

Design for Additive Manufacturing: Challenges, Critical skills, and Effective training methods

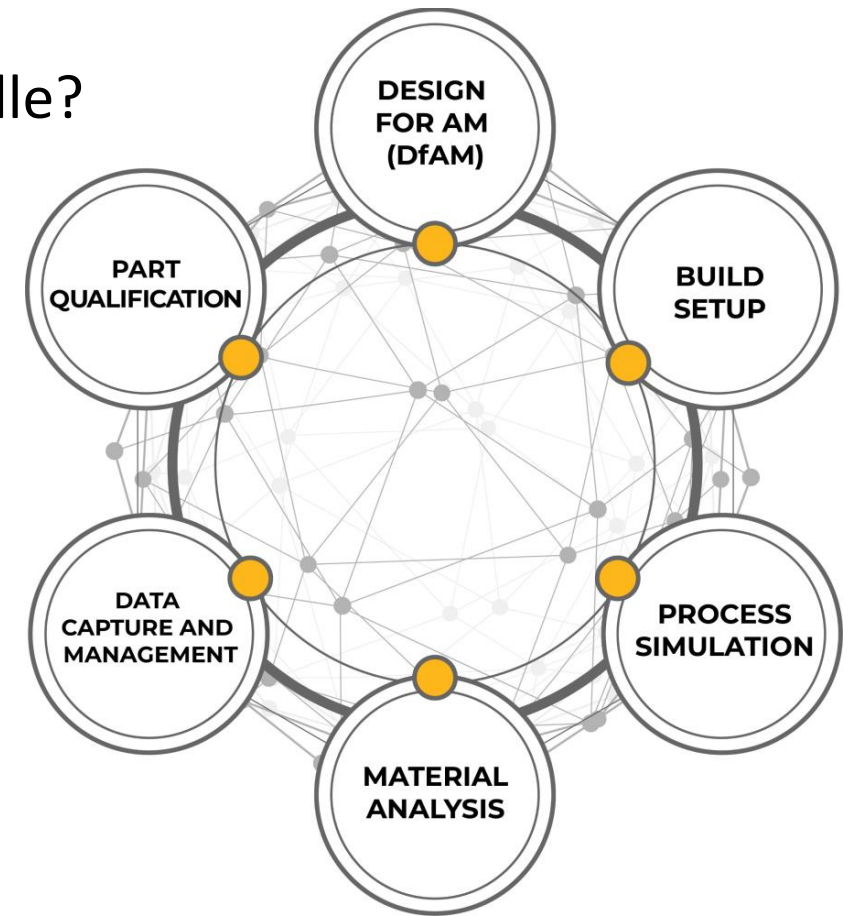
March 16th, 2021

Dr. Alexandre HIRICOIU, Ansys Senior Application Engineer



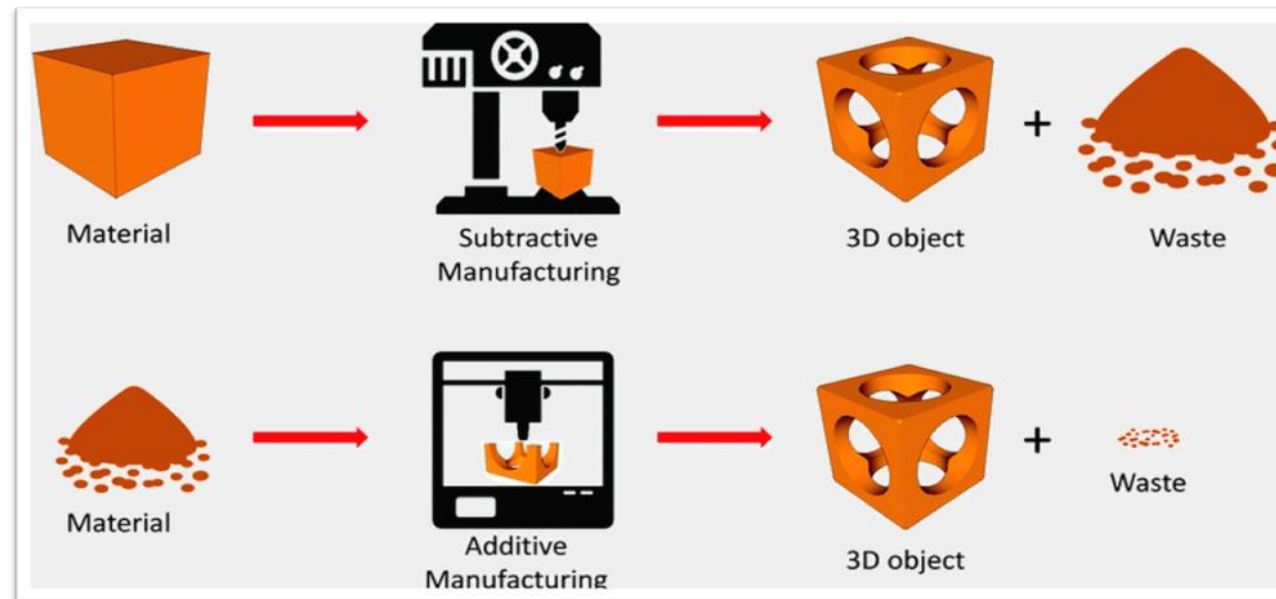
/ Agenda

- Today's biggest challenges in Additive Manufacturing?
- What are the skills required to overcome the AM hurdle?
- 3D design thinking assisted by simulation
 - Generative design
 - Topology Optimization
 - Process modelling
- Training and skills development for AM designers



/ What is Additive Manufacturing?

