DALL'OTTIMIZZAZIONE DI FORMA AL "MATERIAL ENGINEERING"

Le tecnologie di prototipazione virtuale per definire una metodologia di progettazione a supporto dell'addictive manufacturing.

Claudio Bruzzo - Technical Manager

Torino – 10 Marzo 2016

PROGETTIAMO ADDITIVO!

ASPETTI DI PRODOTTO, PROCESSO E GESTIONE PER LE TECNOLOGIE ADDITIVE

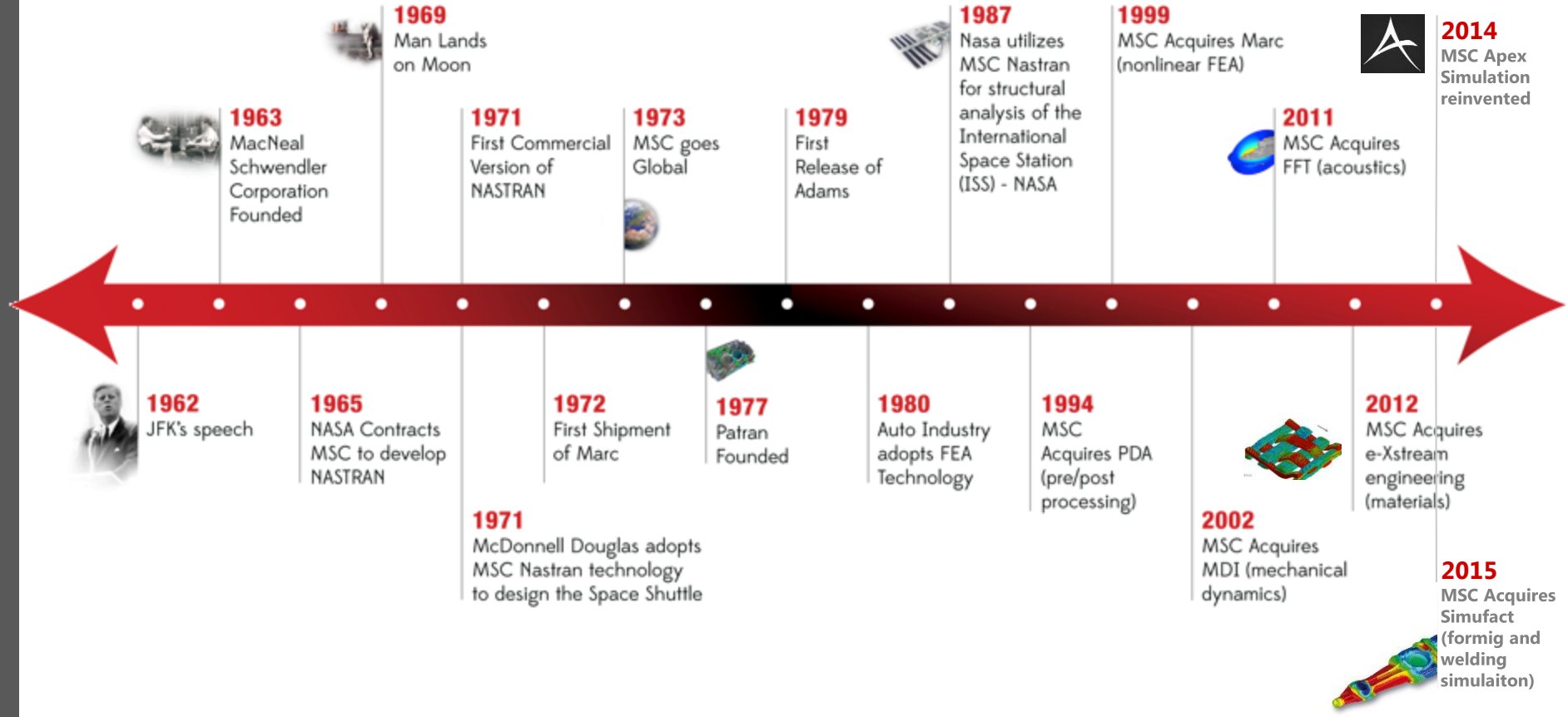
AITA
ASSOCIAZIONE ITALIANA TECNOLOGIE ADDITIVE

MSC Software®
Simulating Reality, Delivering Certainty™

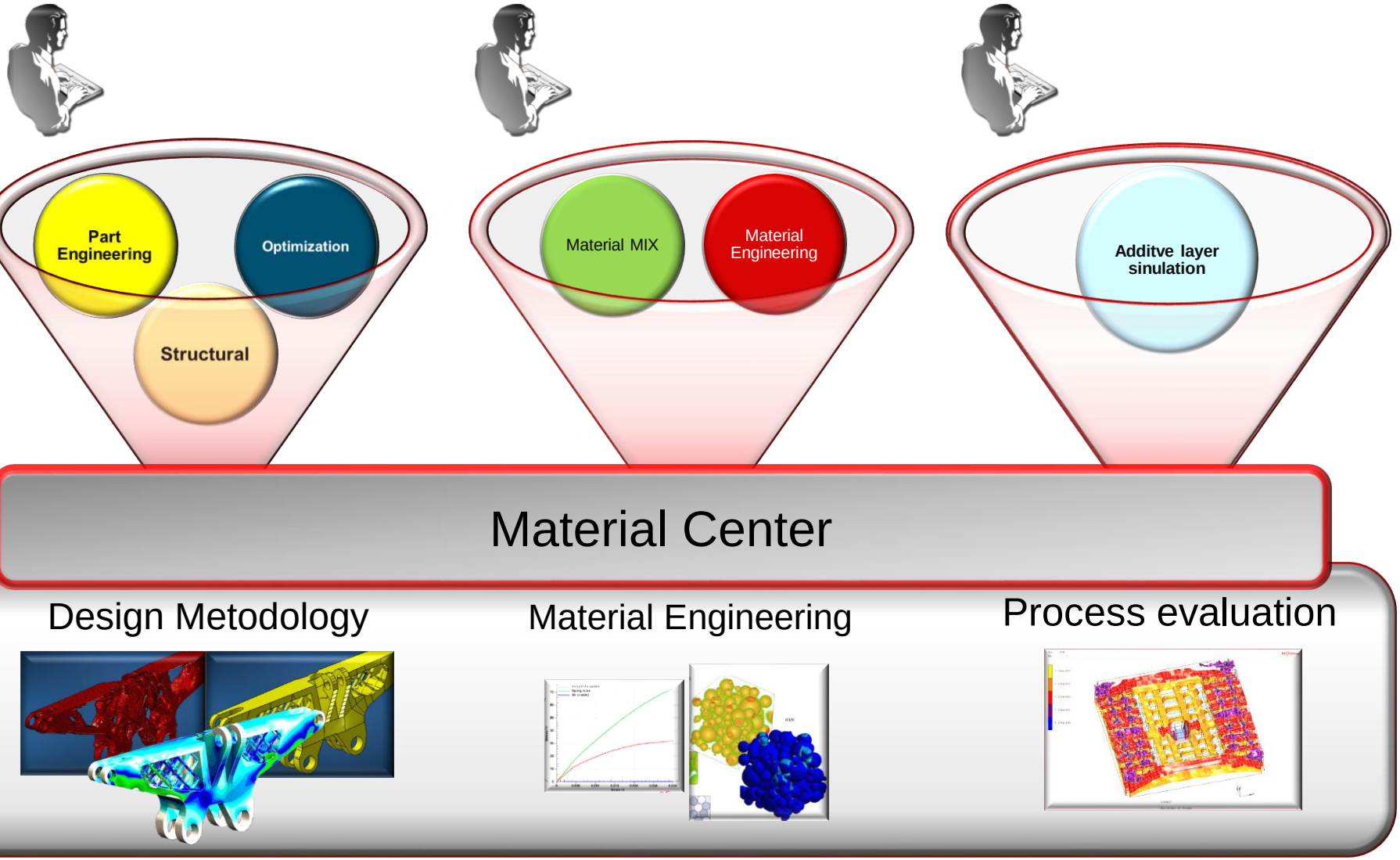
- **~1,200 Employees**
- **20** Countries
- R&D in **6** countries

MSC Software

Experience in Simulation for over 50 years



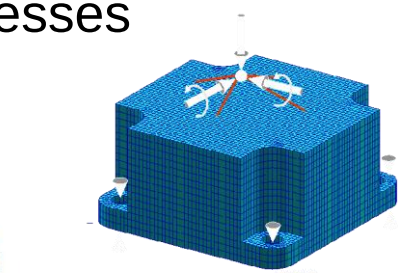
Additive Manufacturing Engineering

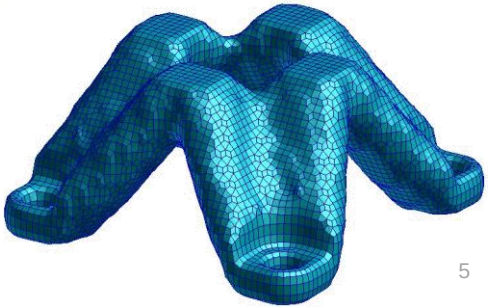


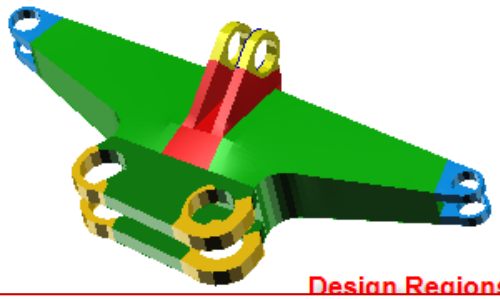
MSC Software

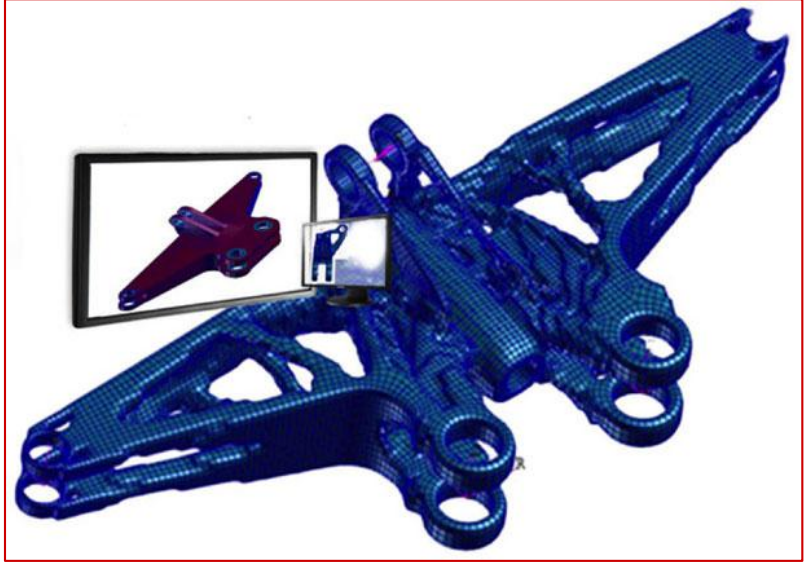
Additive manufacturing: Shape and Size Optimization

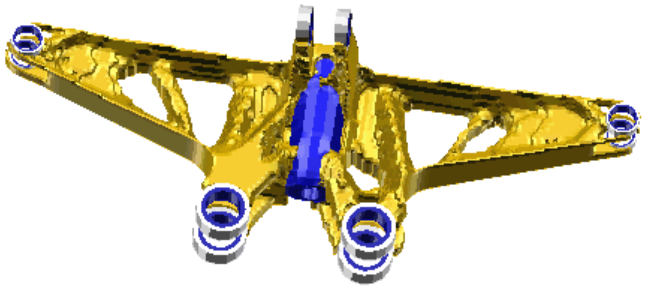
- **Benefits**
  - Used in early design to obtain component designs and shapes
  - Used to redesign existing components
  - Manufacturing & symmetry constraints
  - Evaluate the supports needed in ALM processes



