



HEXAGON



Generative Design: Hocheffiziente Erzeugung optimierter Leichtbau- strukturen

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How design principles need to evolve

Status Quo



- Design is simple and massive
- Limited by
 - software
 - manual effort for construction
- Material waste for manufacturing is high

63% weight
reduction

Reduced fixation
points to 4

1 integrated part
design

0.5h engineering
2.5h calculation



Lightweighting

Efficiency

Time to market

Costs



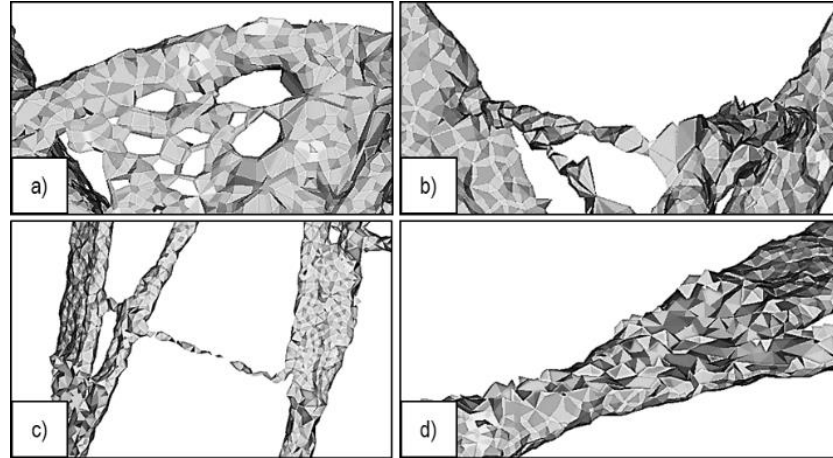
MSC Apex | Generative Design



Problem Solved with “Topology Optimization”“?

