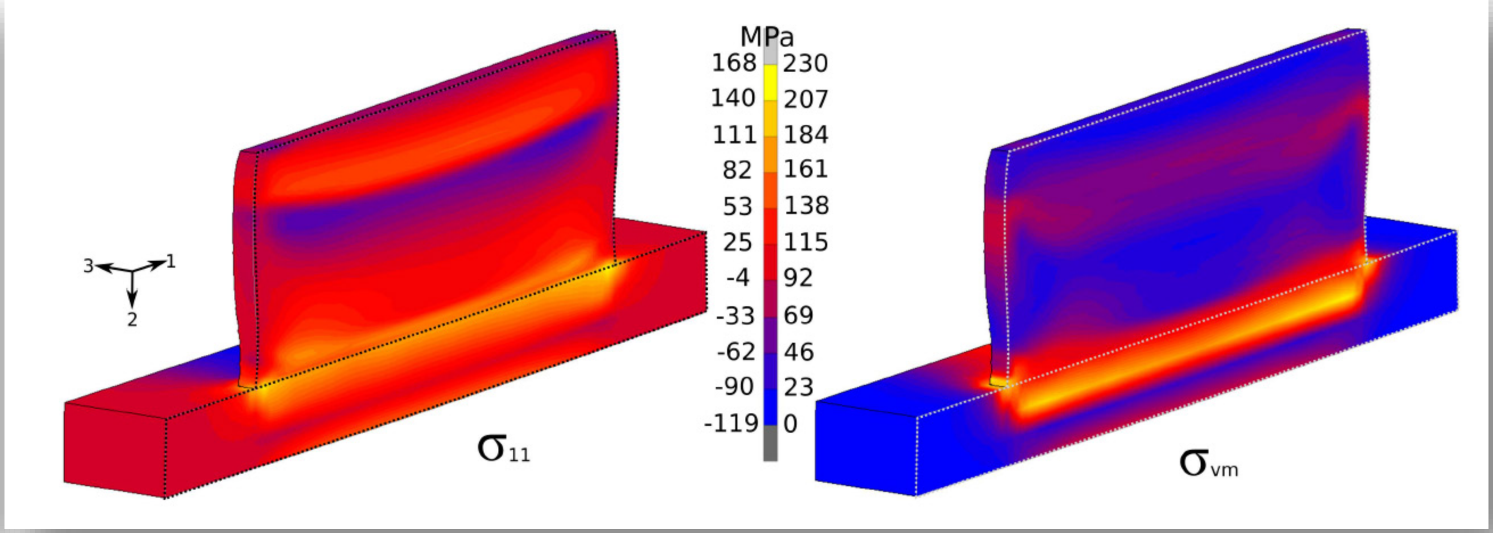




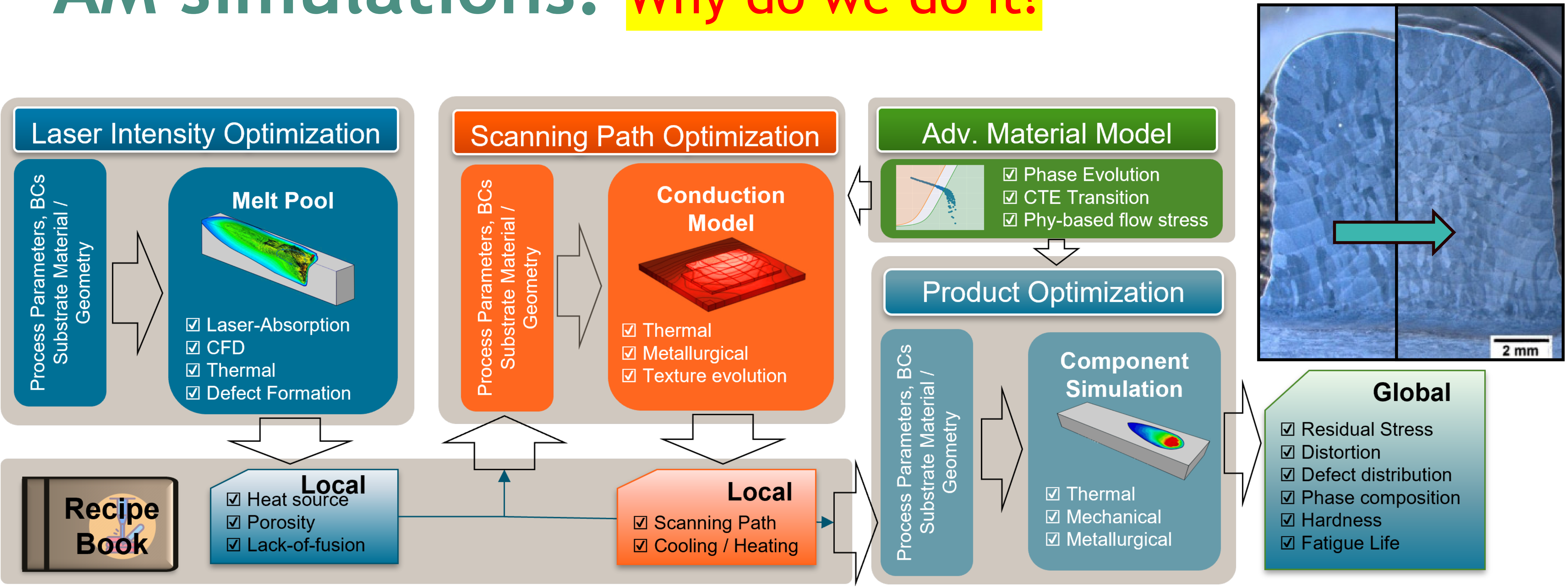






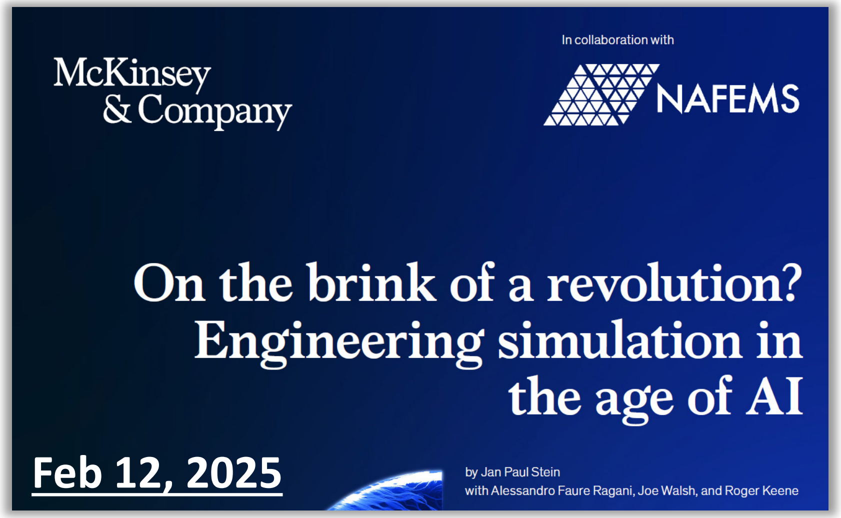


AM simulations: Why do we do it?



- ✓ Tailored microstructure
- ✓ Fewer defects
- ✓ High Productivity

AM simulations: Who is it for?


In collaboration with

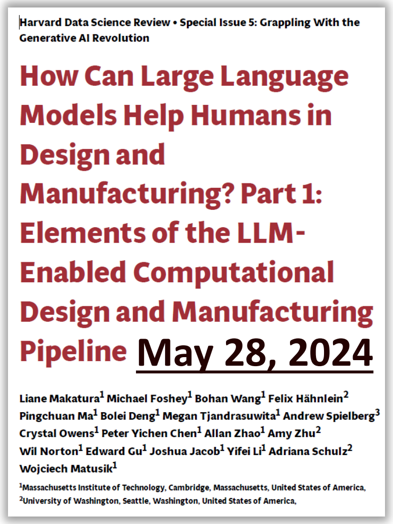
McKinsey & Company

NAFEMS

On the brink of a revolution? Engineering simulation in the age of AI

by Jan Paul Stein
with Alessandro Faure Ragani, Joe Walsh, and Roger Keene

Feb 12, 2025

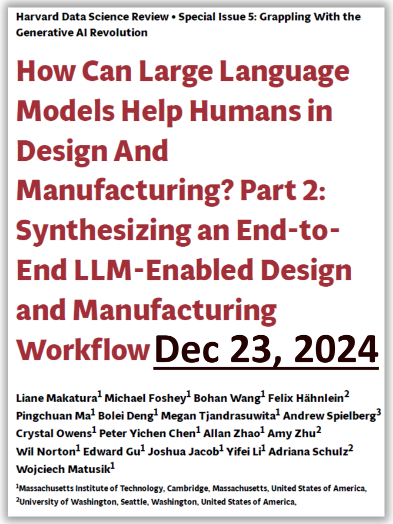

Harvard Data Science Review • Special Issue 5: Grappling With the Generative AI Revolution

How Can Large Language Models Help Humans in Design and Manufacturing? Part 1: Elements of the LLM-Enabled Computational Design and Manufacturing Pipeline

May 28, 2024

Liane Makatura[1] Michael Foshey[1] Bohan Wang[1] Felix Hähnlein[2] Pingchuan Ma[1] Bolei Deng[1] Megan Tjandrasuwita[1] Andrew Spielberg[3] Crystal Owens[1] Peter Yichen Chen[1] Allan Zhao[1] Amy Zhu[2] Wil Norton[1] Edward Gu[1] Joshua Jacob[1] Yifei Li[1] Adriana Schulz[2] Wojciech Matusik[1]

[1]Massachusetts Institute of Technology, Cambridge, Massachusetts, United States of America, [2]University of Washington, Seattle, Washington, United States of America,


Harvard Data Science Review • Special Issue 5: Grappling With the Generative AI Revolution