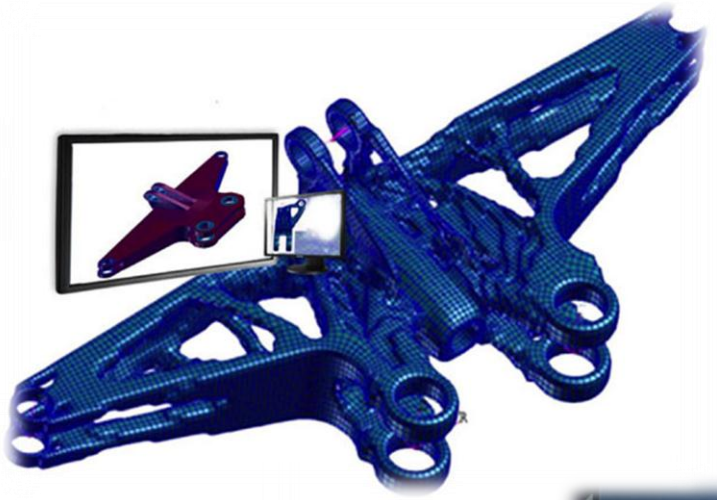


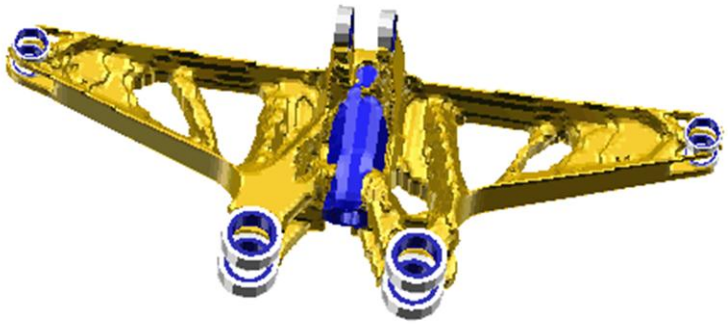


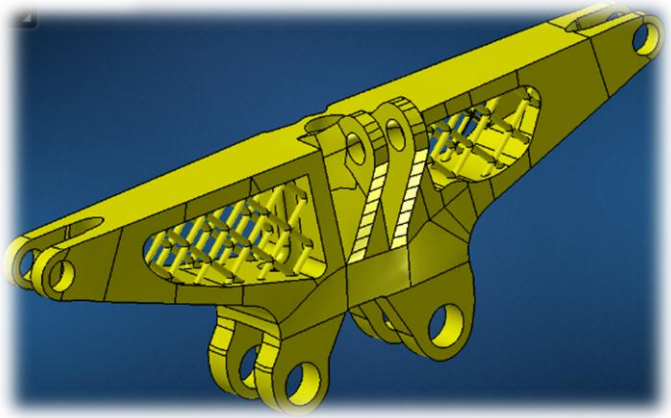




Additive manufacturing: Shape and Size Optimization





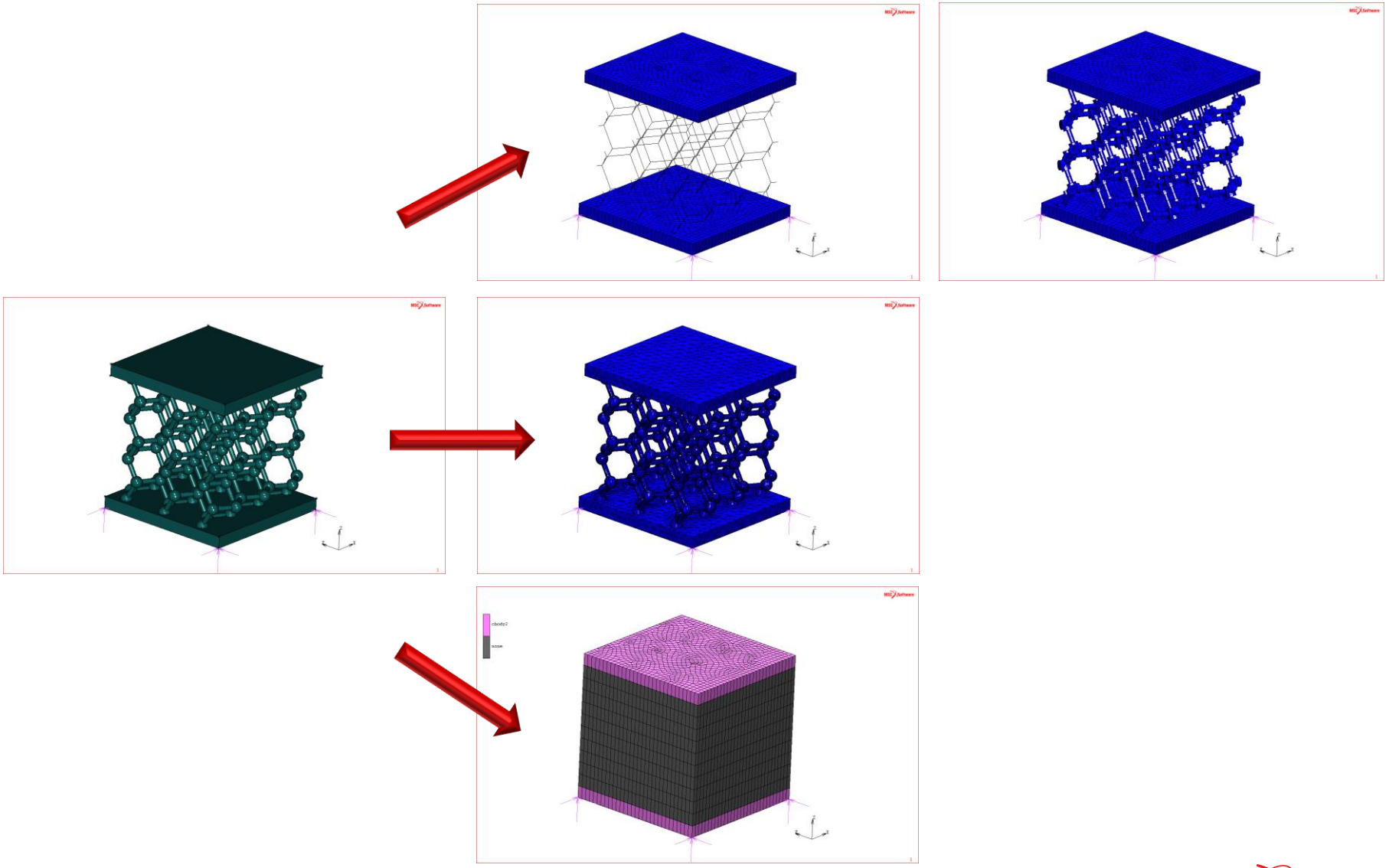


Additive optimization

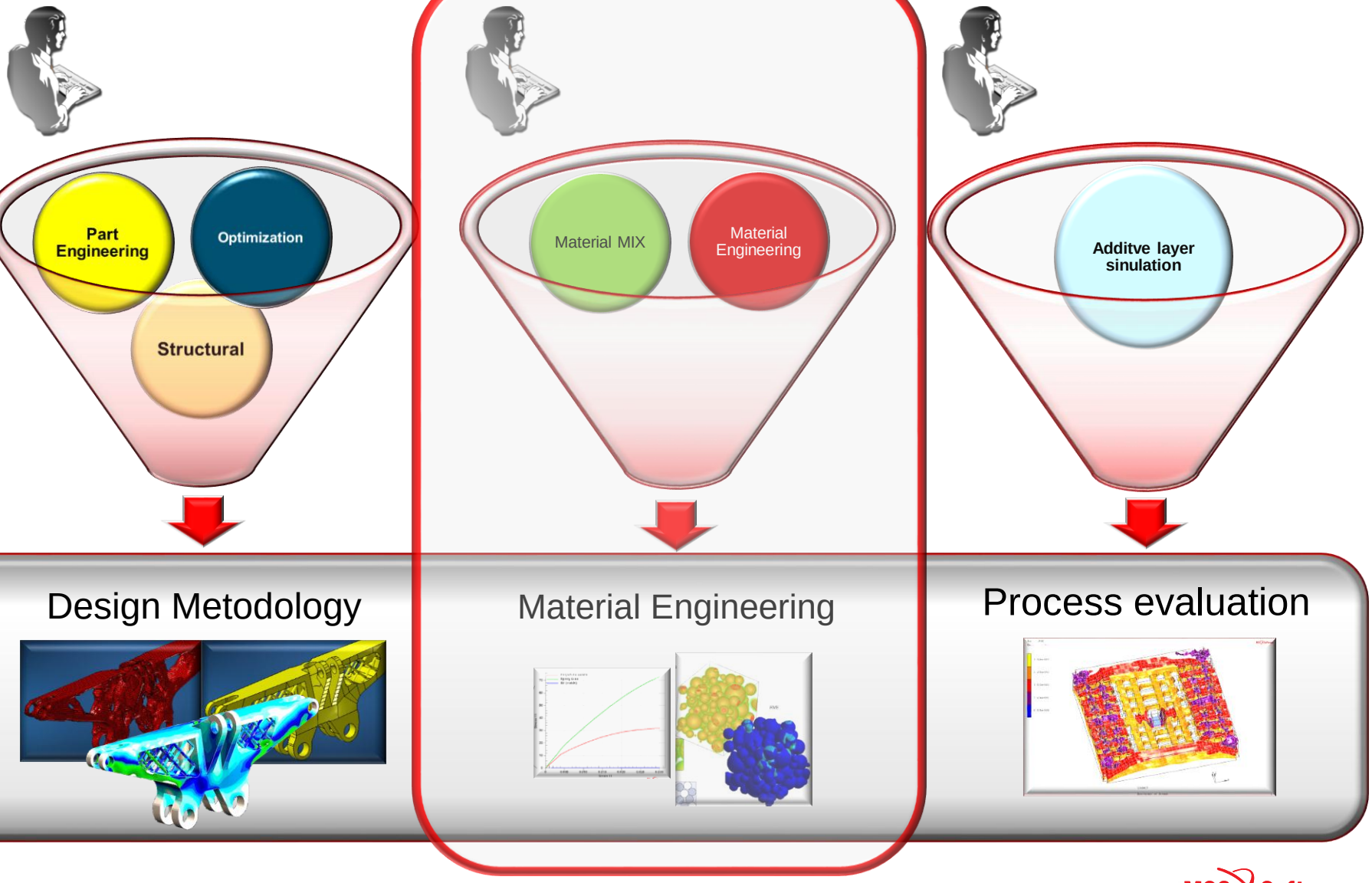
Additive Manufacturing enhanced

Additive manufacturing: Part engineering

Model approaches for Lattice structures



Additive Manufacturing Engineering



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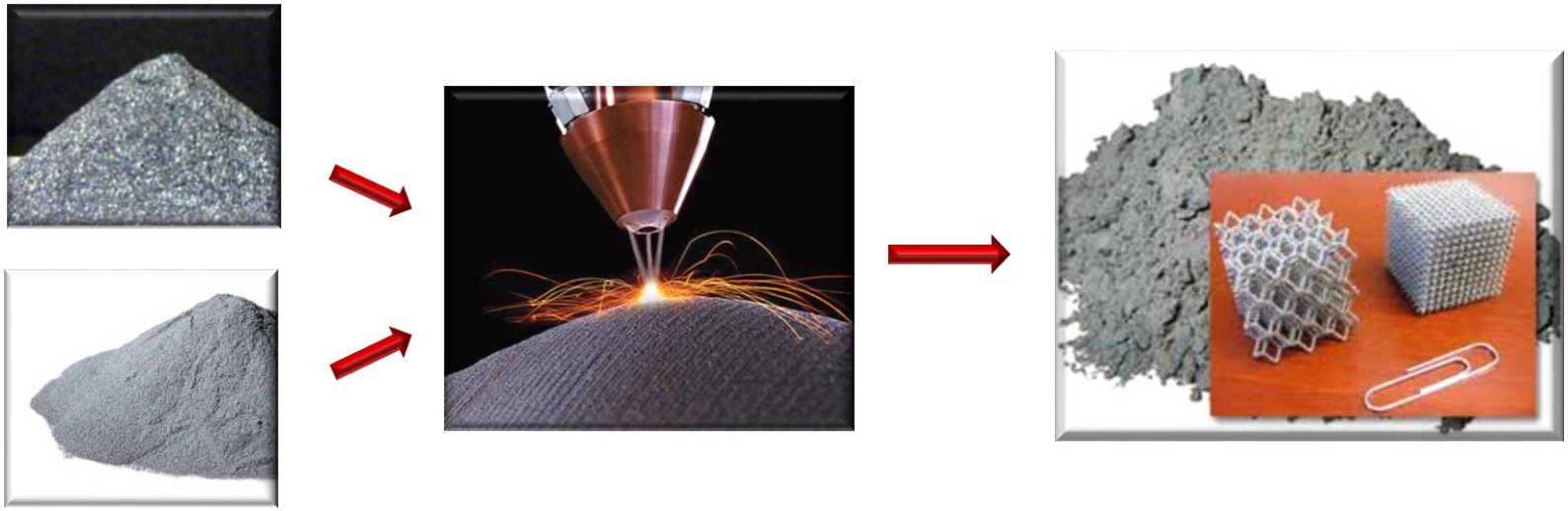
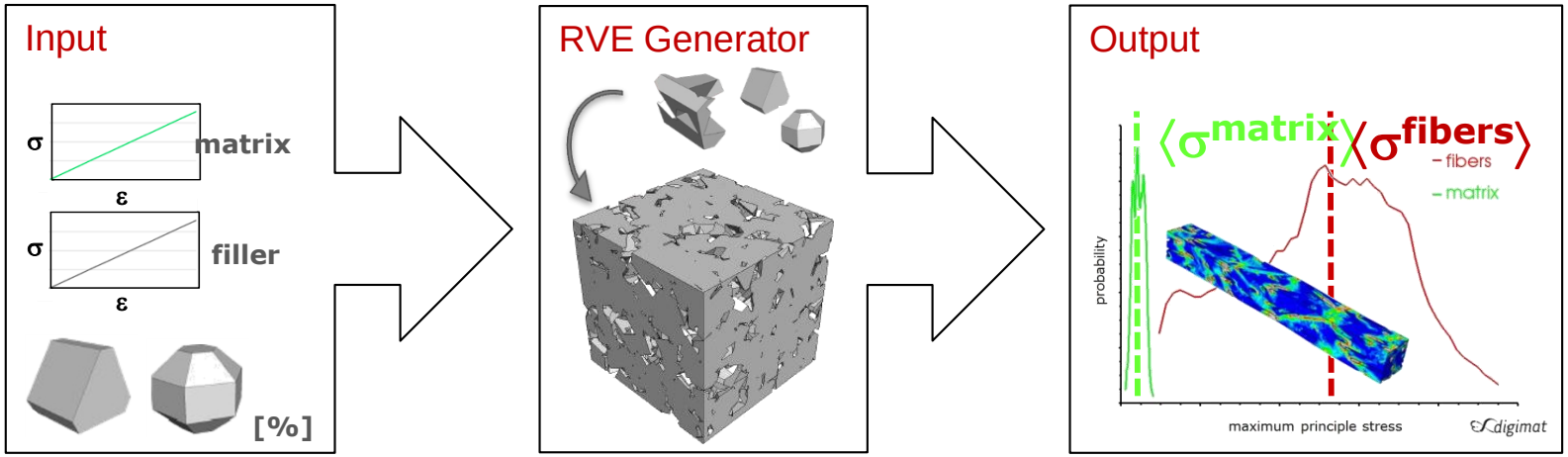
Additive manufacturing: Material engineering