Unclear
results

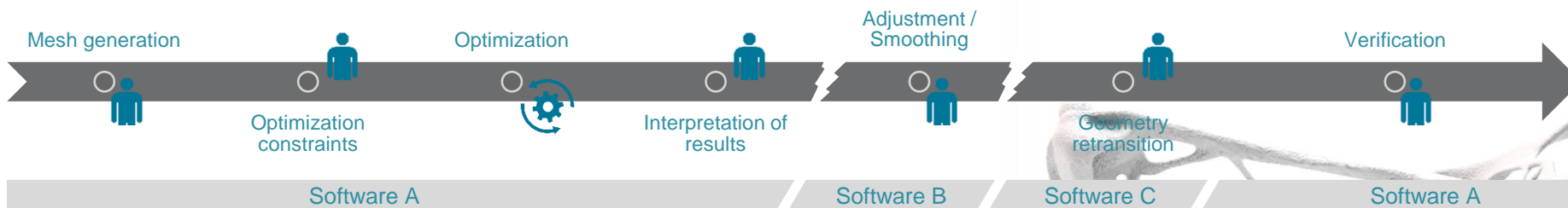
Discontinuous
connections



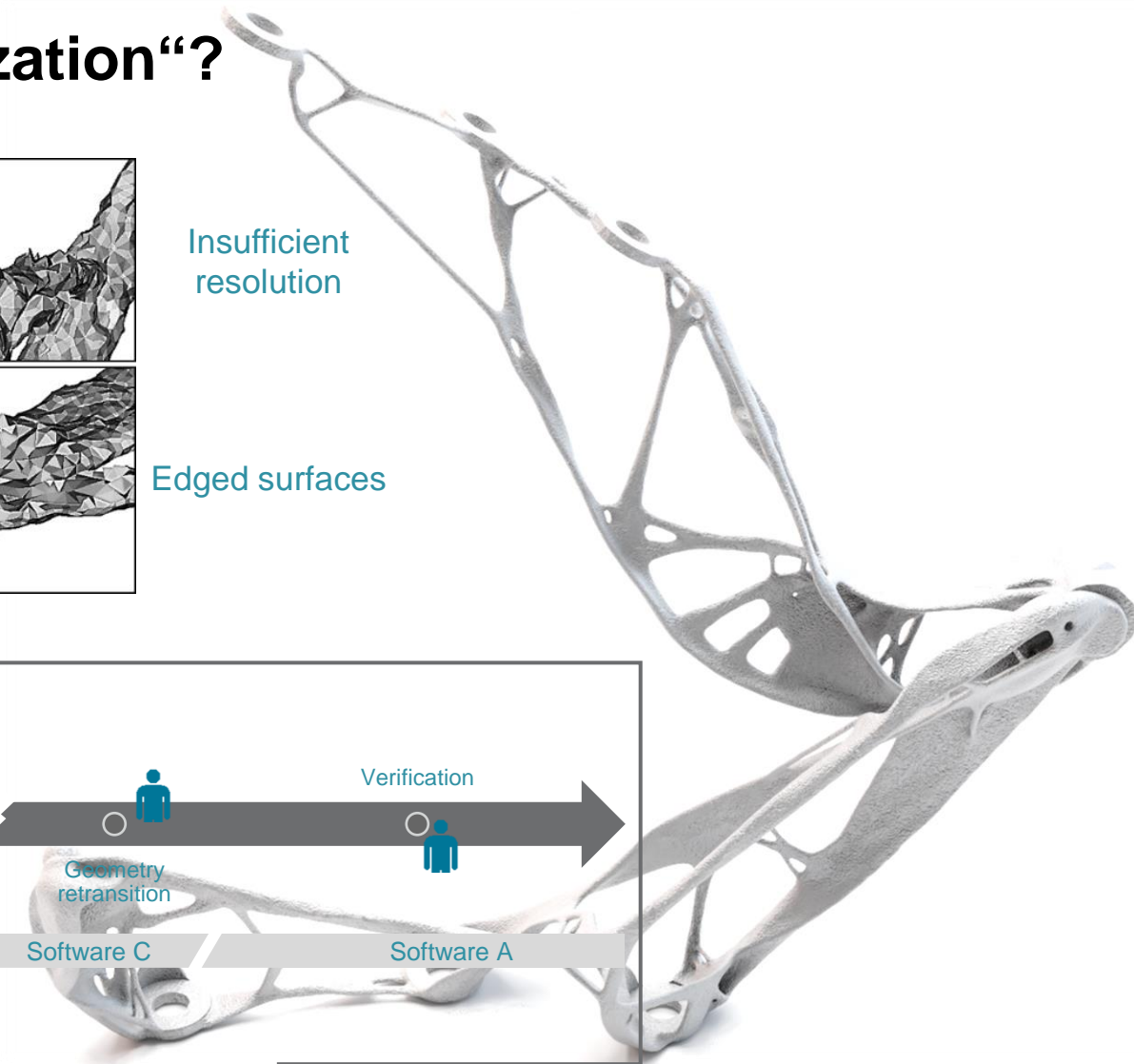
Insufficient
resolution

Edged surfaces

Existing Topology Optimization



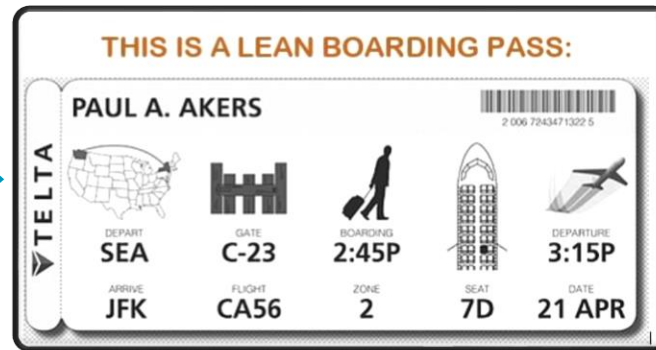
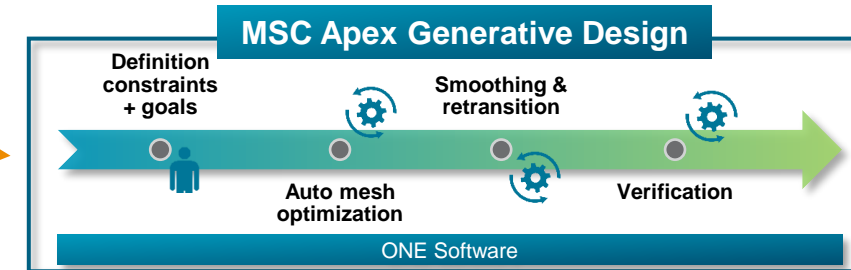
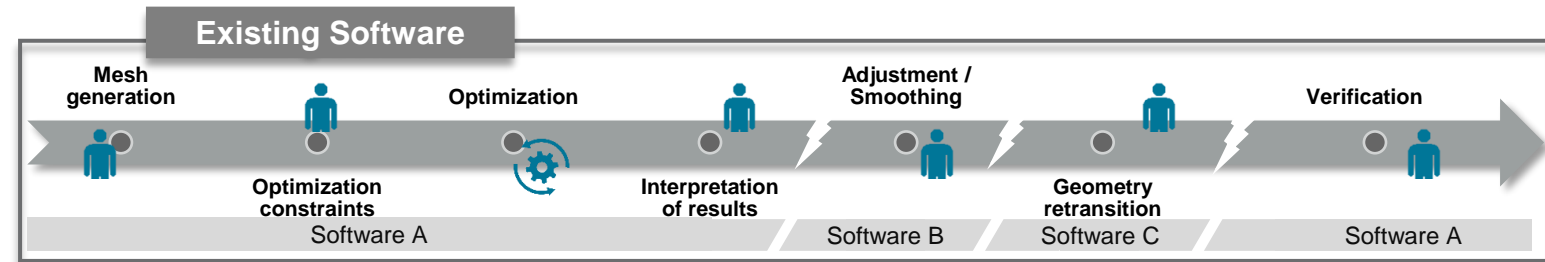
- Several different software required
- Information losses between these software
- High manual effort, low automation



Rethink the existing!

Concentrate on DfAM core!

- Apply new principles and developments
- Be customer focused
- Develop lean processes
- Keep it simple - focus on the necessary





"In 2025, virtual computation is used at every engineer's workstation."

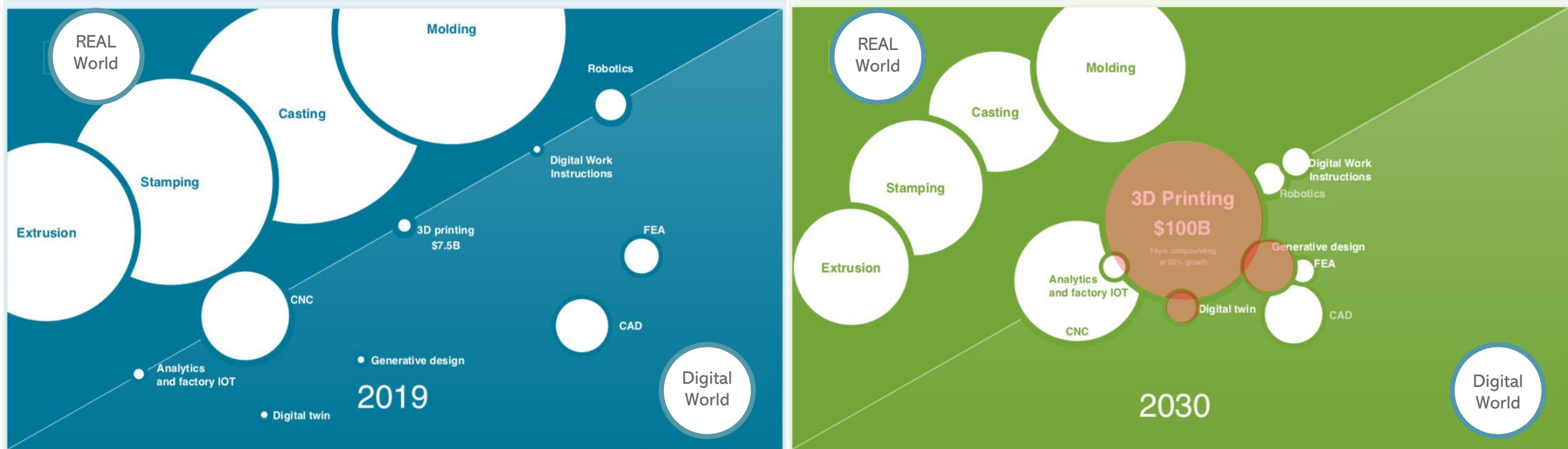
"CAE processes must be operable without special expertise."

Ralph Sundermeier

Head of CAE Methods VW at ESI Forum 2019



Expected transformation of the market within the next 20 years

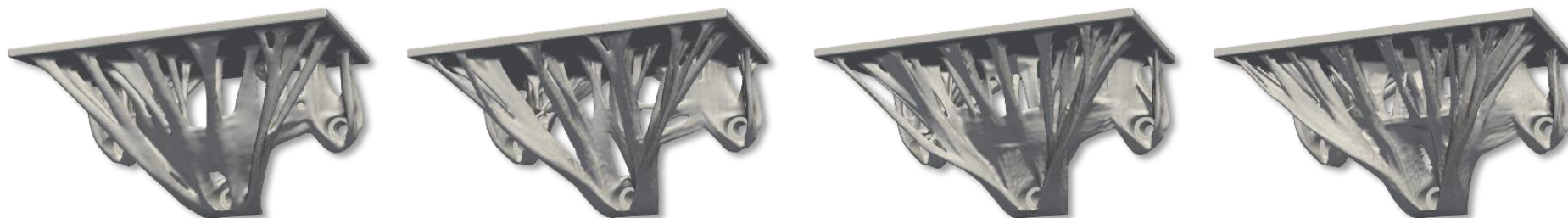


“Generative Design Market size is expected to grow from \$111 million (2018) to \$275 million by 2023 at a CAGR of 19.9% during the forecast period.”