- Additive Manufacturing (AM) refers to the technology in which a structural 3D component is made by adding material successively
- Subtractive Manufacturing refers to the traditional technologies in which a structural 3D component is made by removing material from raw stock (e.g., machining)

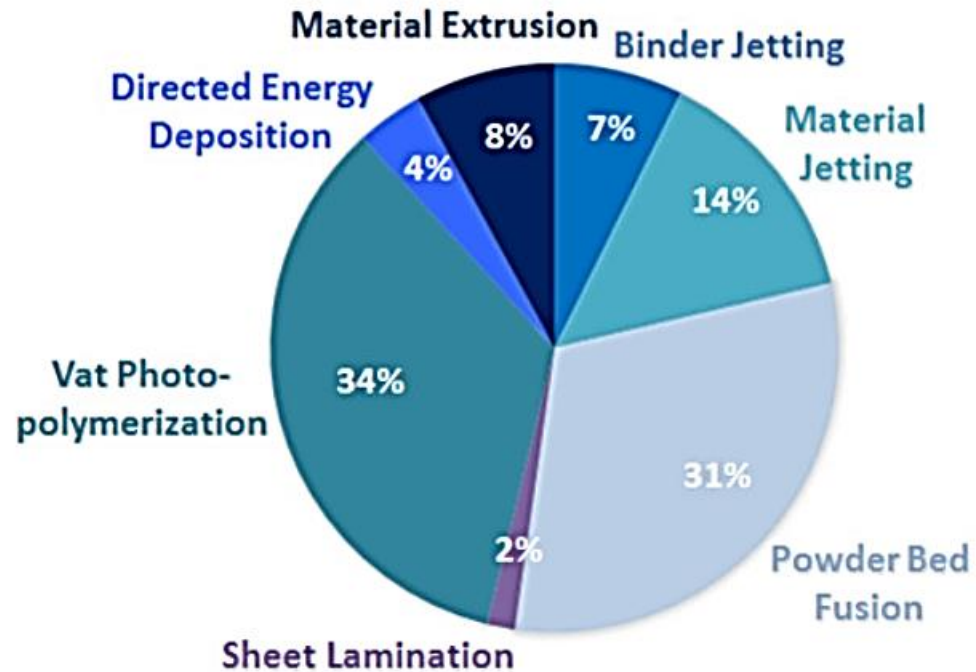


Source: rsc.org

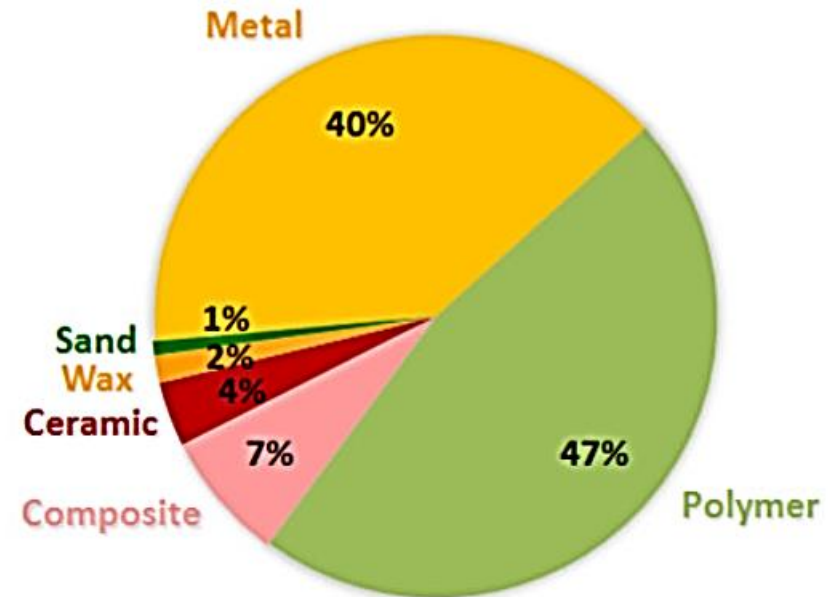
Additive Manufacturing landscape

Senvol Database

Additive Manufacturing
Machines by Process



Additive Manufacturing
Materials by Material Type



[1] <https://www.engineering.com>

/ Practical application cases for Additive Manufacturing

prototyping



Technology is established

- › prototyping
- › design studies
- › show cars

tooling



Technology is partly established and economically used

- › hot forming tools
- › high pressure die casting molds
- › functional integration
- › robot grapper