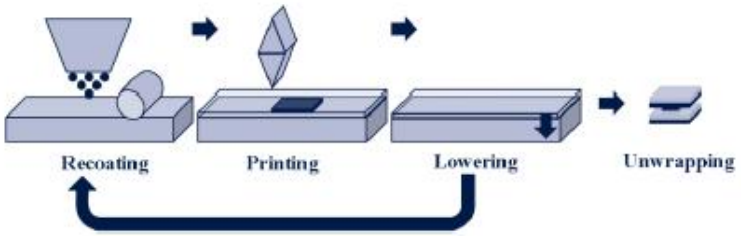


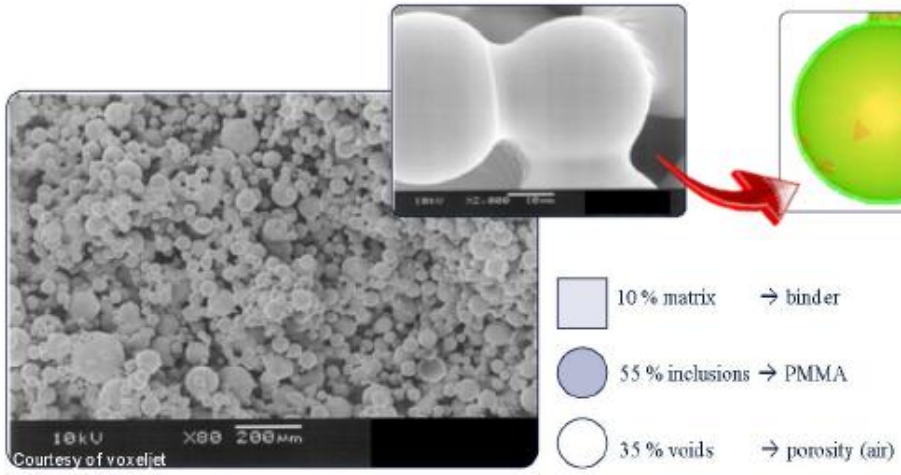
Homogenization to perform Finite Element modeling of realistic Representative Volume Elements (RVE)

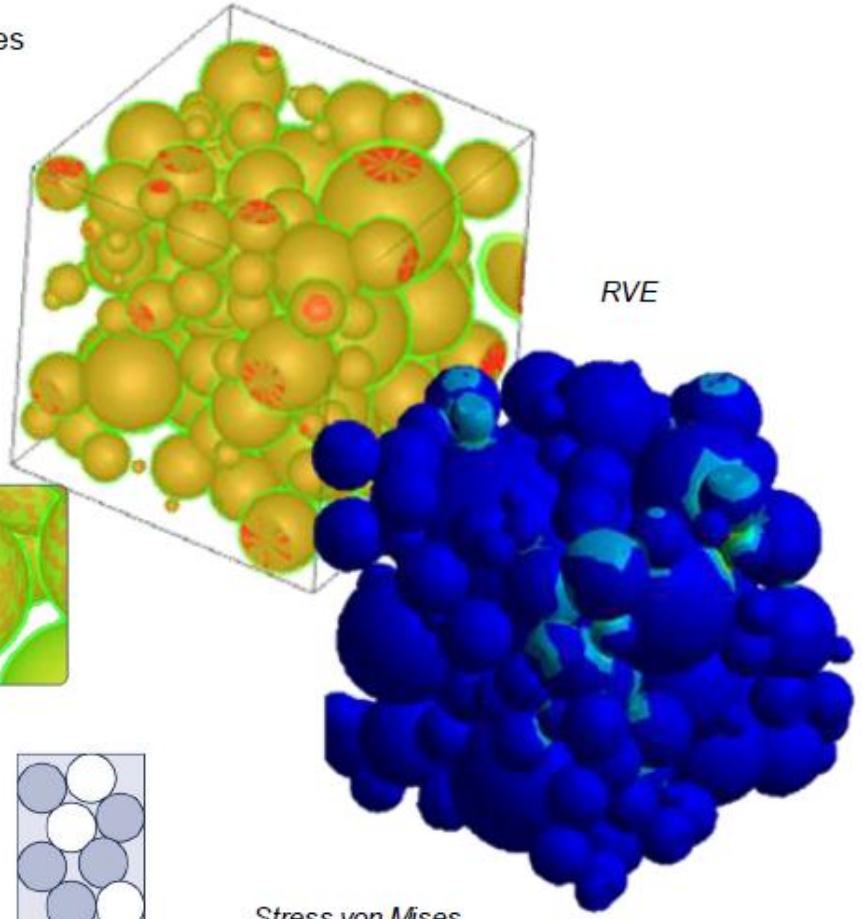
Glued Particles

Mechanical Analysis – 3D

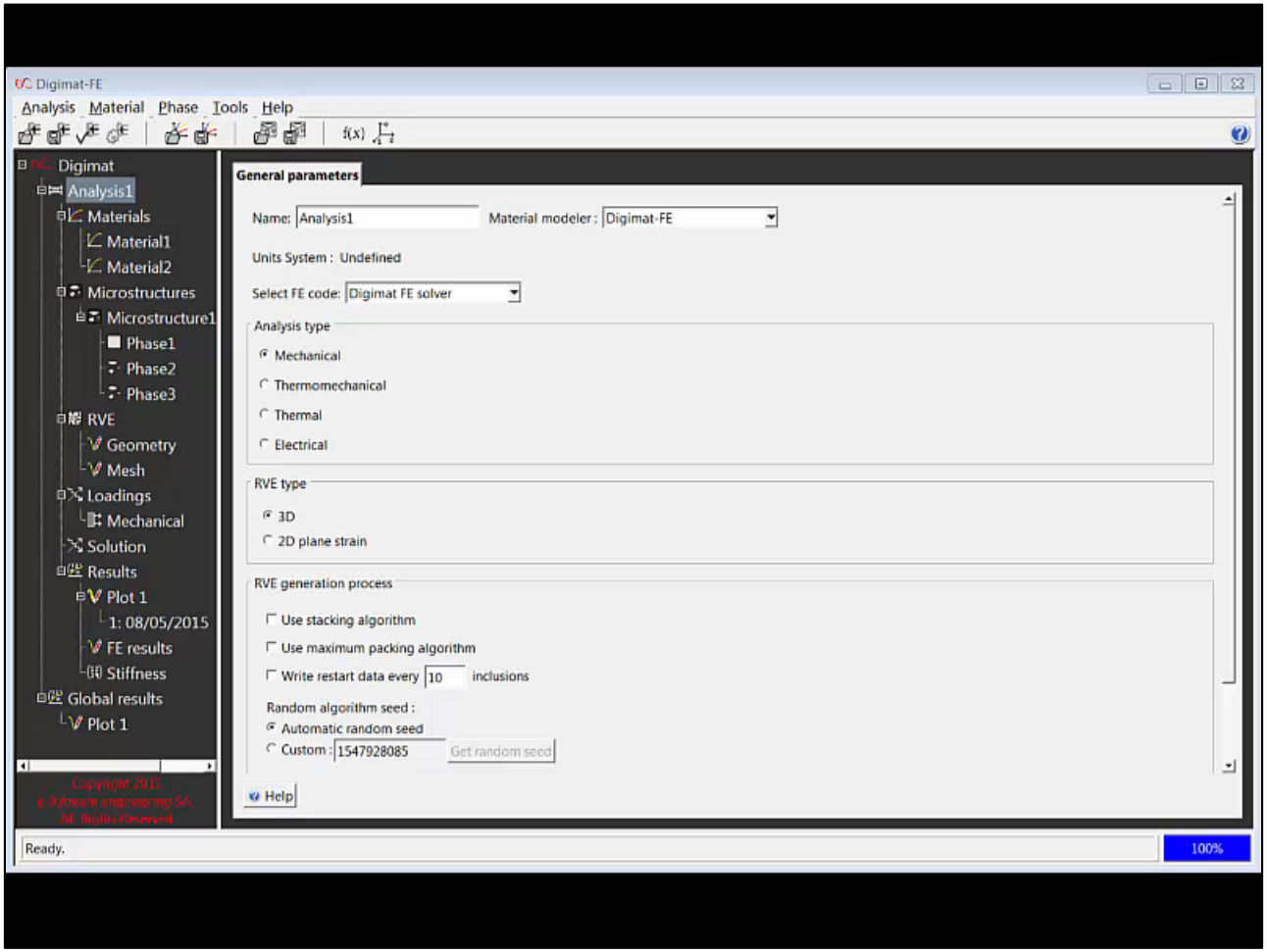
- **3D printing application from 2009**
  - Digimat 4.1.2 / Ansys WB manual procedures
  - About 6 months of effort for 1 RVE