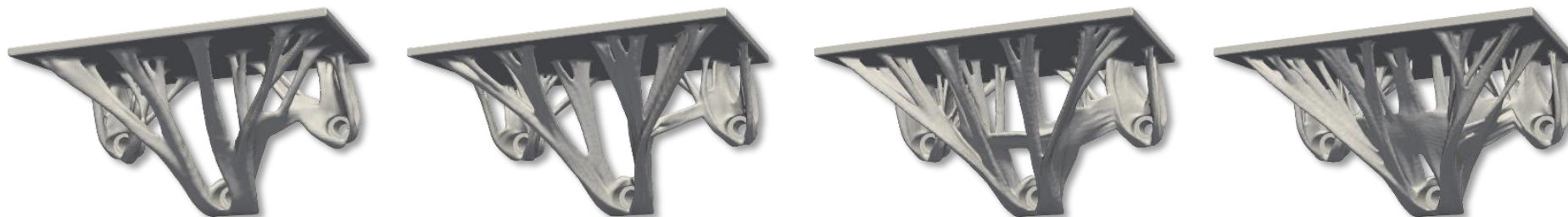
Explaining Generative Design vs. Topology Optimization

Generate printable designs automatically

Design type:
Dense



Design type:
Medium



Design type:
Sparse



Design Funnel

STRESS

Designs have to meet the stress limitation

DESIGN

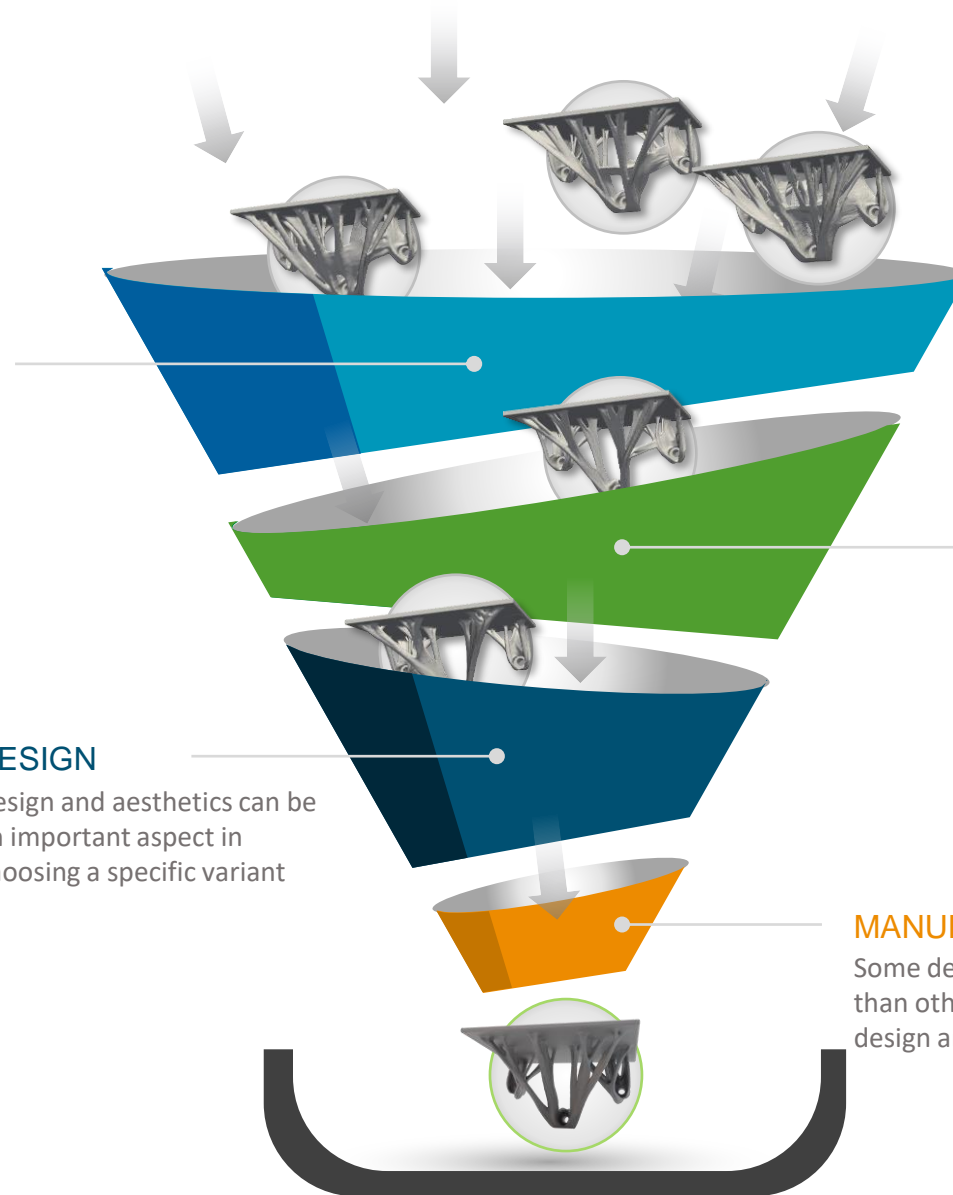
Design and aesthetics can be an important aspect in choosing a specific variant