serial parts

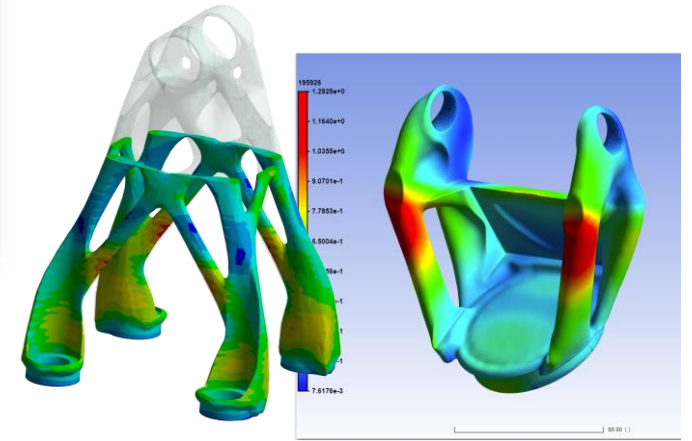


First parts in exclusive serial applications

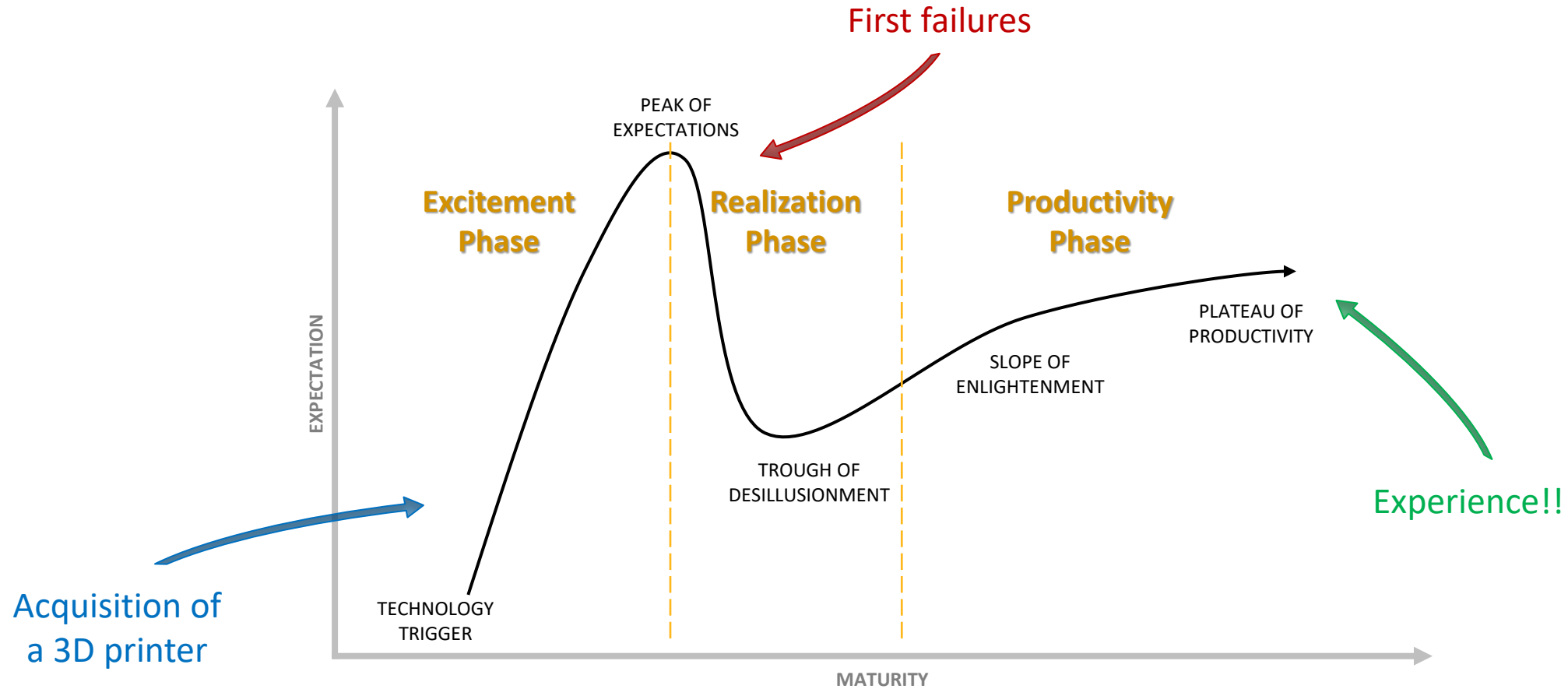
- › light weight
- › bionic structures
- › mass customization
- › after sales

/ Today's biggest challenges in Additive Manufacturing

- Technology related matters
 - Material (quality and regulations)
 - Process implementation
 - Post-processing
 - Control & certification
- Short or lack of standardization for AM technologies
- Shortage of skilled technician (at design but also machine level)
- Difficulties to think 3D printing for designers (adherence to well established processes like metal forming, casting...)



New technology learning curve



/ Skills required to overcome those challenges

- Good CAD knowledge
- Open to innovation – DfAM
- Good understanding of Post-processing and material knowledge
- Reserve engineering
- Teamwork skills



/ Quantified impact of Additive Manufacturing

Cost Reduction

Up to

75%

Product development savings*

Lead Time Reduction

Up to

80%

Savings from assembly
consolidation and
distributed production*

Weight Reduction

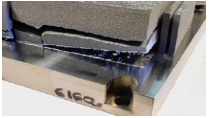
Up to

95%

More efficiency and fuel
savings*

*Reducing Satellite Antenna Components from 100 Parts to 1

/ How can simulation help?