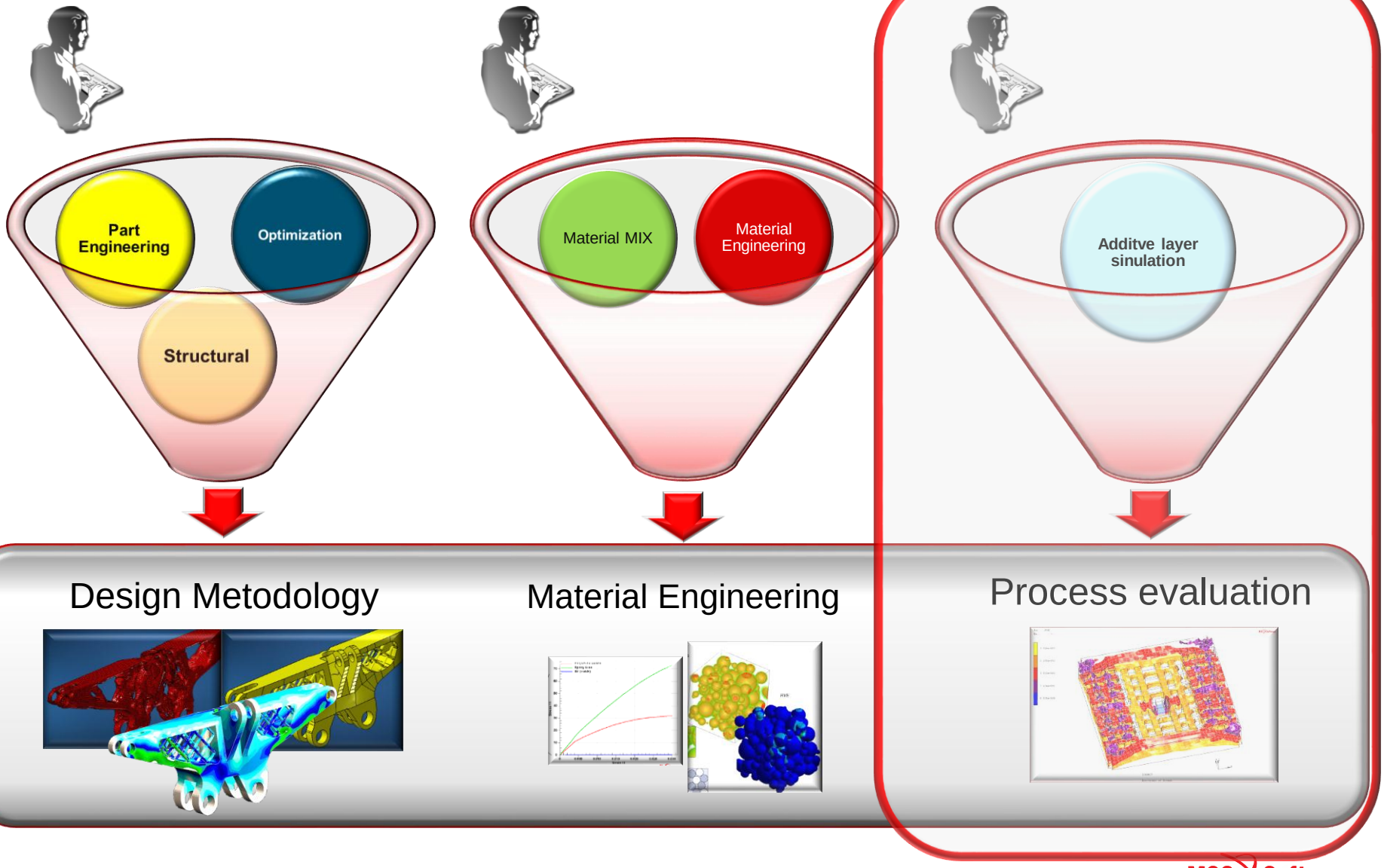




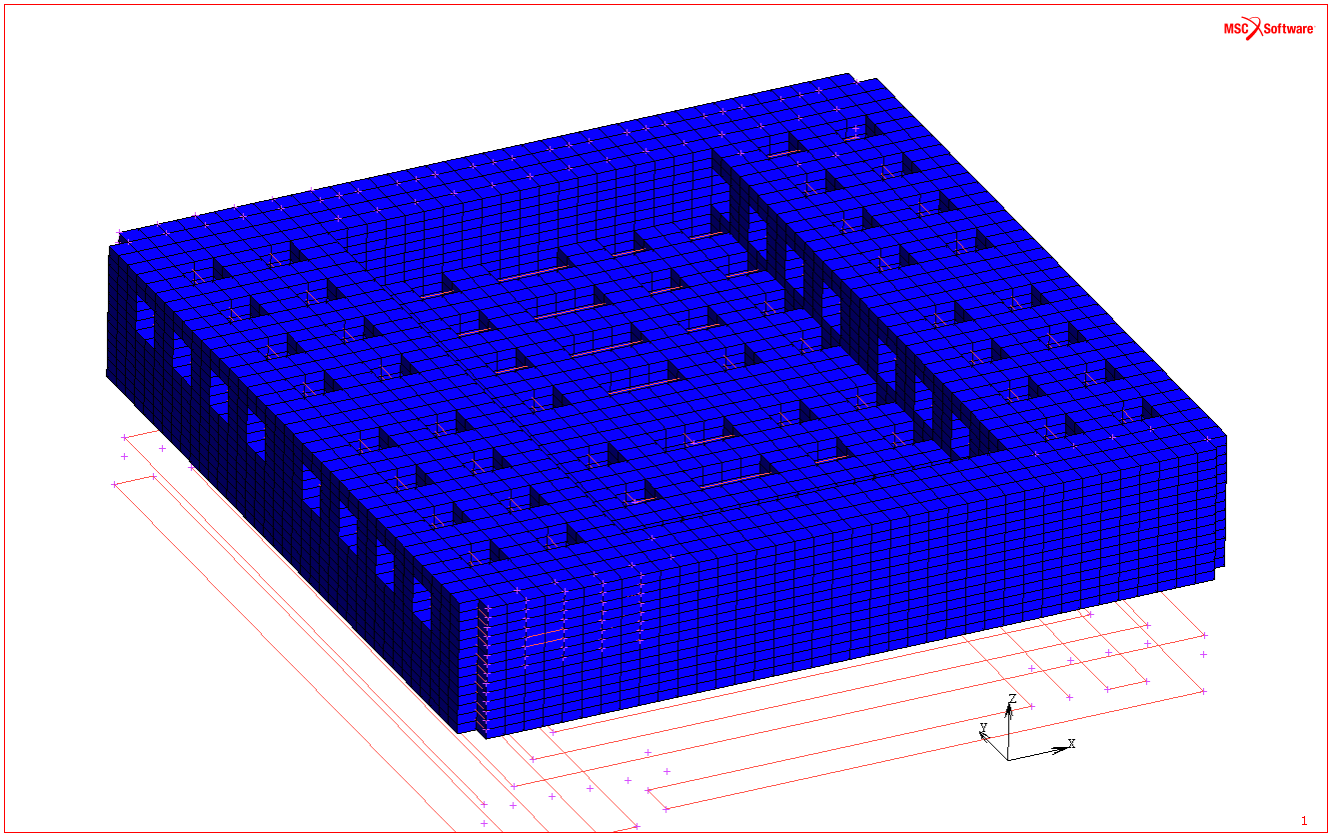
Material engineering



Additive Manufacturing Engineering

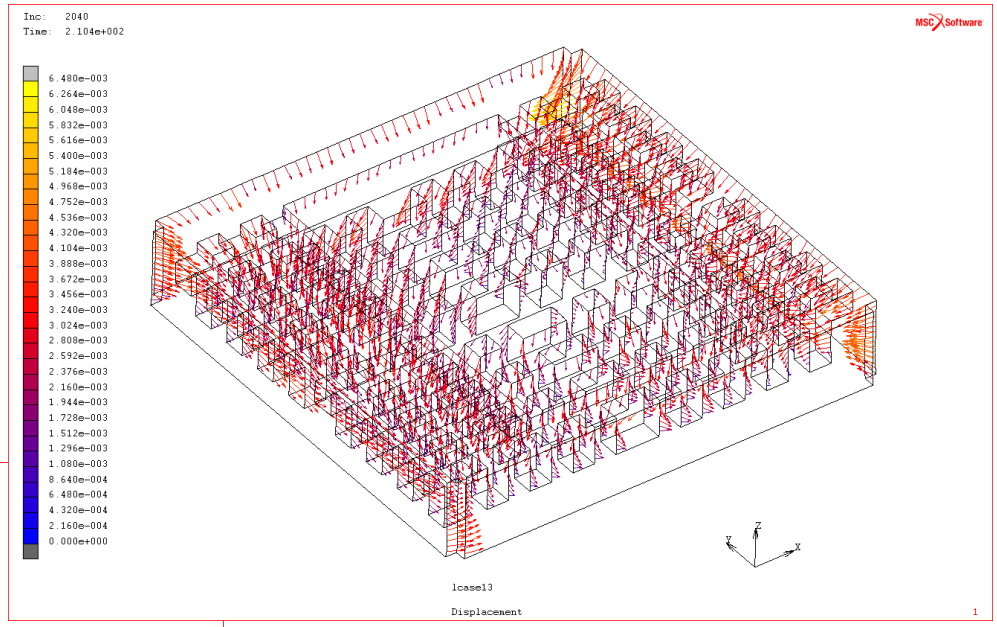


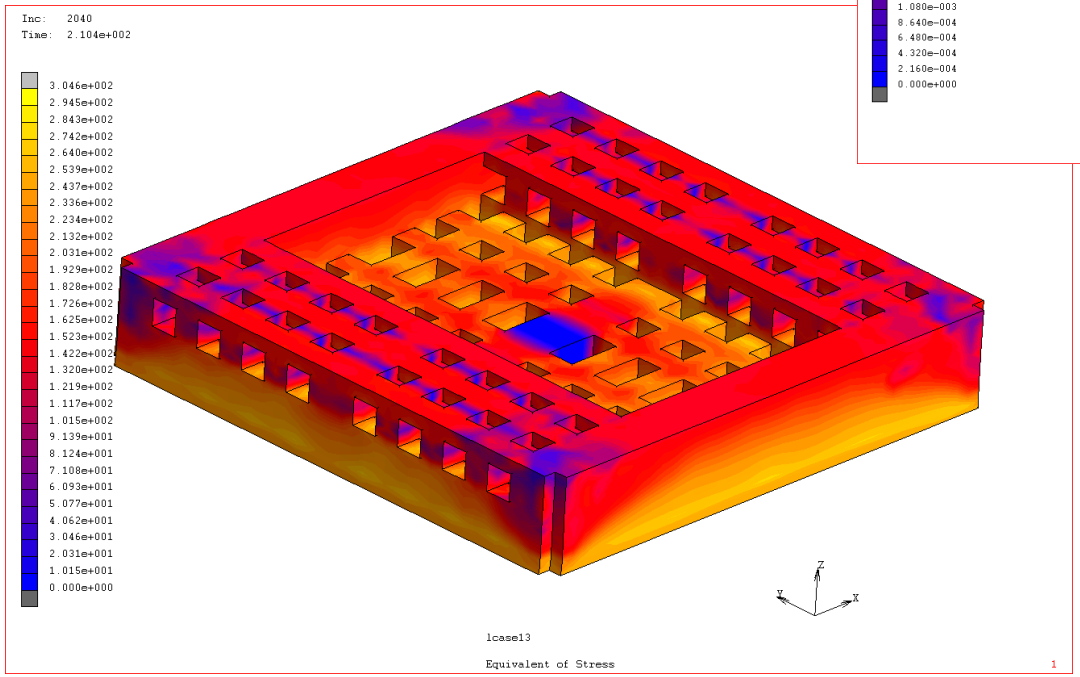
Additive Layer Simulation



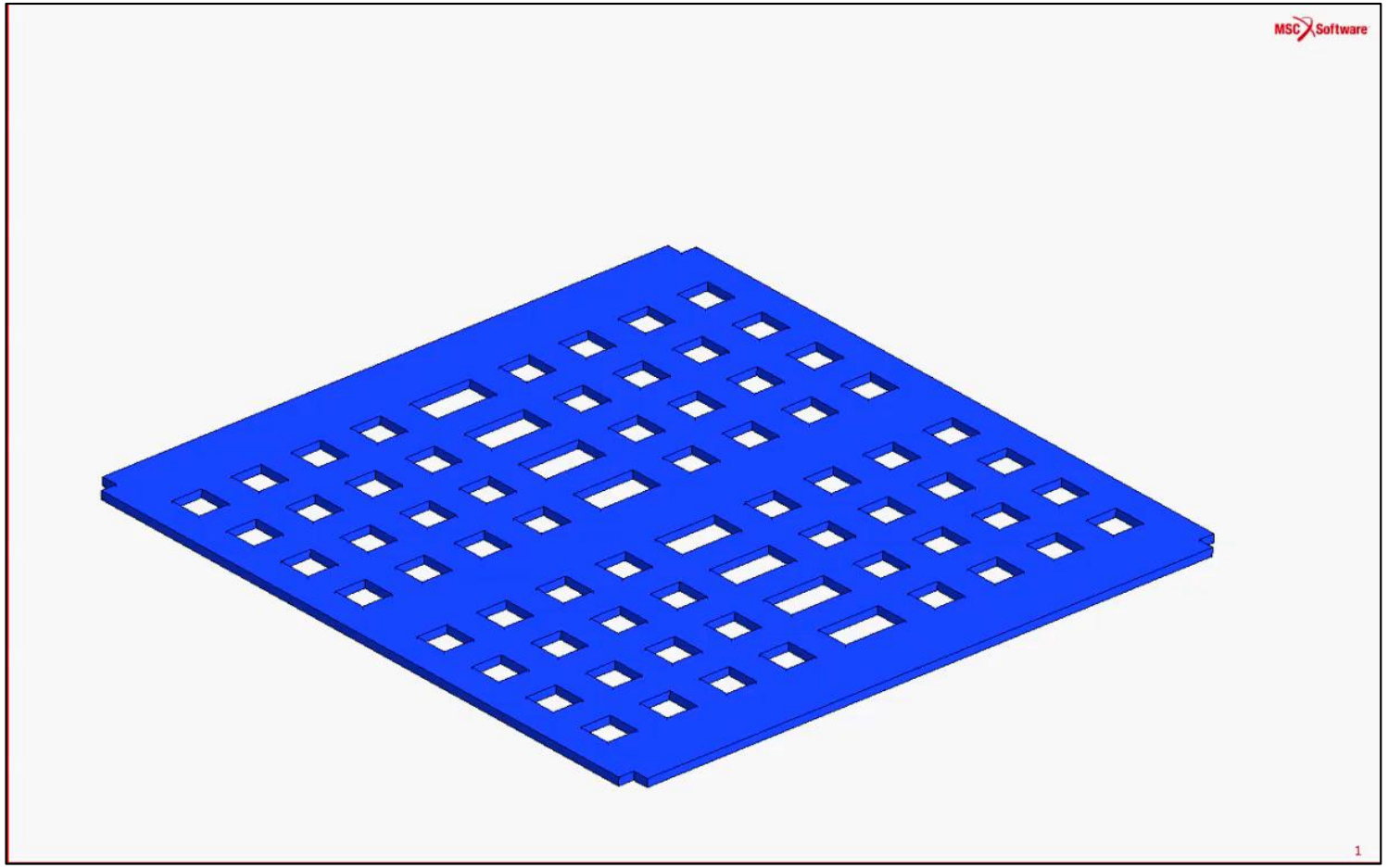
Full model

Additive Layer Simulation



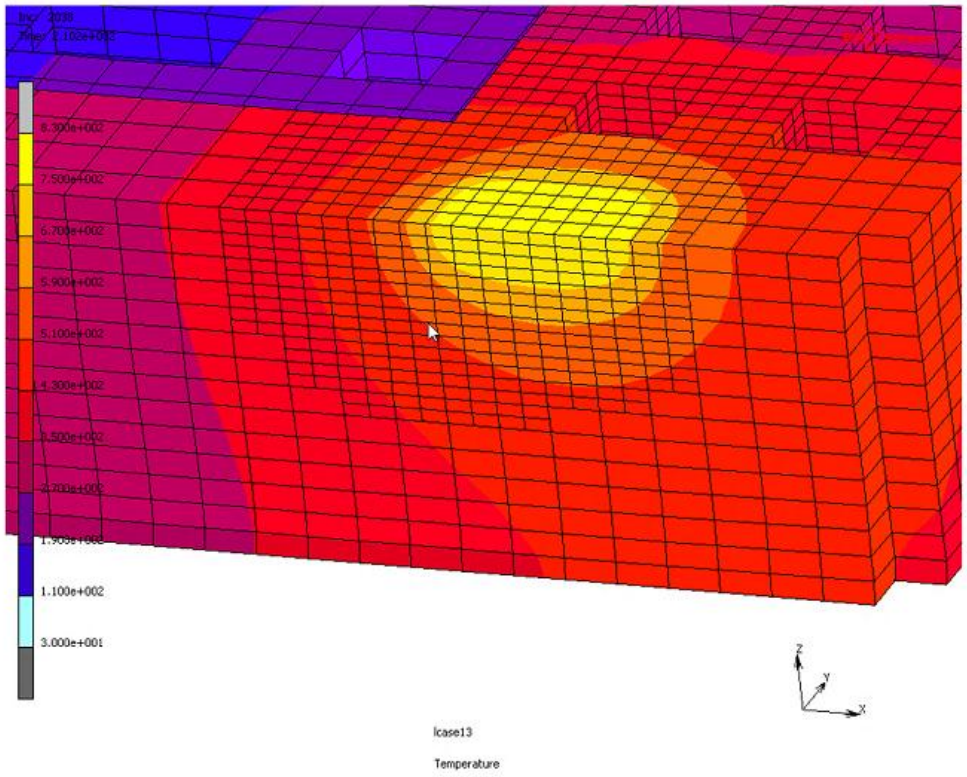


Additive Process Simulation



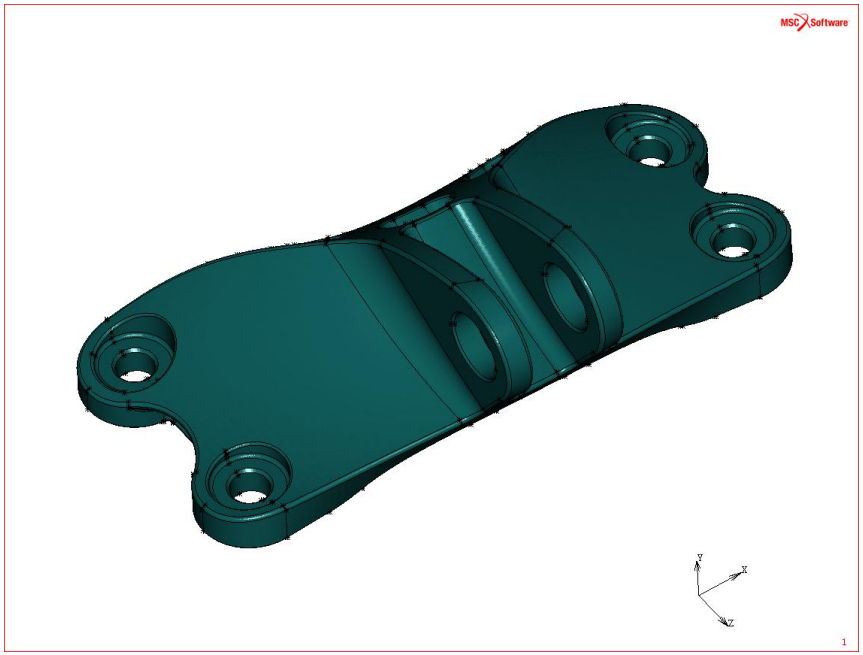