WEIGHT

Too heavy designs cause higher costs for material and energy

MANUFACTURING

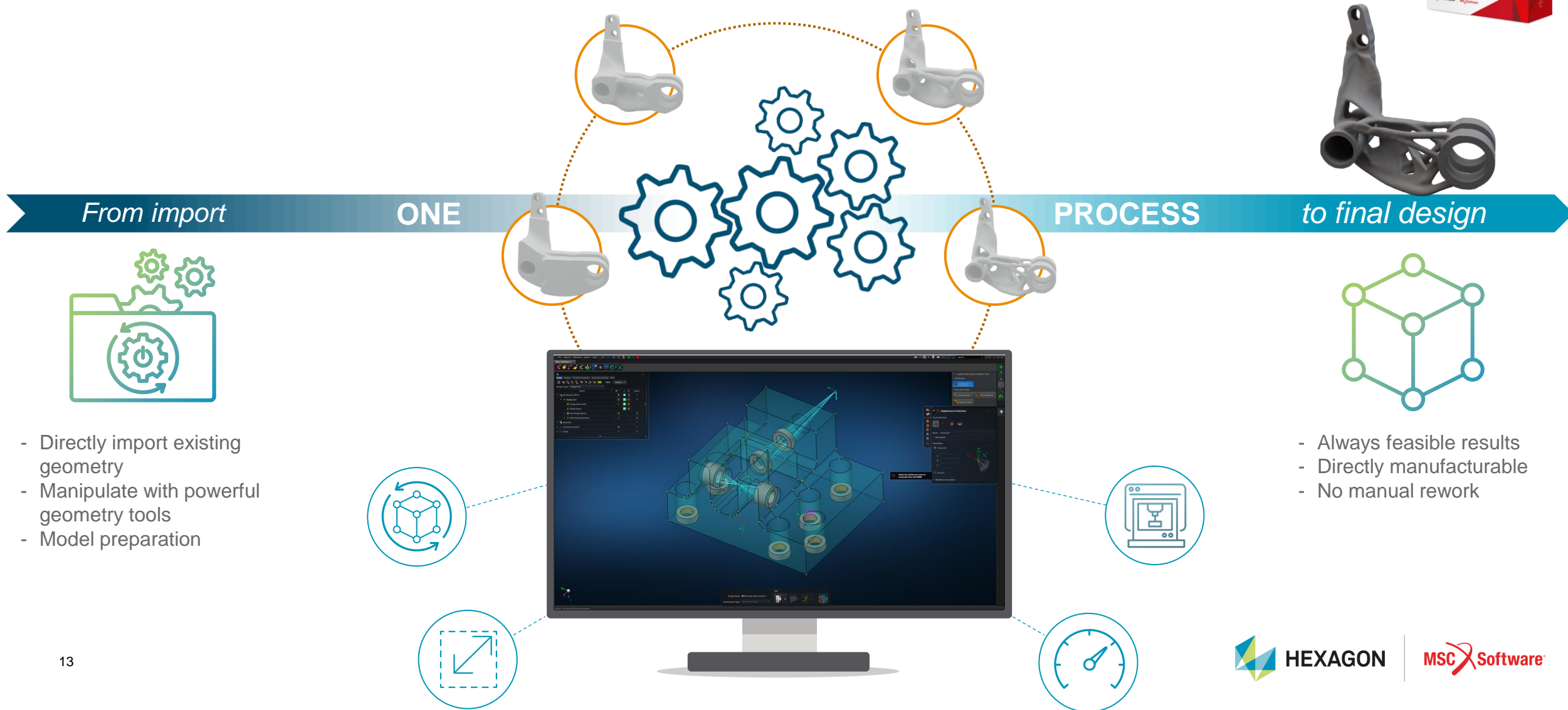
Some designs are easier to manufacture than others, highly depending on the design and process