- Cost
- Repeatability
- Reliability
- Qualification



Metal AM equipment cost > \$1M + materials & human resources



Hundreds of machine and material parameters impact part quality

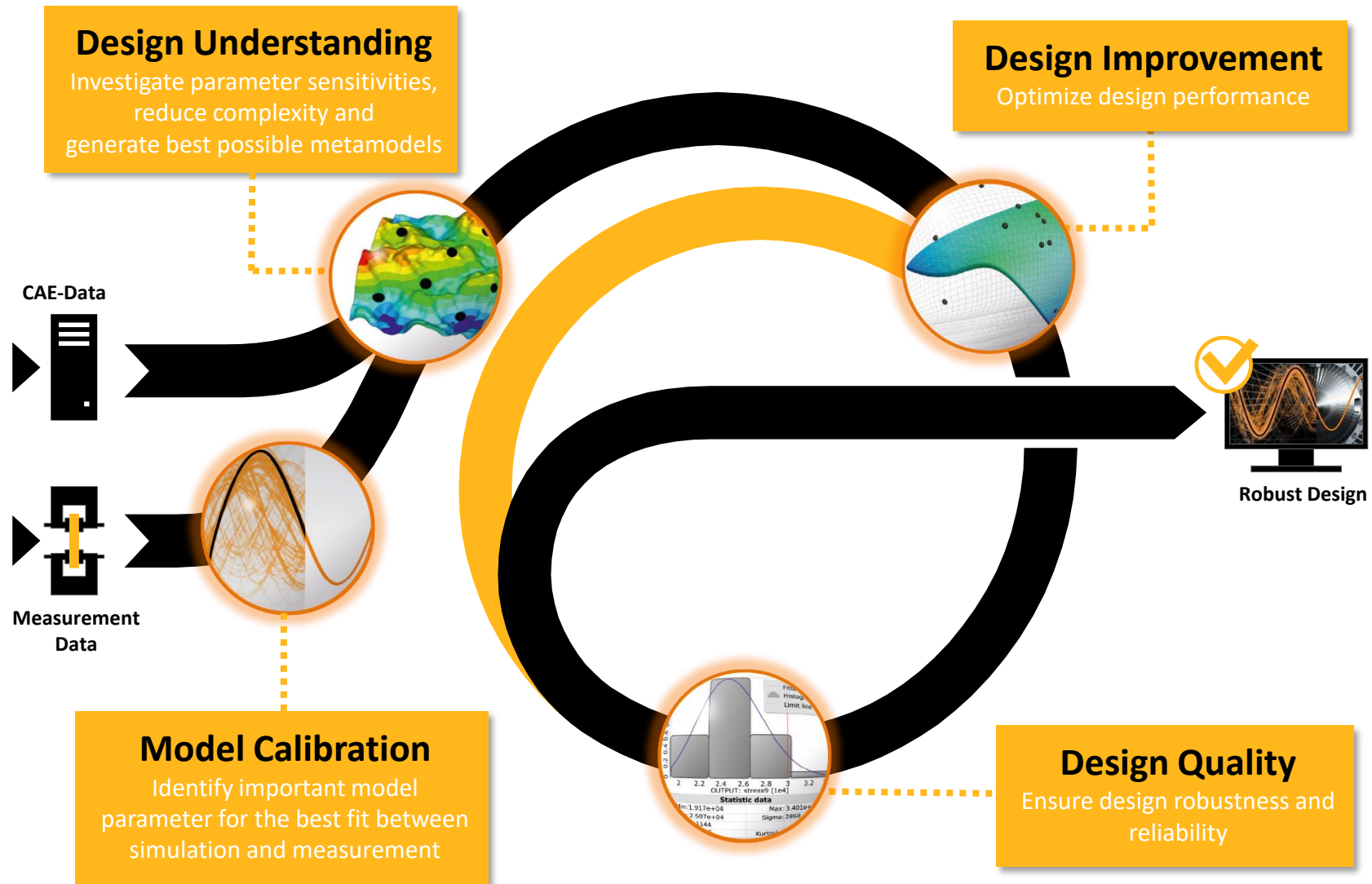


Relatively new technology (<10 years) still developing

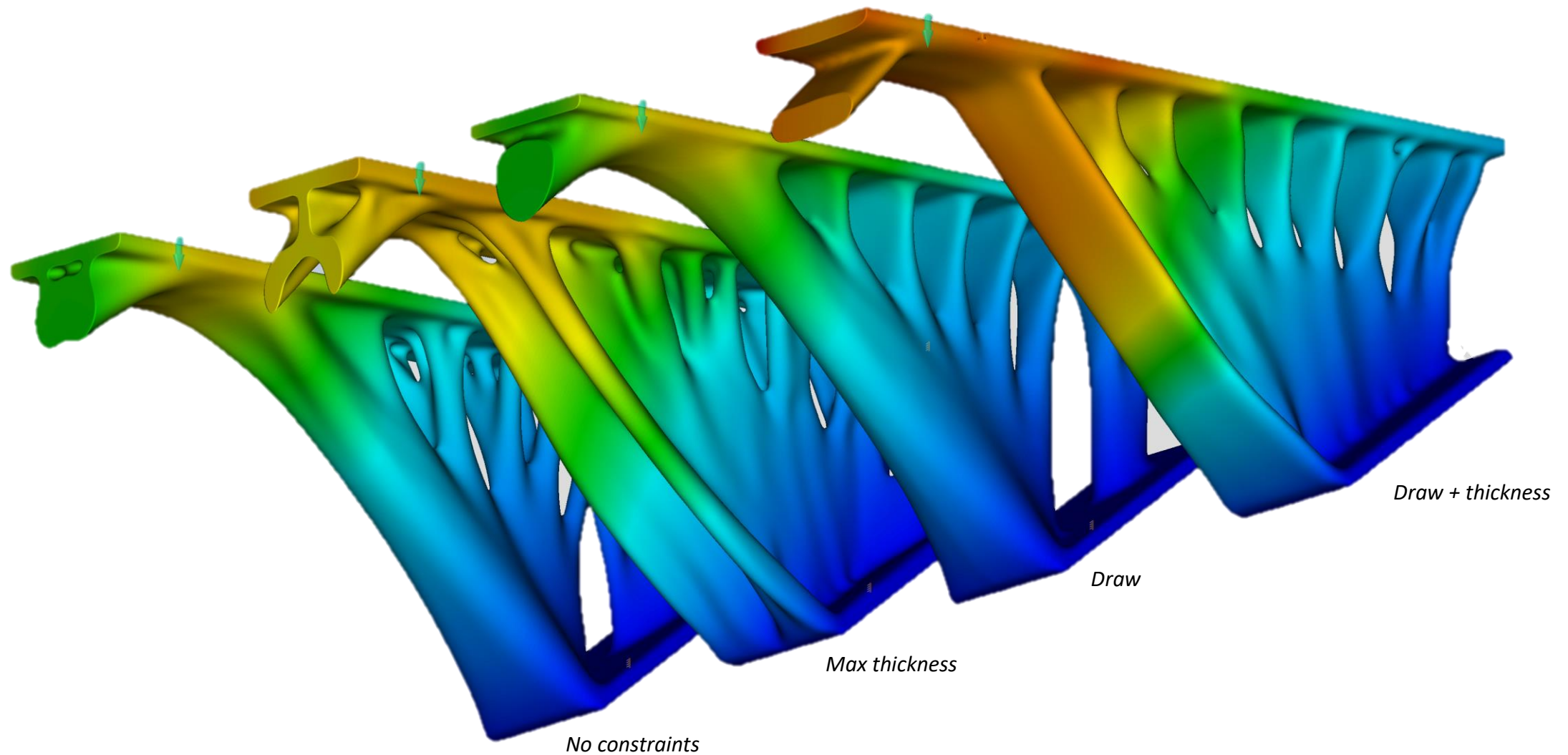


Less data available to qualify and certify parts for production use

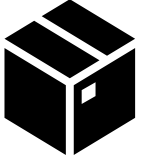
Practice guideline for virtual product development



/ Generative design or design exploration



/ Why Topology Optimization?