Additive Process Simulation

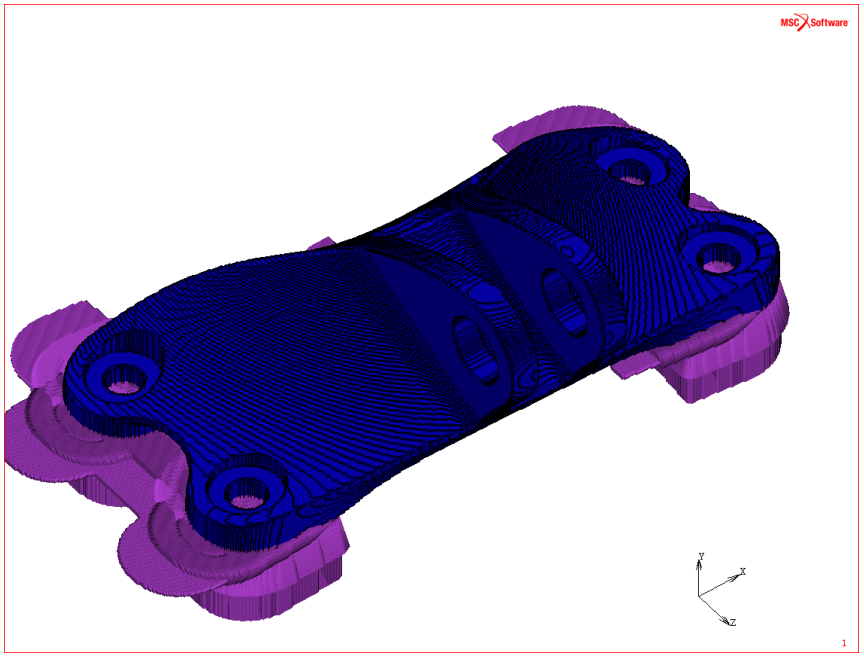
Level 1 – Adaptive Meshing – Temperature Profile

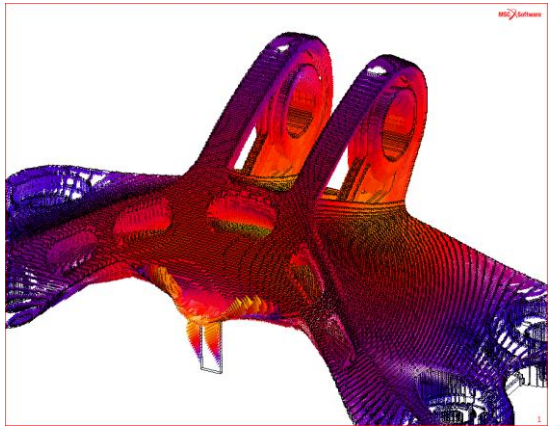


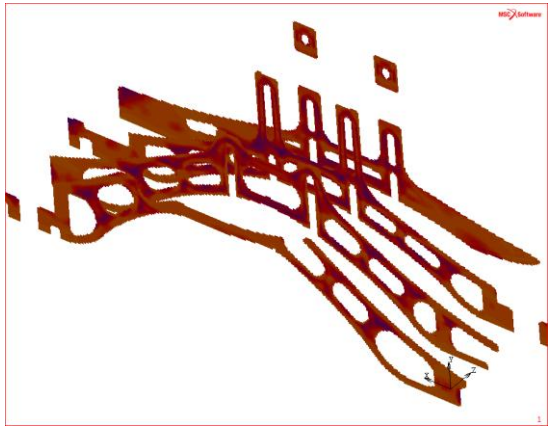
One can observe that the reasonably high gradient that triggered adaptive meshing for 8 levels of elements – in-plane gradient due to motion is larger!

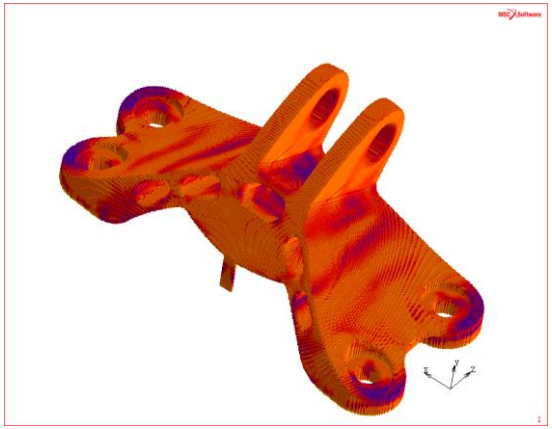
Additive Process Simulation – layer growth