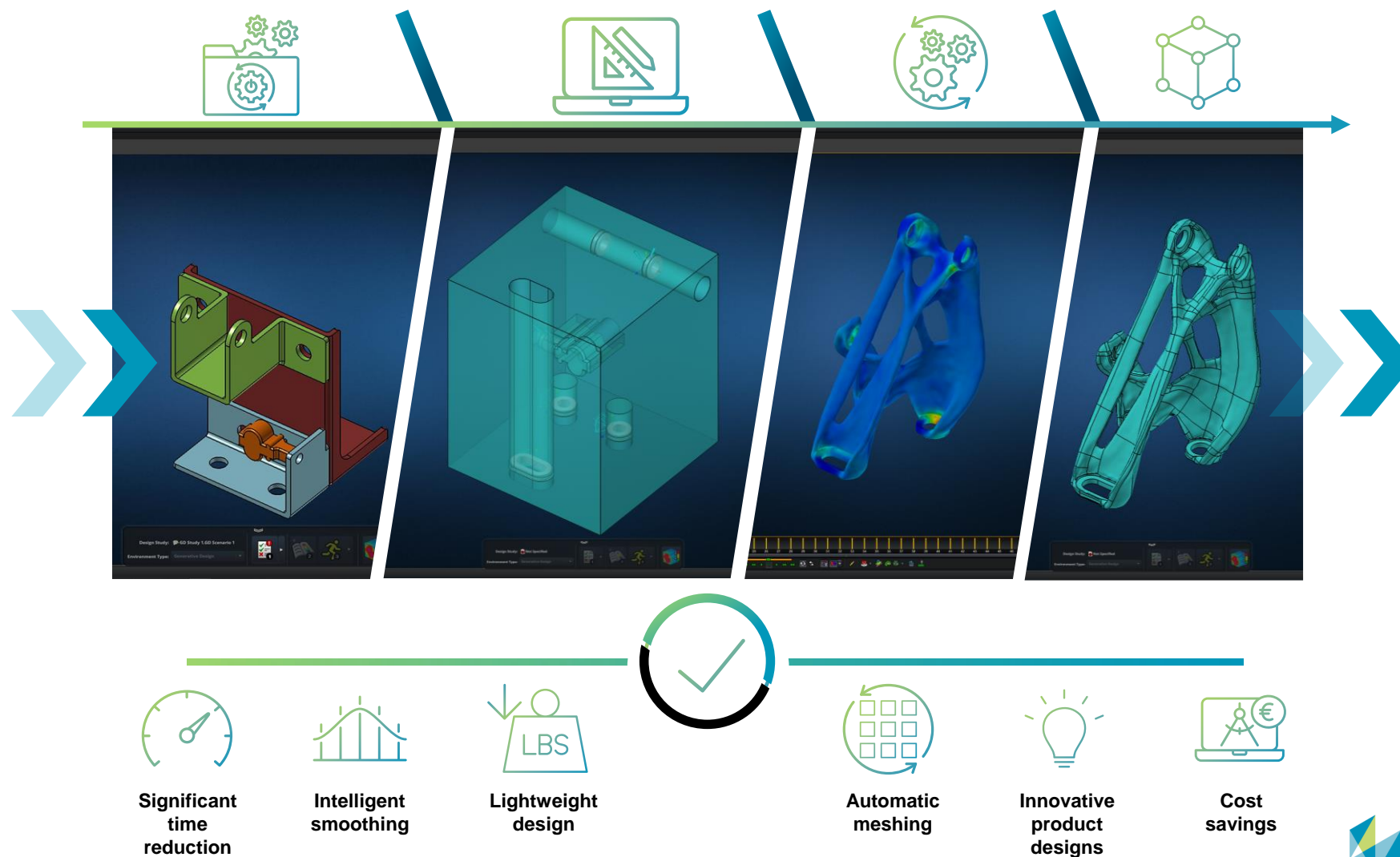


From structural task to robust design

Generating manufacturing-ready results

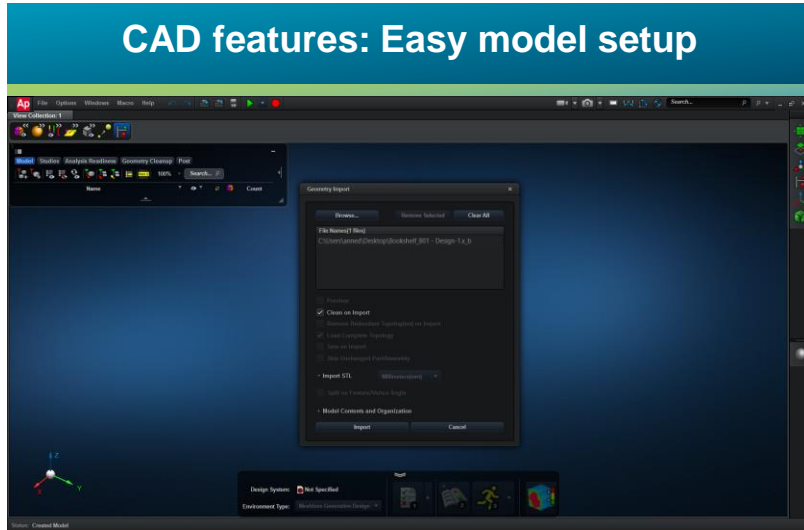


One Fluent Optimization Workflow from CAD to CAD



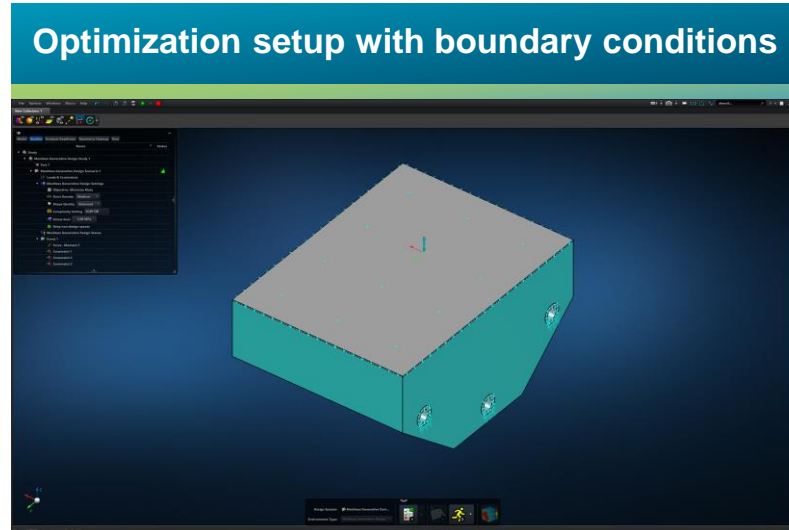
At a Glance: Easy-to-use Generative Design

CAD features: Easy model setup



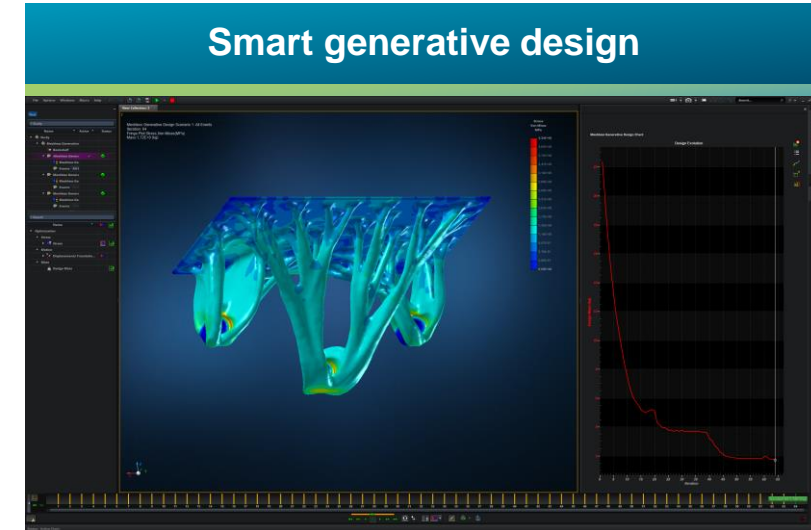
- Various input formats
- Basic CAD functionalities
- Split design / non-design with few clicks
- Comprehensive material definition

Optimization setup with boundary conditions



- Boundary conditions are directly added to non-design spaces
- Loads are applied as known from classic FE