PRODUCT

- Light-weighting
- Reduced material waist and part consolidation (+AM)
- Improved product performance and design
- Physics based not intuition/experience based
- New material properties (+AM)

PEOPLE

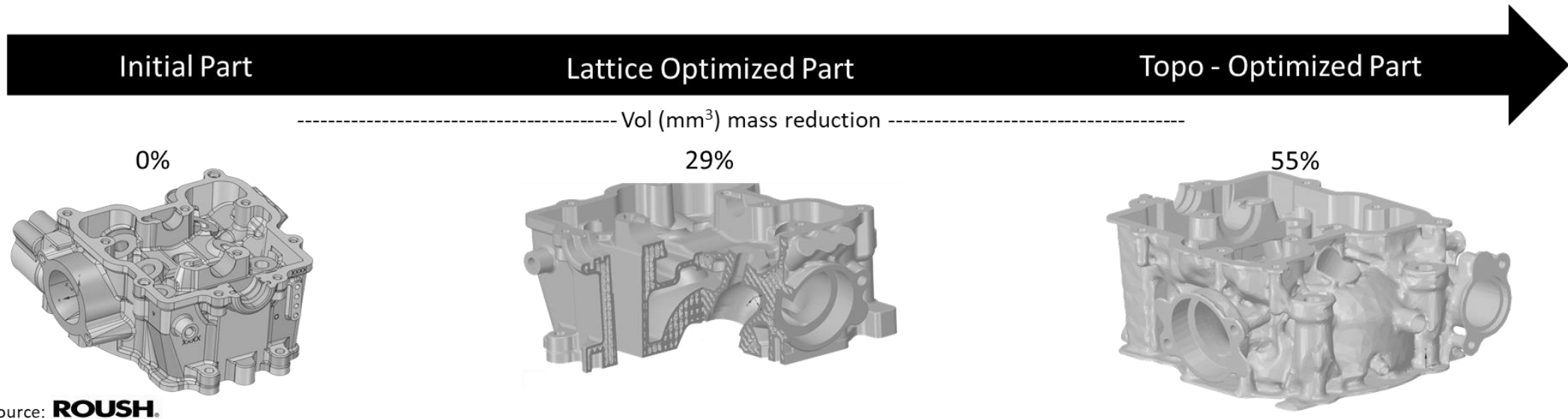
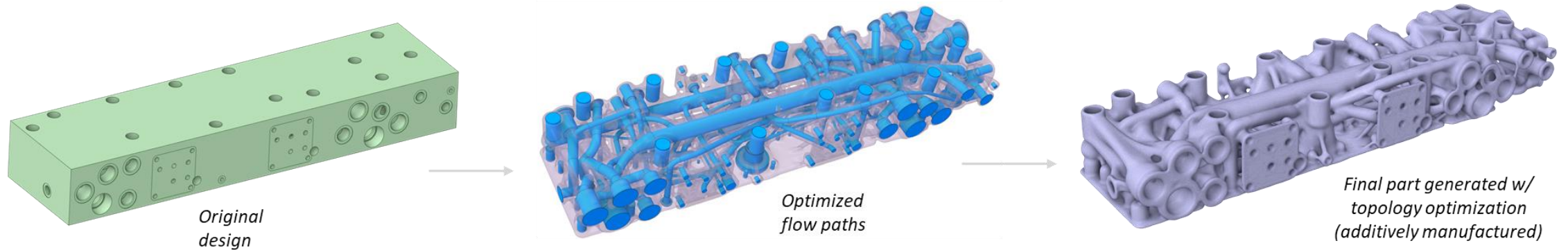
- Physics driven optimization of parts, not constrained by CAD
- Deeper insight in the product performance
- Better collaboration between designers & analysts
- Know-how build-up



PROCESSES

- Physics driven product development from the very beginning
- Process compression and automation
- Less prone to human bias

Design assessment through Topology Optimization



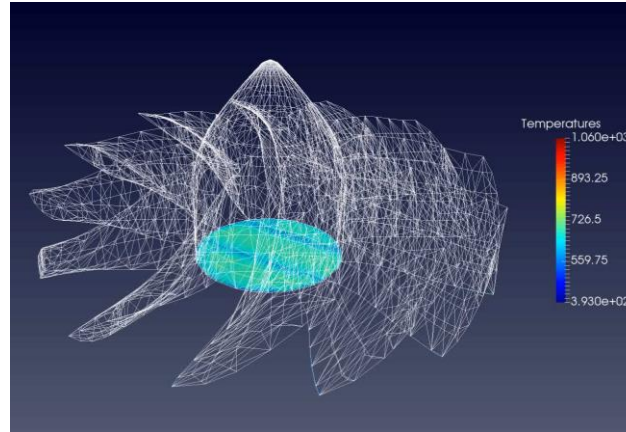
/ Benefits of process simulation for Additive Manufacturing

Engineering Challenges

- Part failures and aborted jobs
- High residual stresses
- High costs due to post-processing
- Printing of complex geometries
- Post-processing