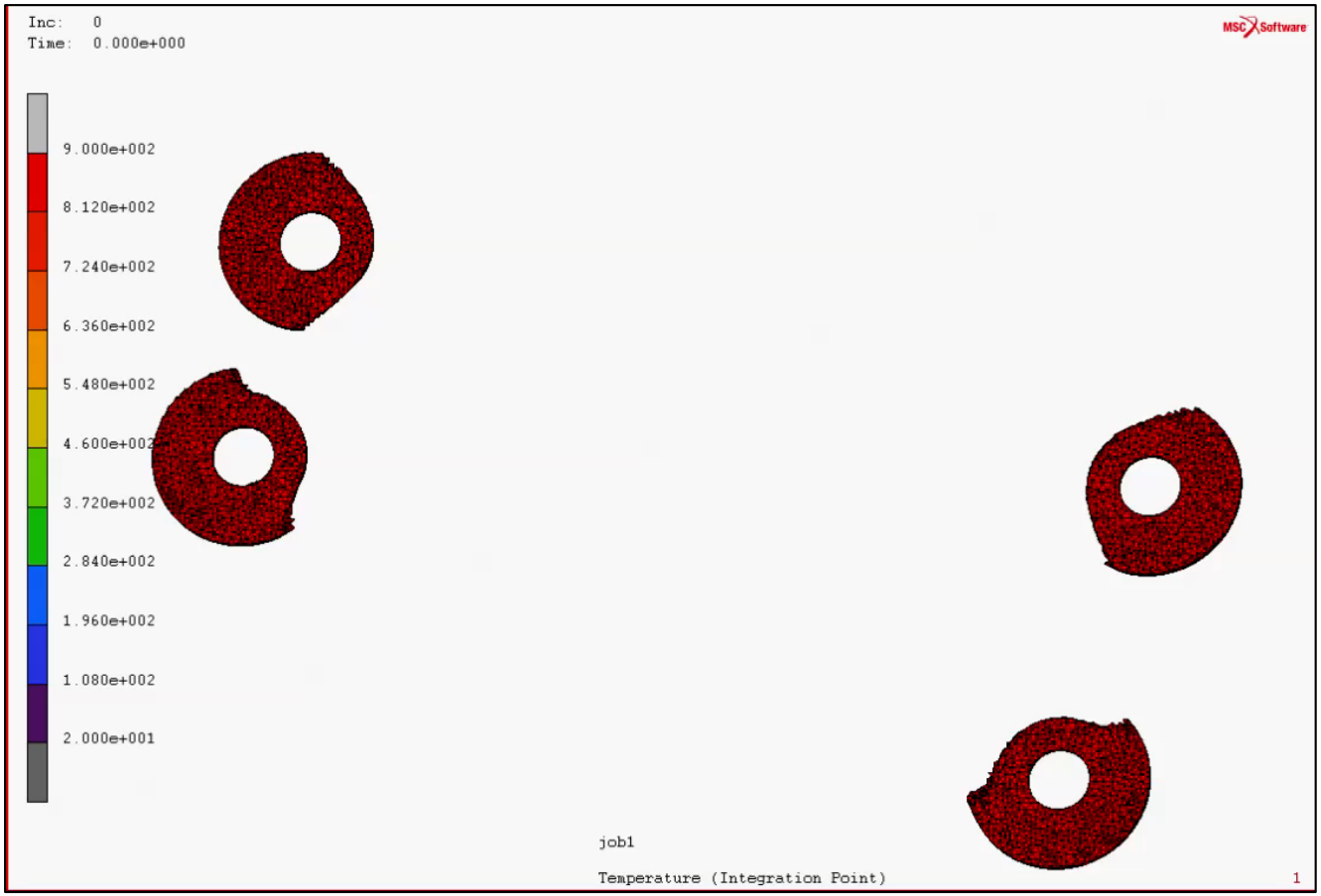




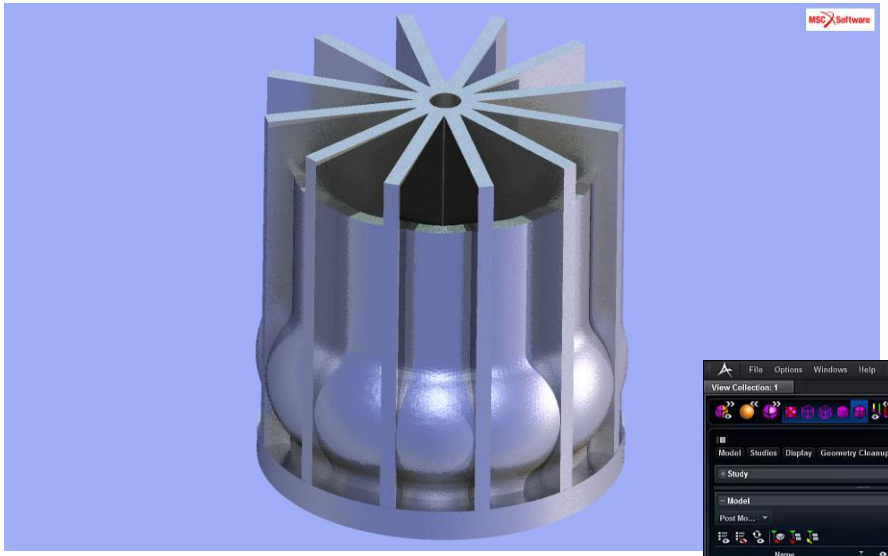


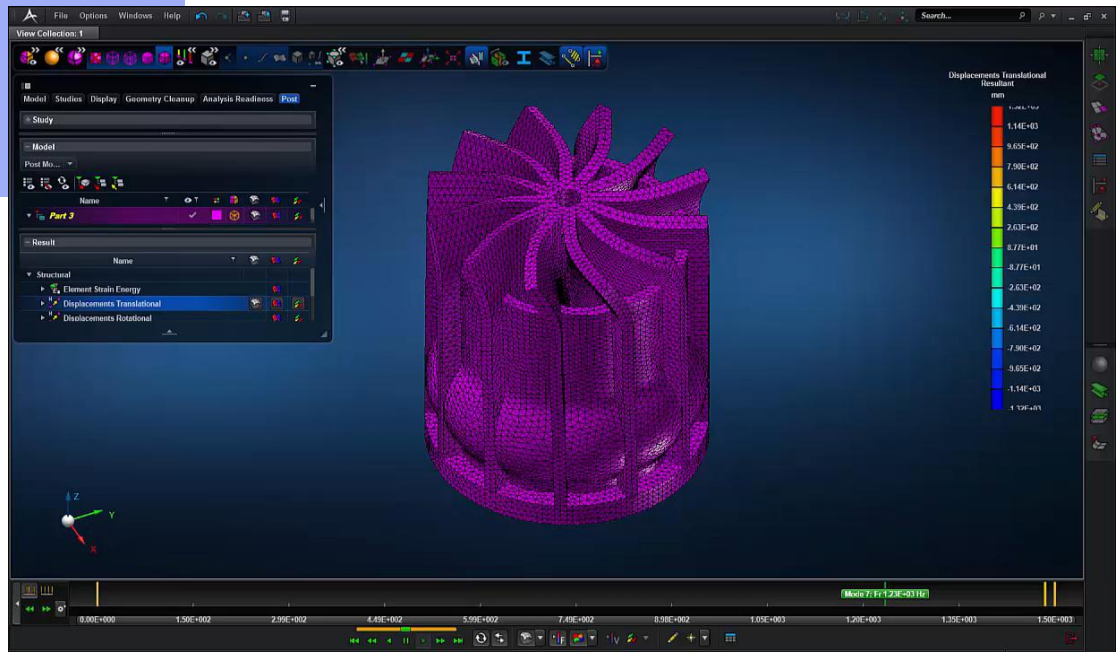


Additive Process Simulation – layer growth

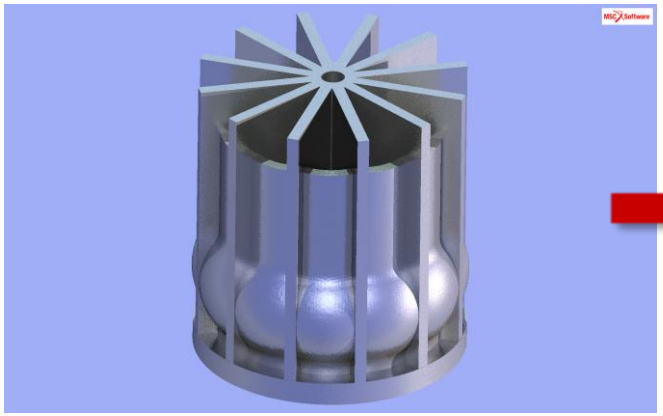


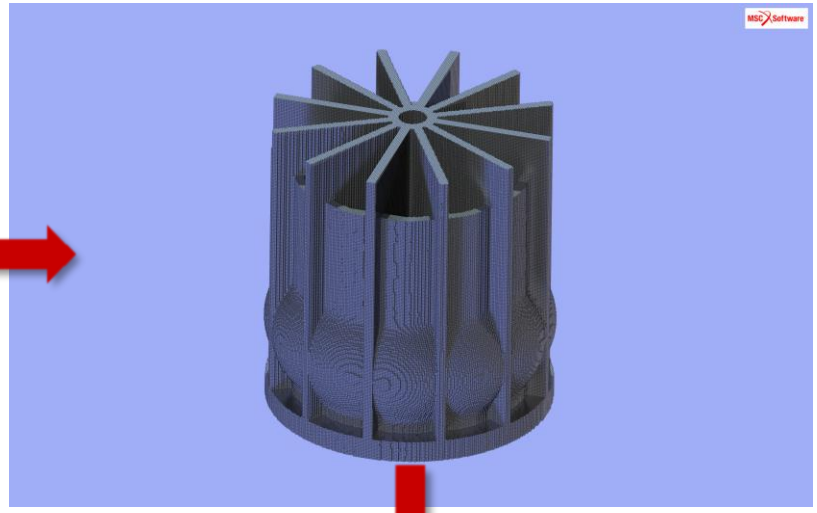
Additive Process Simulation – layer growth Metal example

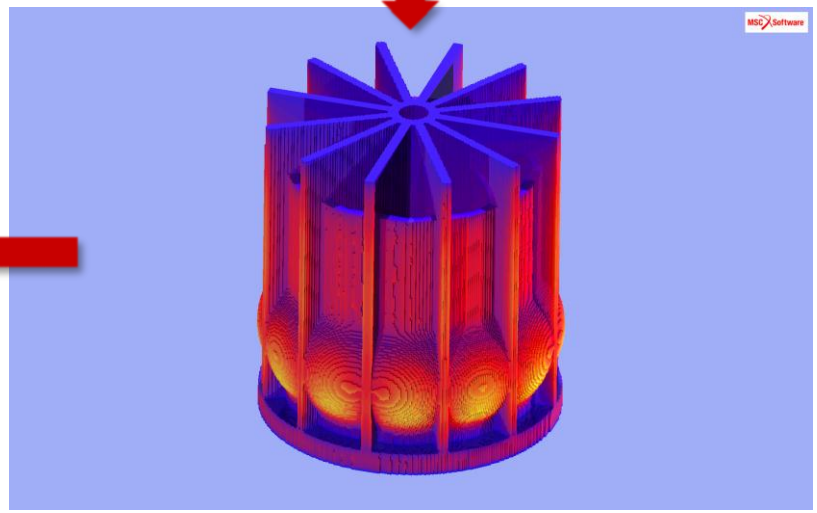




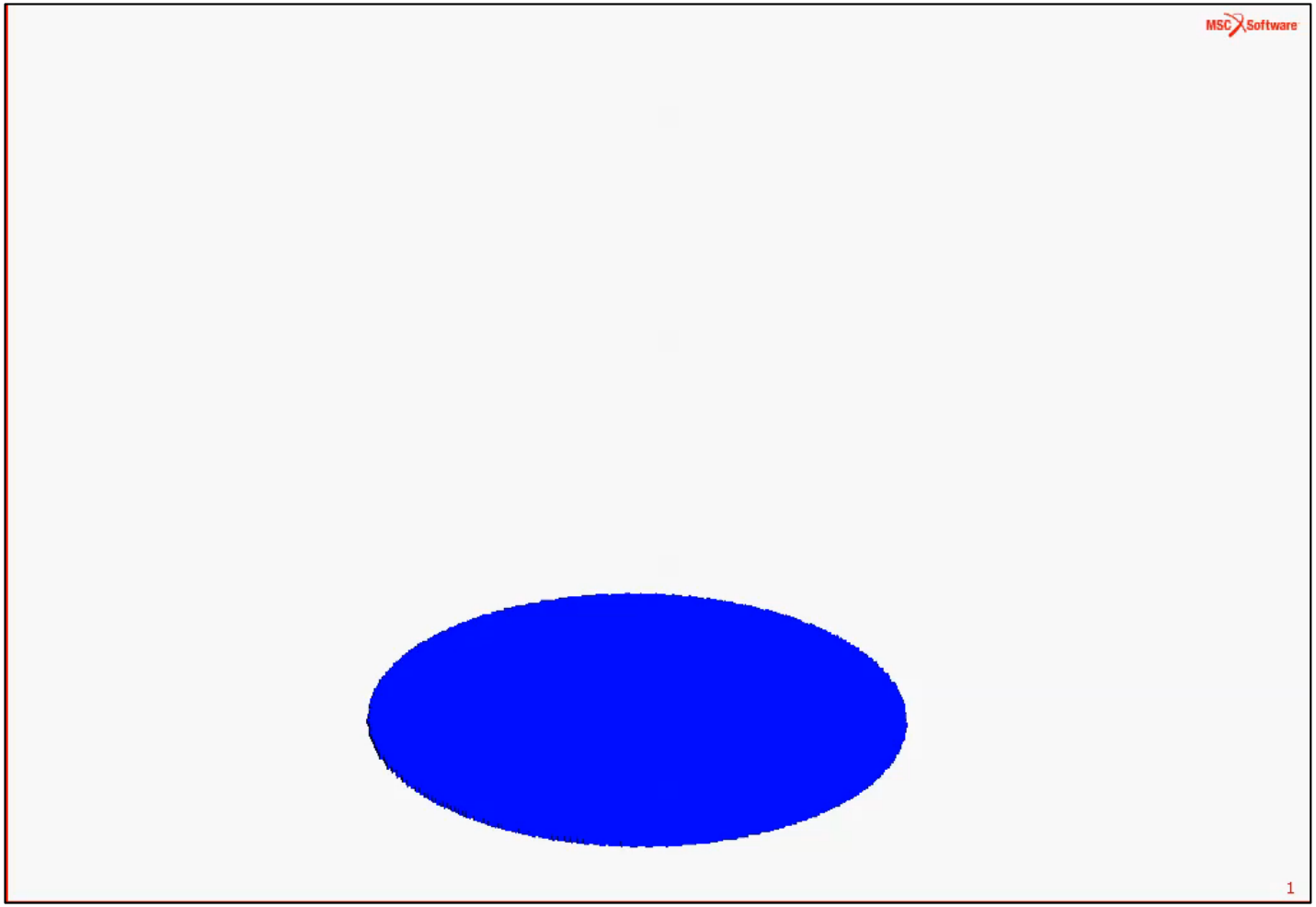
Additive Process Simulation – layer growth Metal example