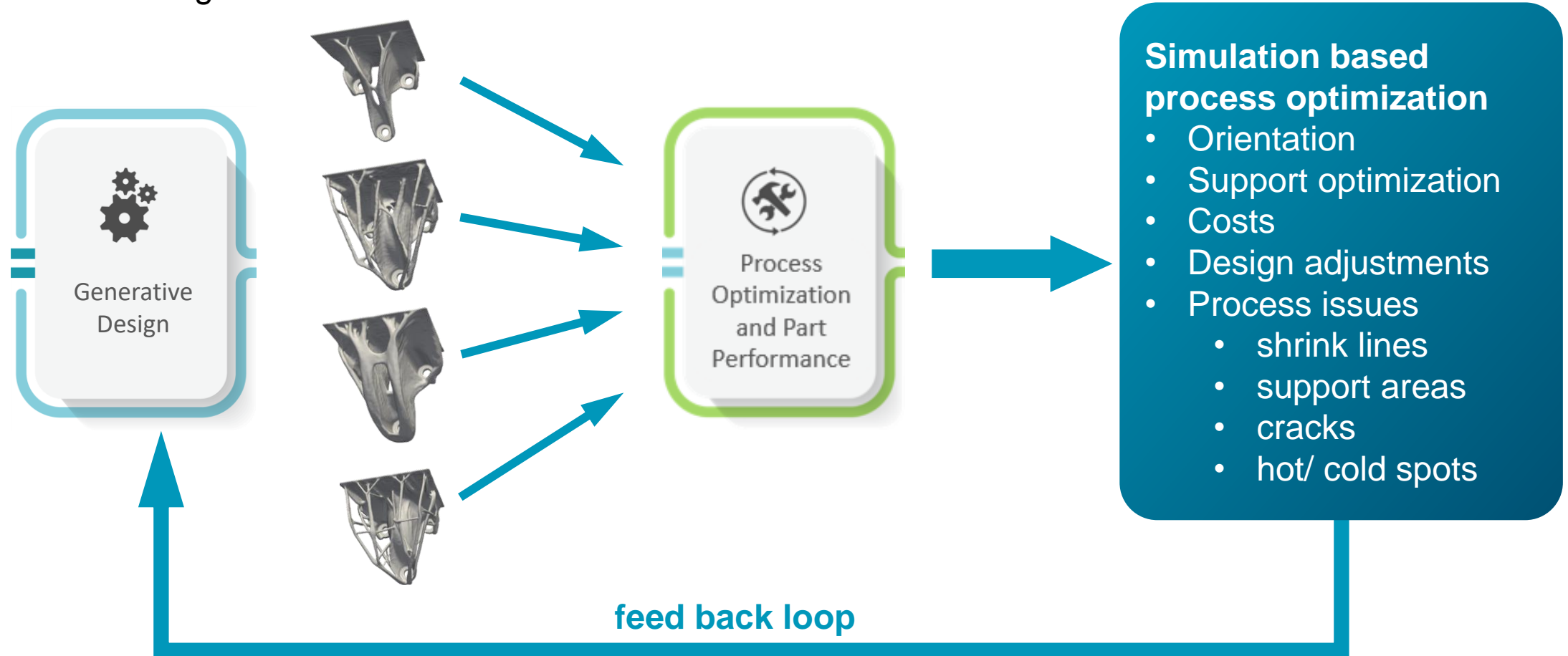
Smart generative design



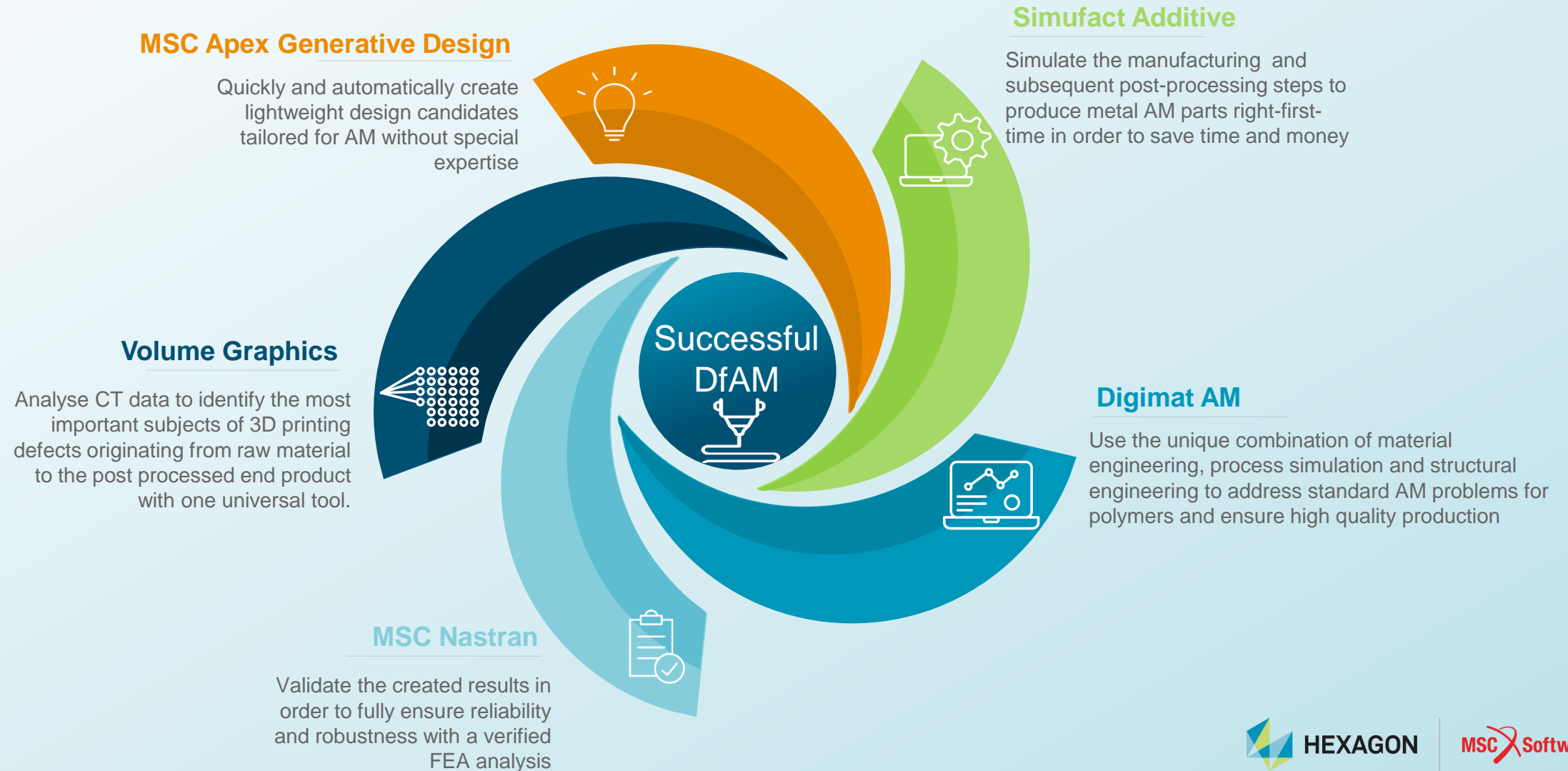
- Cutting edge optimization technology
- Fast & reliable results
- Feasible output in every iteration
- Opportunity of alteration at any time
- Generative design for a broad variety of optimal solutions