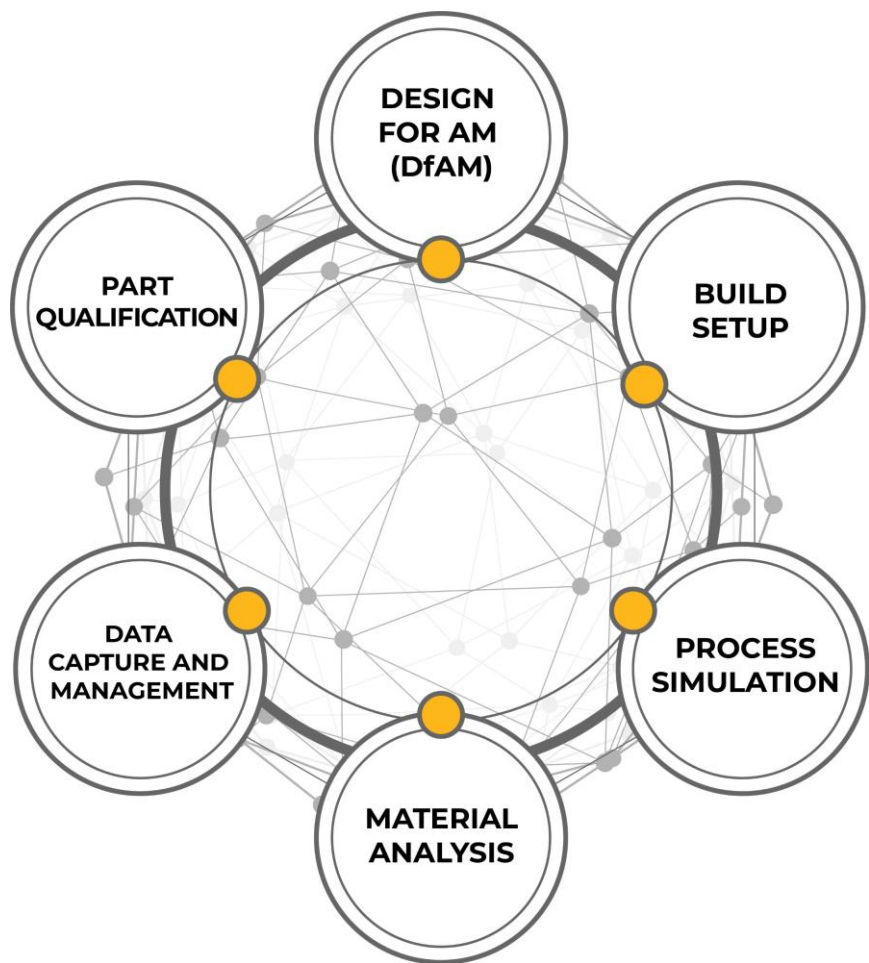
Ansys Capabilities

- Thermomechanical simulation methods with varying fidelity levels
- Capabilities to read build files from certain machine providers



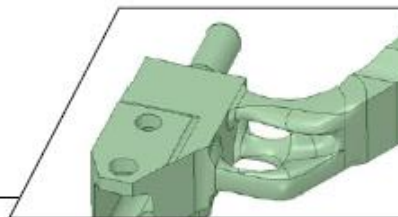
Example Outputs

- Prediction of distortion and residual stresses
- Detection of potential blade crash
- Distortion compensated geometries
- Baseplate distortion prediction considering multiple parts
- Consideration of the influence of heat treatments and cutoff direction



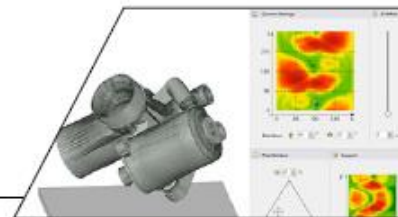
/ Design for AM (DfAM)

- CAD Modeling
- Topology Optimization
- Lattice and Light weighting



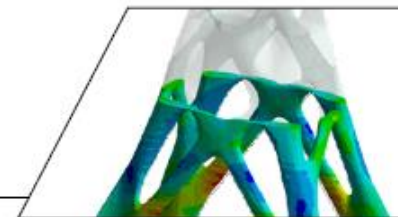
/ Build Setup

- STL File Repair and Geometry Manipulation
- Part Nesting and Support Generation
- Orientation Guidance and Wizards



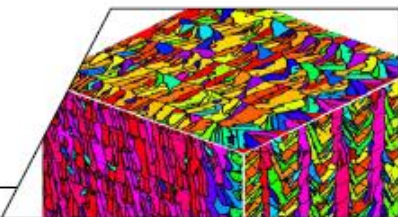
/ Process Simulation

- Metal AM Process Simulations
- Distortion Compensation
- Build Failure Prediction



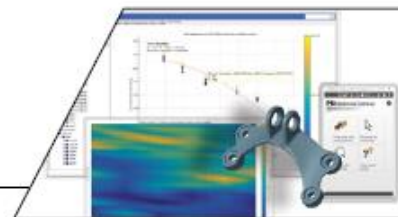
/ Material Analysis

- Curated Material Property Databases
- Grain Morphology Predictions
- Melt pool and Porosity Prediction



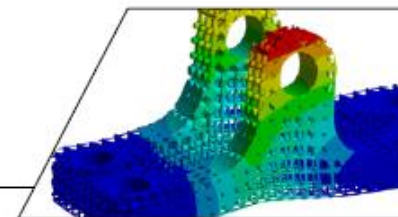
/ Data Acquisition and Management

- Traceability and full control of AM Data
- Consolidate, control and share AM data across organization