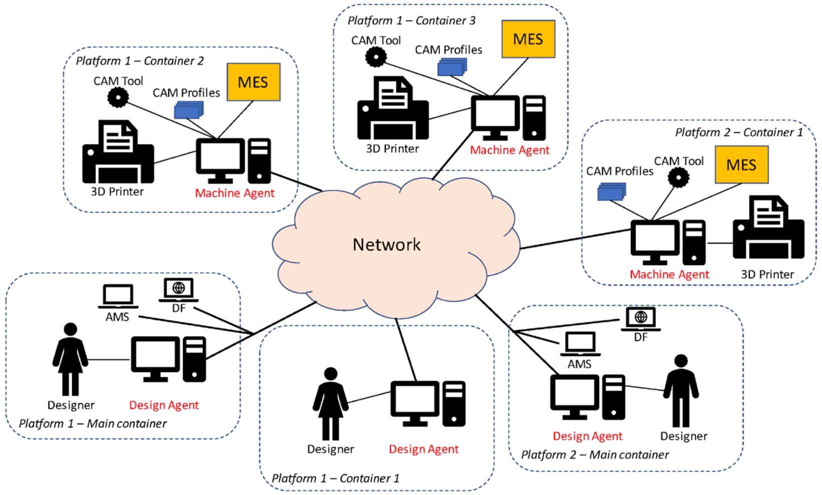
How Can Large Language Models Help Humans in Design And Manufacturing? Part 2: Synthesizing an End-to-End LLM-Enabled Design and Manufacturing Workflow

Dec 23, 2024

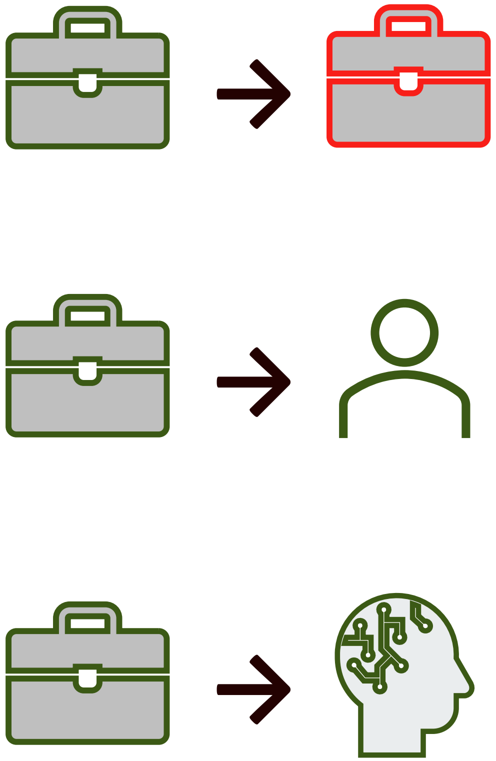
Liane Makatura[1] Michael Foshey[1] Bohan Wang[1] Felix Hähnlein[2] Pingchuan Ma[1] Bolei Deng[1] Megan Tjandrasuwita[1] Andrew Spielberg[3] Crystal Owens[1] Peter Yichen Chen[1] Allan Zhao[1] Amy Zhu[2] Wil Norton[1] Edward Gu[1] Joshua Jacob[1] Yifei Li[1] Adriana Schulz[2] Wojciech Matusik[1]

[1]Massachusetts Institute of Technology, Cambridge, Massachusetts, United States of America, [2]University of Washington, Seattle, Washington, United States of America,

An Agent-Based Platform for AM



https://doi.org/10.3390/app10144953



aerobase

AM simulations: VMAP Standards

- Standardized Data Exchange
  - Seamless data exchange between simulation software using the VMAP format, allowing consistent and compatible export/import of material properties, boundary conditions, load cases, and results.
- Interoperability with Multiphysics Software
  - In Multiphysics workflows (e.g., structural, thermal, fluid simulations), interoperability with other software like CFD tools is essential. Communication with simulation environments using VMAP enables streamlined multi-physics simulations.
- Material Property Transfer
  - Simulation workflows often require transferring complex material models with various properties. The VMAP wrapper would standardize the data structure for seamless transfer between software.
- Efficient Data Management
  - Facilitate data organization for easier storage, retrieval, and management in cloud or local environments. This is especially true for large-scale simulations or iterative design processes.

AM simulations: VMAP Standards

- User-friendly interface for Engineers
  - A VMAP wrapper with an intuitive interface would facilitate quick integration into their workflow, reducing the learning curve and minimizing data transfer errors.
- Data Structuring and Labeling
  - The VMAP wrapper should organize and label simulation data to meet ML model requirements by tagging variables (e.g., material properties, load conditions, results) and providing metadata. This structure allows ML algorithms to process data effectively without manual reformatting.
- Bidirectional Data Flow
  - A robust VMAP wrapper should export simulation data to ML models and allow feedback from ML predictions back into the simulation. This creates iterative learning, where ML optimizes parameters and configurations in future runs.

aerobase


https://aerobase.se