Enabler: Generative Design combined with build simulation

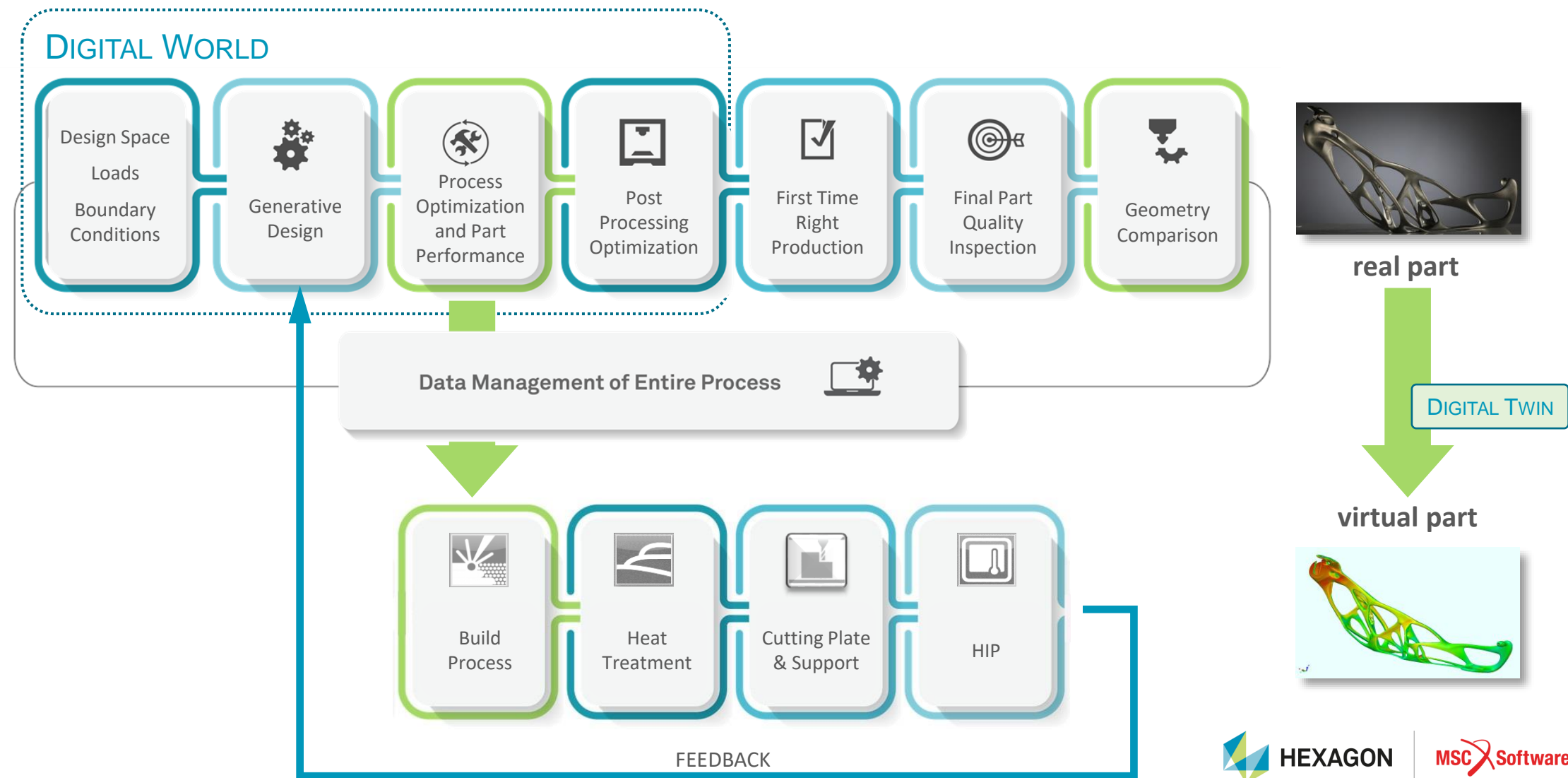
Design candidates – several variants



Design end to end process through interconnected products



Process Optimization through Virtual Manufacturing



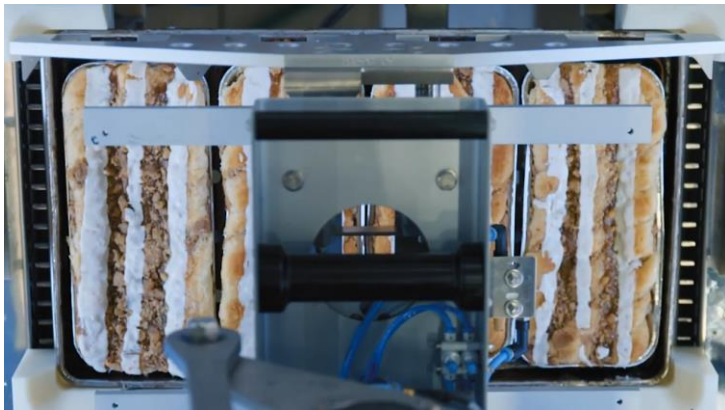


Case study: Packaging Gripper

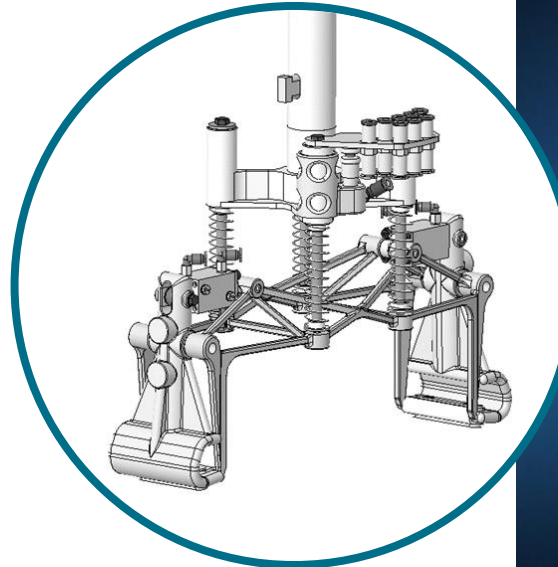
Optimize highly complex gripper

Use case:

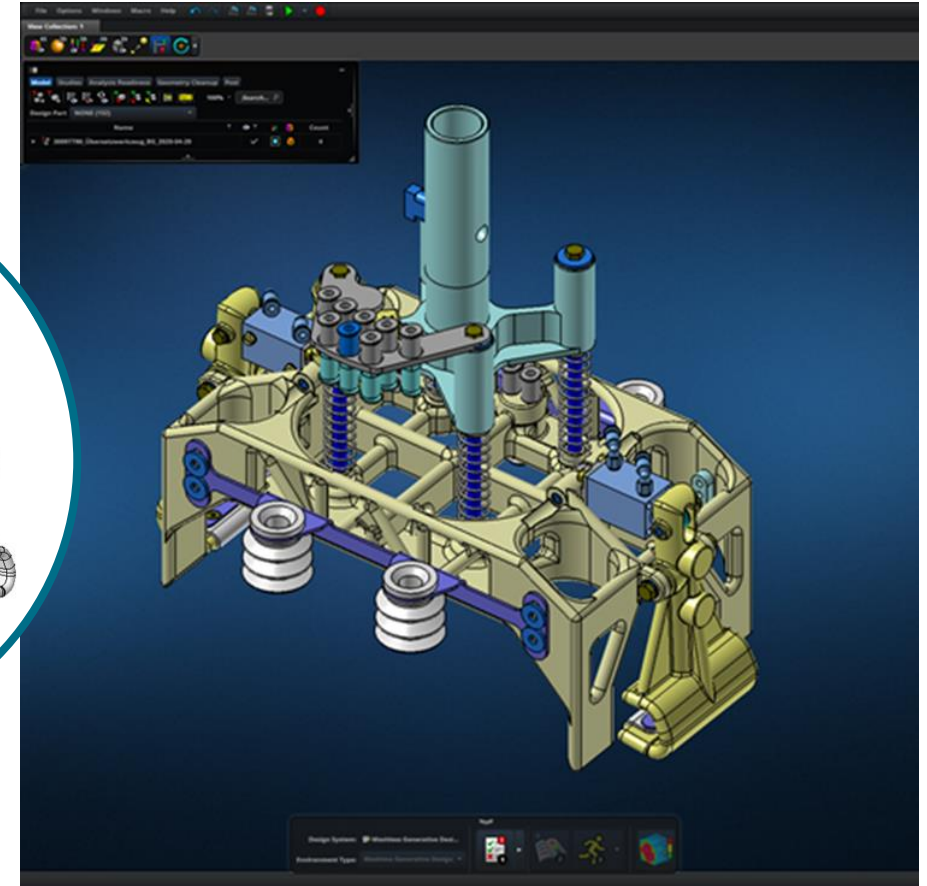
- Gripper picks a packing unit, grips the unit, transports it to a different place and unclasp the packing unit
- Part's length: ~250mm
- Classic design too heavy
- Manual optimization not stiff enough