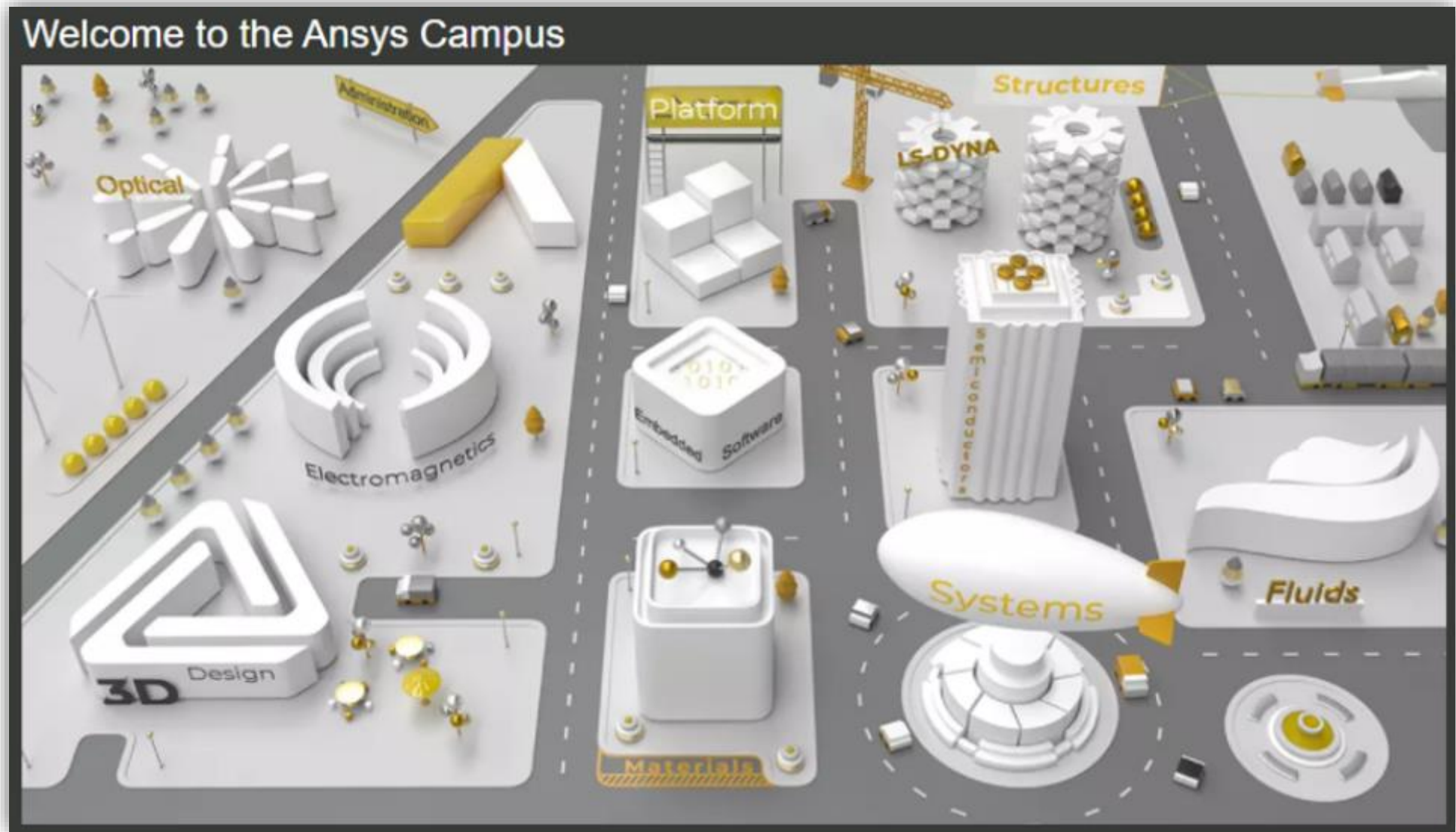


/ Part Qualification

- Design Validation
- Structural and Thermal Analysis
- Document control and Certification

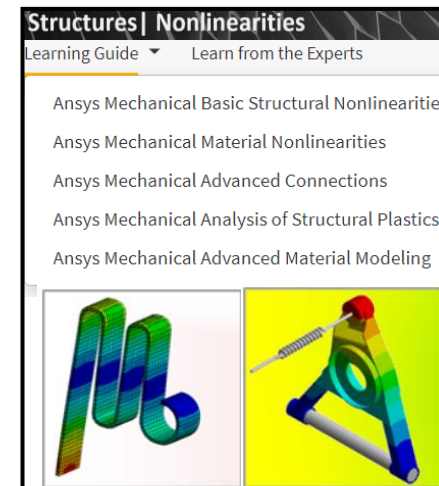
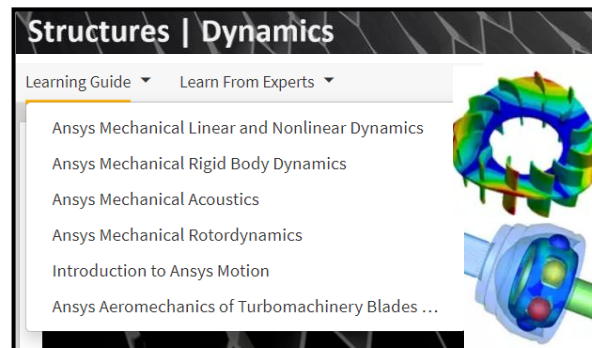
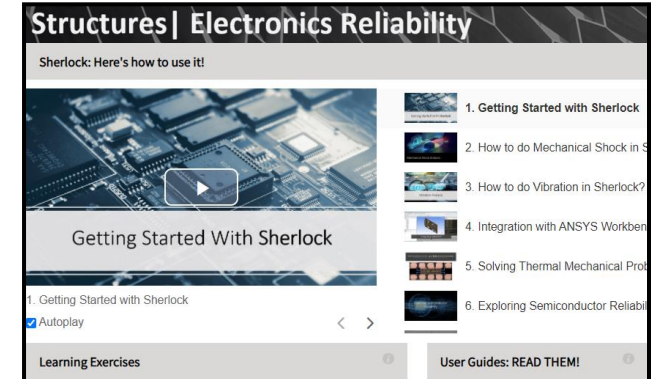
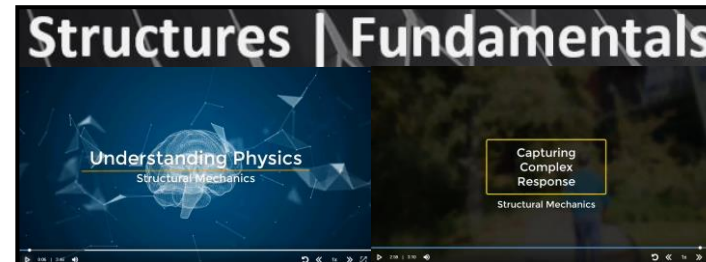