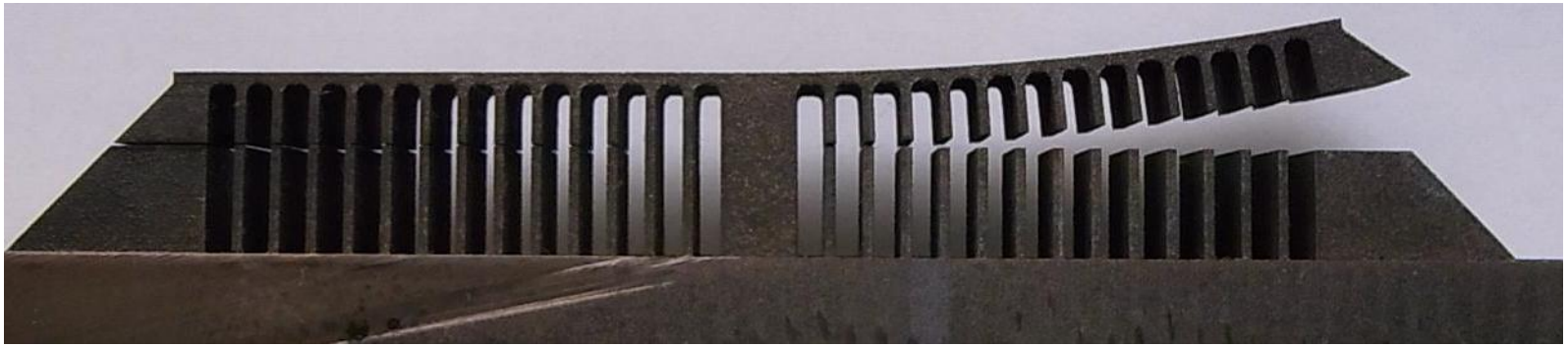




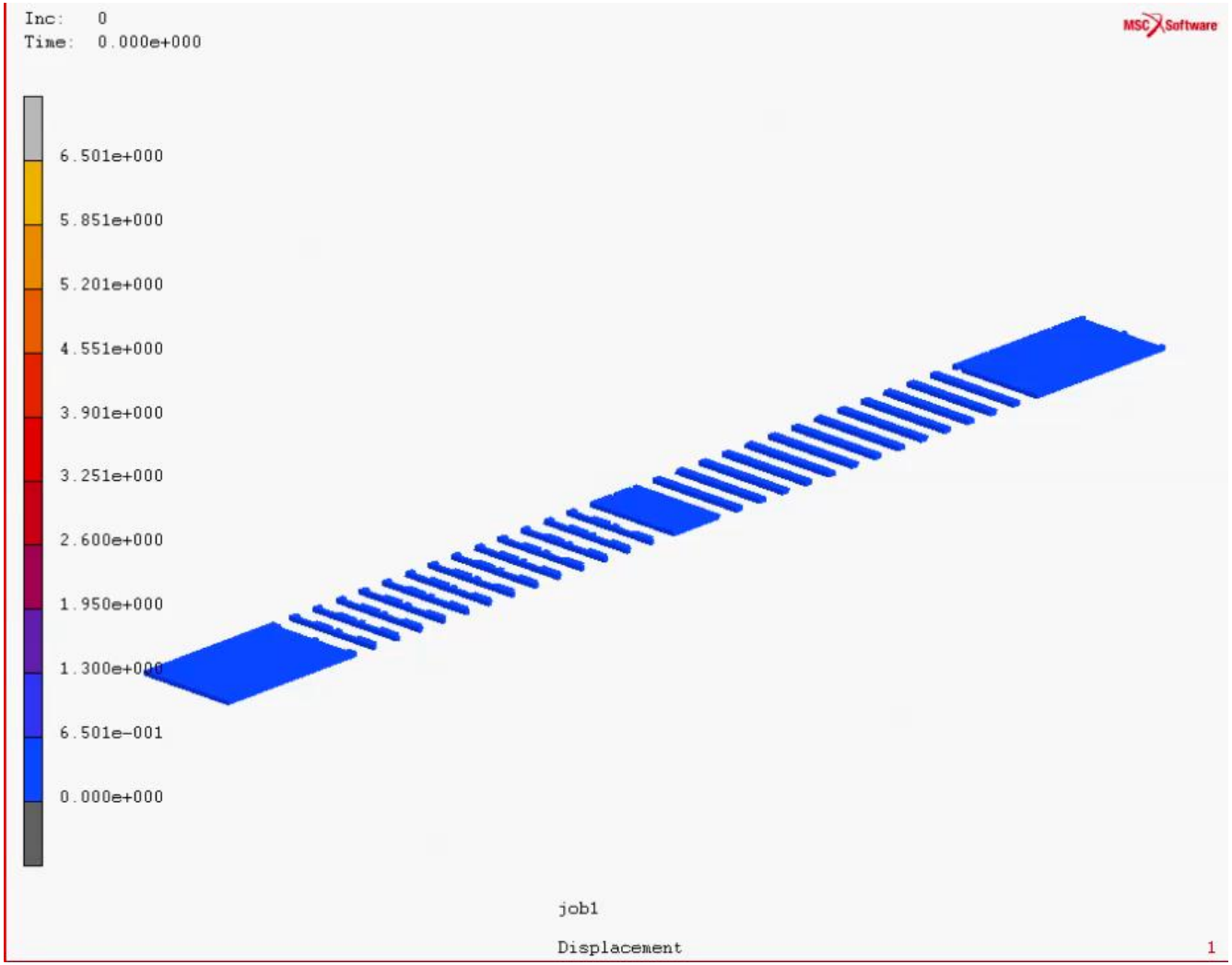
Additive Process Simulation – layer growth Metal example



Test cases: Eos Ti 64



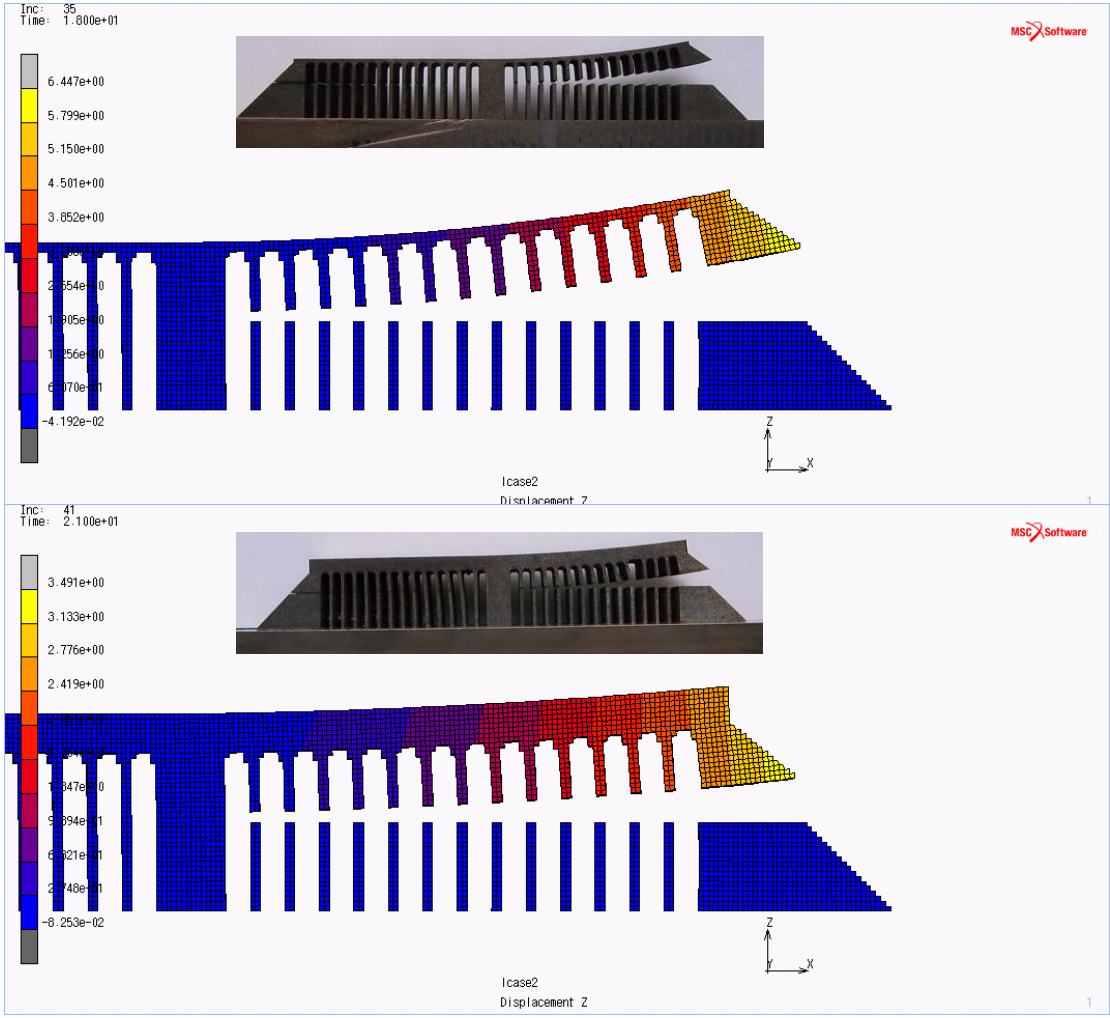
Additive Process Simulation – layer growth example



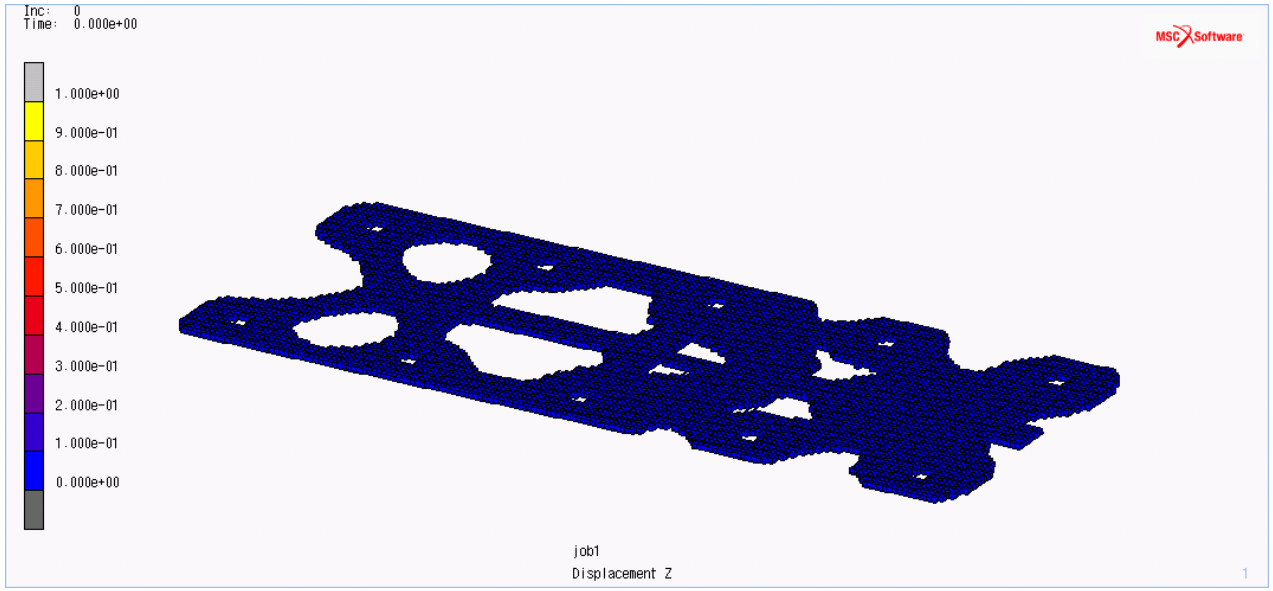
Results

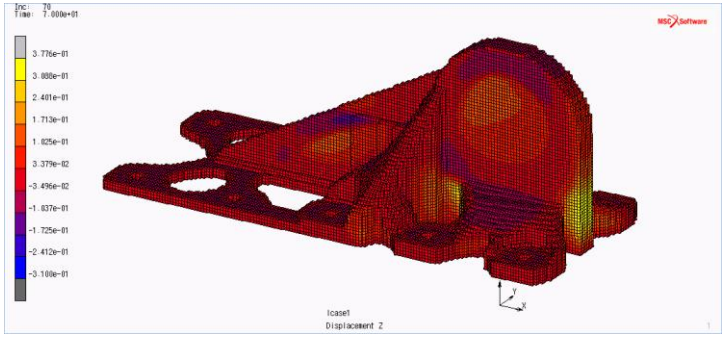
- **Thin specimen**
  - Test result 6.4
  - Marc result 6.4