Training and skills development



Ansys Campus Buildings – Structures Building

Welcome to the Structures Building



The Structures Building hosts:

Ansys Mechanical
Ansys Additive Print
Ansys Aqwa

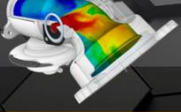
Ansys Mechanical APDL
Ansys Motion
Ansys Composite PrepPost

Ansys nCode DesignLife
Ansys Sherlock
Ansys Autodyn

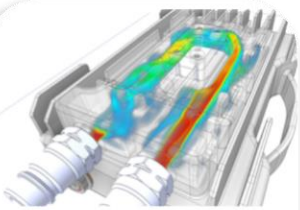
Ansys OptiSlang
Ansys DesignModeler
Ansys Meshing

Ansys ACT
Ansys SpaceClaim Meshing
Ansys SpaceClaim Direct Modeler

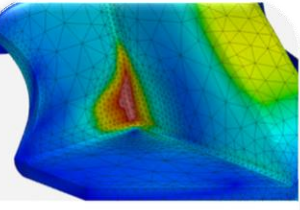
Ansys Campus Buildings – 3D Design Building




3D Design



Ansys Discovery Live
Easy-to-use tools allow interactive exploration and iteration of ideas. Simulation results appear in real time and provide directional guidance for more informed decisions.



Ansys Discovery AIM
Intuitive and complete upfront simulation tools to validate concepts. Guided workflows, optimization tools and proven Ansys solvers deliver accurate results and design insights.

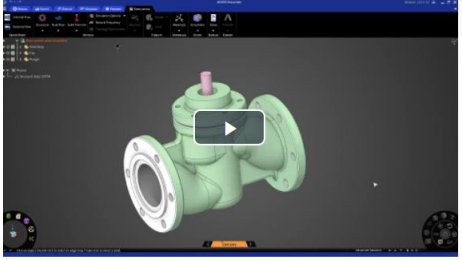


Ansys SpaceClaim
Multipurpose 3D modeling for concept modeling, design, manufacturing, reverse engineering, 3D printing and simulation preparation.

The 3D Design Building hosts:
Ansys Discovery Live
Ansys Discovery AIM Ansys Discovery SpaceClaim


Ansys Discovery Live

Ansys Discovery: Getting Started Tutorials



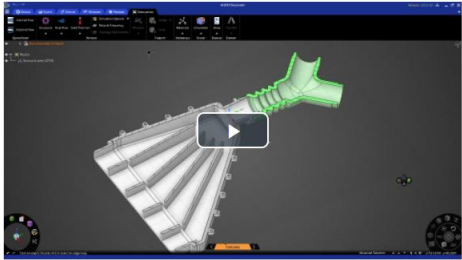
- Getting Started - UI Overview
- Getting Started - Structural Part 1
- Getting Started - Structural Part 2
- Getting Started - PART 1 Fluids Simulation
- Getting Started - PART 2 Fluids Simulation
- Getting Started - Topology Optimization in Ansys Discover
- Getting Started - Thermal Analysis in Ansys Discovery

Ansys Discovery: In Depth Structural Tutorials



- In Depth - Structural Part 1
- In Depth - Structural Part 2
- In Depth - Structural Part 3
- In Depth - Structural Part 4

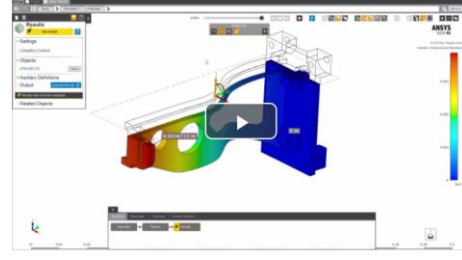
Ansys Discovery: In Depth Fluids Tutorials



- In Depth - Fluids Part 1
- In Depth - Fluids Part 2
- In Depth - Fluids Part 3
- In Depth - Fluids Part 4
- In Depth - Fluids Part 5
- In Depth - Fluids Part 6

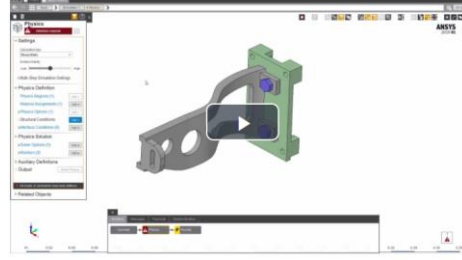
Ansys Discovery Aim

Discovery AIM: Getting Started



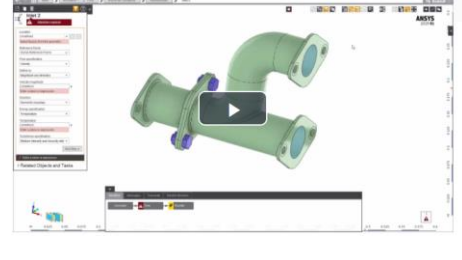
- 1. Structural Simulation
- 2. Internal Fluids Simulation
- 3. Modal Simulation
- 4. Thermal Simulation
- 5. Fluid-Solid Heat Transfer (CHT) Simulation

Discovery AIM: Structural Tutorials



- 1. Structural Simulation
- 2. Structural Assembly Brace
- 3. Structural Assembly Manual Meshing
- 4. Insertion Force Prediction

Discovery AIM: Fluids Tutorials



- 1. Internal Fluids Simulation
- 2. Fluid Flow Mixer-T
- 3. Fluid Solid Interaction

/ Simulation World Conference 2021

<http://www.simulation-world.com>



 Thank you!

Questions?



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 **Ansys**