- **Thick specimen**
  - Test result 3.4
  - Marc result 3.5

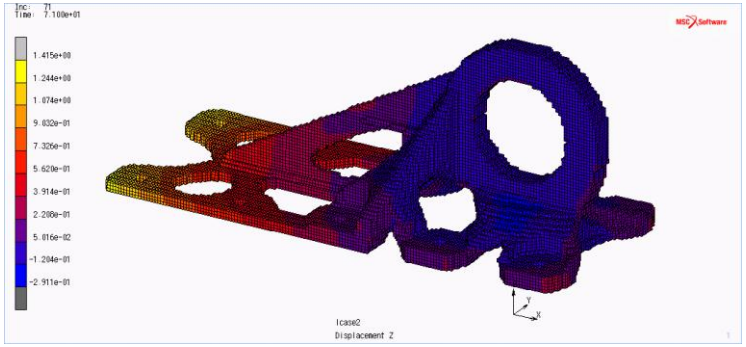


Support evaluation



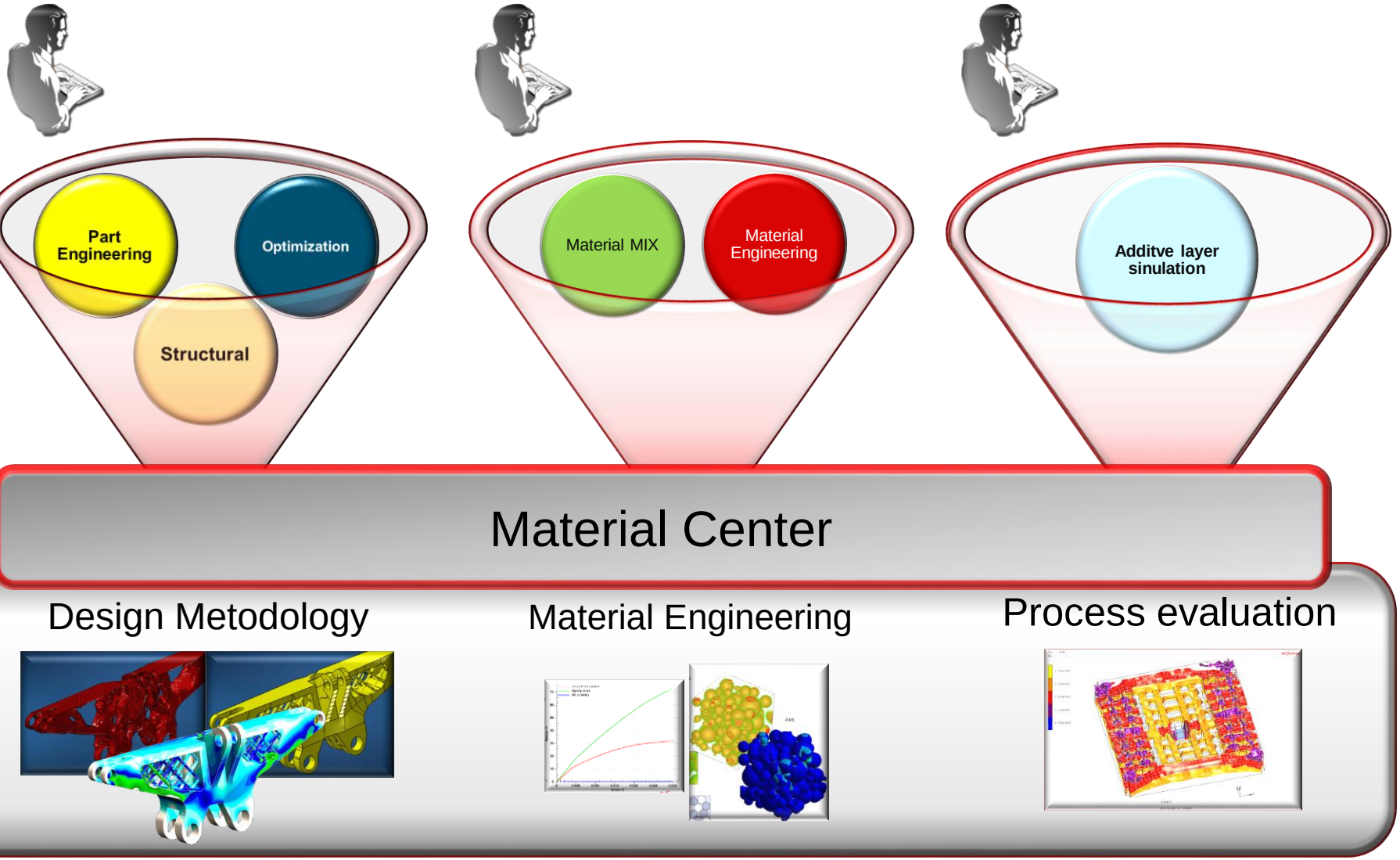


Before support removal



After support removal

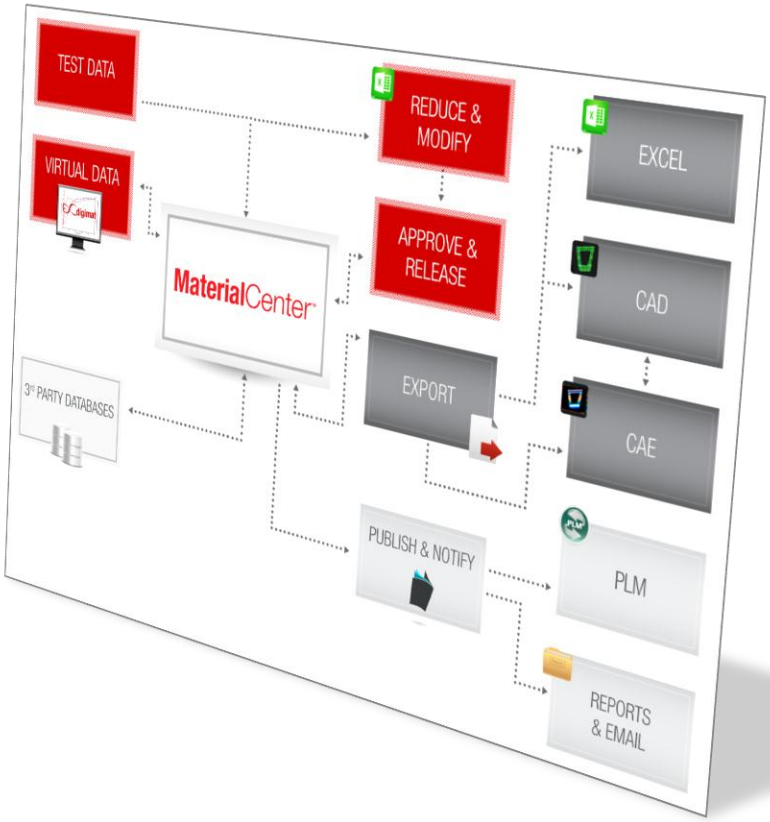
Additive Manufacturing Engineering



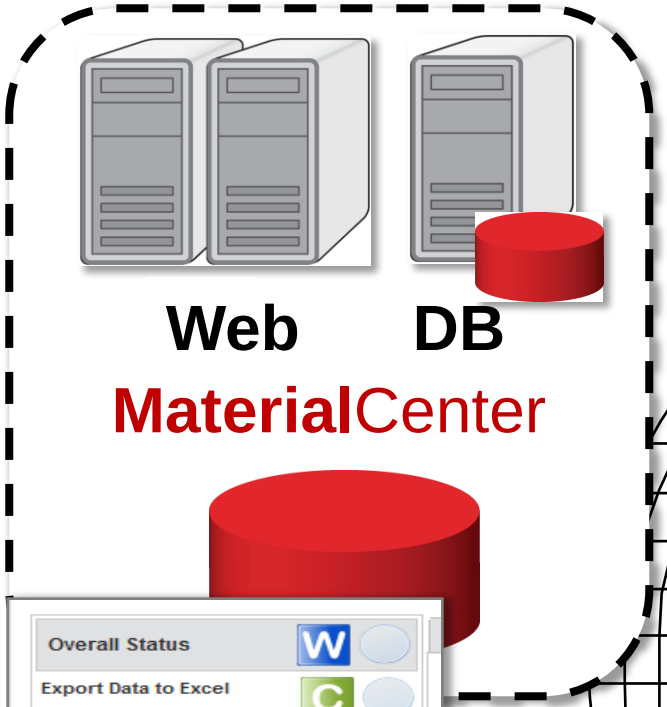
MSC Software

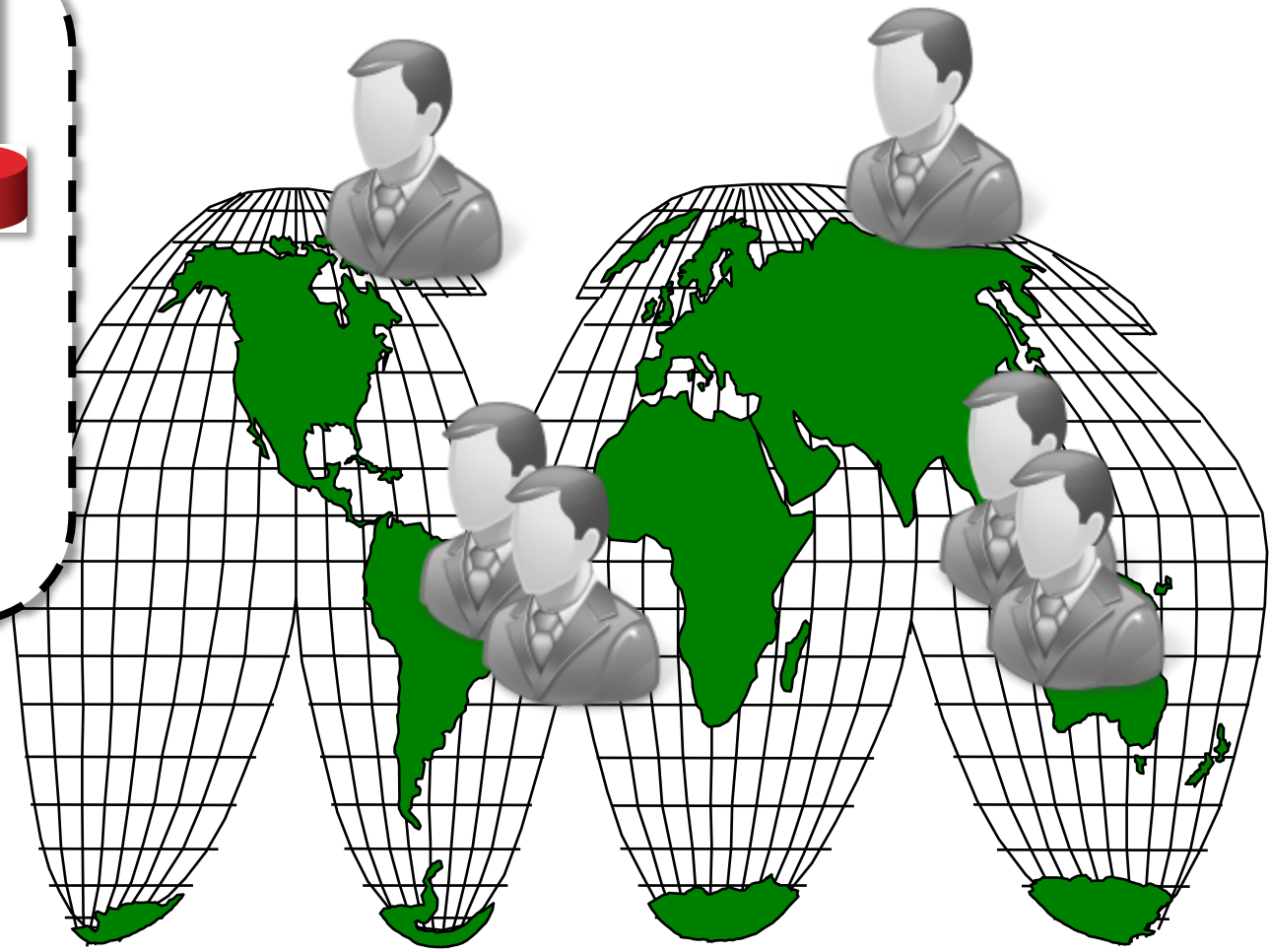
MaterialCenter

- **MaterialCenter is a Material Lifecycle Management (MLM) system**
- **Scope: From Manufacturing *to* Physical & Virtual Test *to* CAE, PDM/PLM**
- **Capabilities:**
  - Full material traceability
  - Best in class Excel integration
  - Data & process management for physical & virtual - manufacturing & test
  - Automation of Materials Process
  - Open flexible schema to characterize Manufacturing, Material & Test at any level
  - Export to Solvers & Deep client integration
  - Work flow & Approval flow
  - Built in, direct Mvision integration



Manage Materials Globally

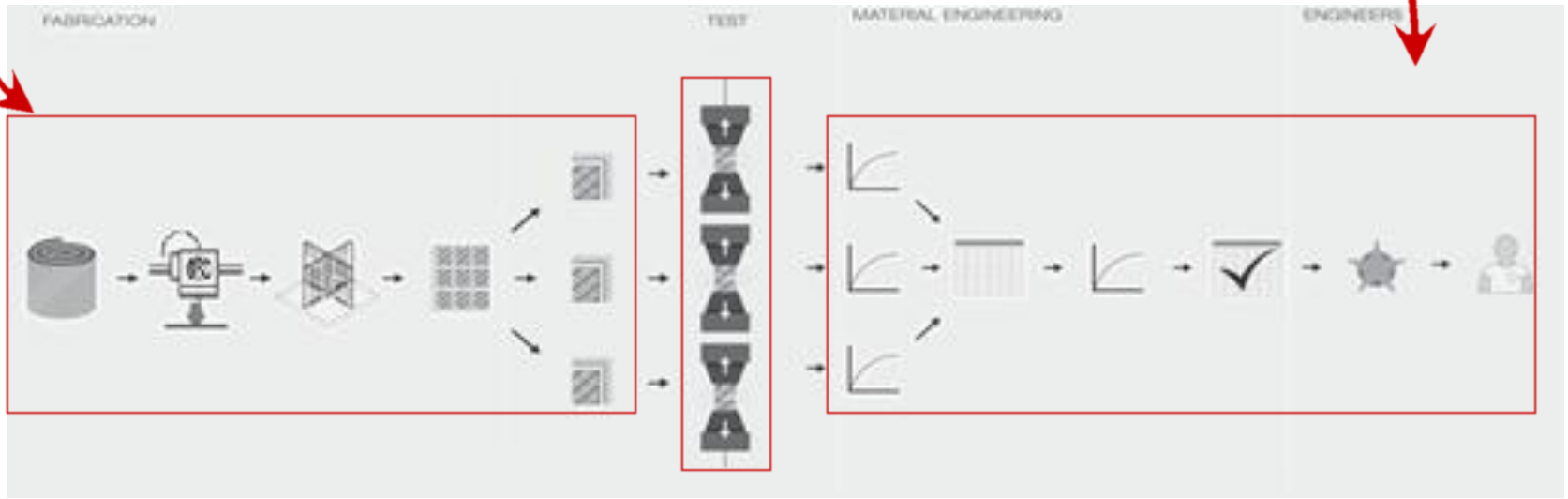




Project Manager

Capturing the Entire Material Lifecycle

- **“Right of Test”- Material products track from *test to export***
- **“Left of Test”**
  - Capture manufacturing inputs that are used to create a part or specimen
  - Leverages MaterialCenter Work Request, Pedigree and Process features
  - Project tracks test specimen from raw material through specimen build process
  - Track:
    - Materials & environment
    - Batch/Specimen numbers
    - Tracking of Inspection



Capturing Additive Manufacturing Parameters

- **Customer Need**
  - Optimize additive manufacturing parameters to produce reliable “field worthy” components
- **MaterialCenter Solution**
  - Develop an additive manufacturing schema to enable the storage of all machine parameters along with corresponding material properties
  - Utilize excel integration in order to map and import custom templates for:
    - Directed Electron Beam Deposition
    - Directed Laser Deposition
    - Powder Bed Fusion
- **Value**
  - Quickly search across thousands of material coupon batches in order to find desired optimal material properties
  - Leverage comparison tools, such as material compare and cross plot, in order to optimize machine parameters to produce consistent and reliable components.

Thank You

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