Exemplary application



Manual optimization attempt

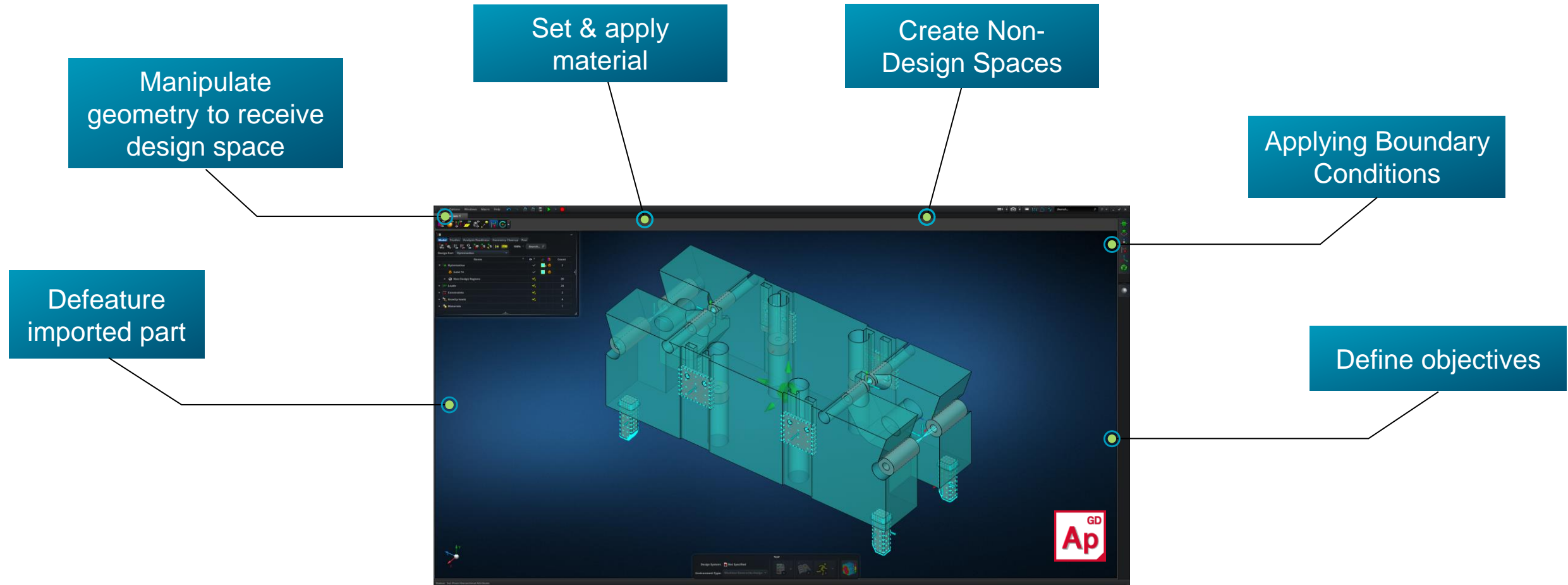


Original geometry imported to MSC Apex Generative Design

→ New approach required

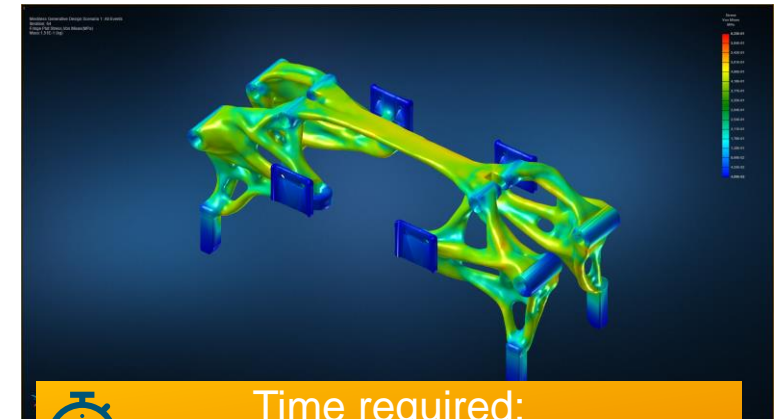
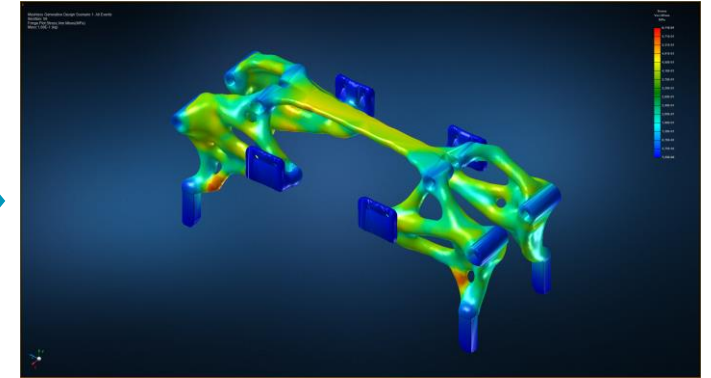
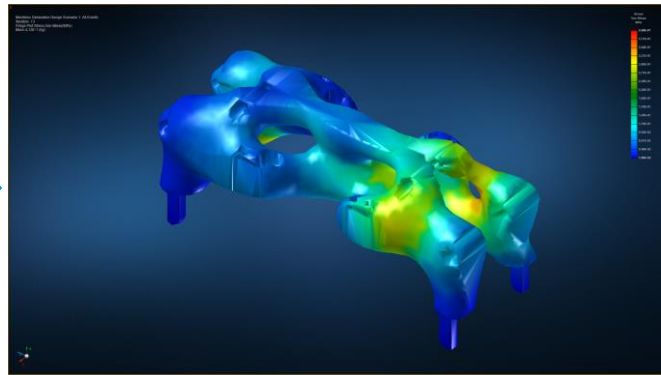
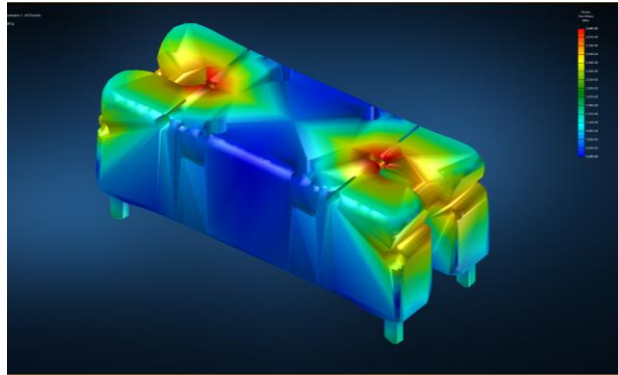
Optimization model set-up

MSC Apex Generative Design



Optimization 1 – PA12 Polymer

Optimisation start

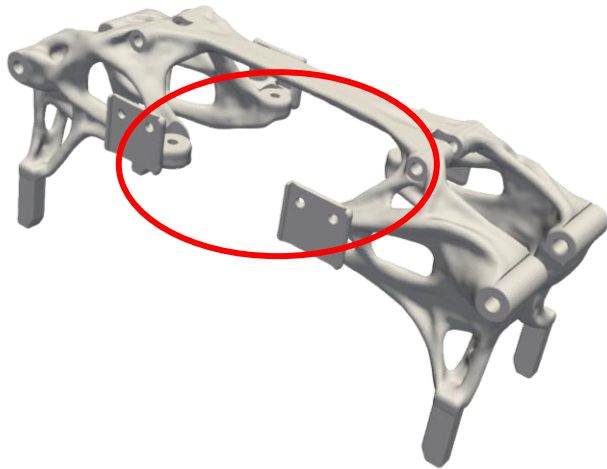


Time required:
18 min on calculation server

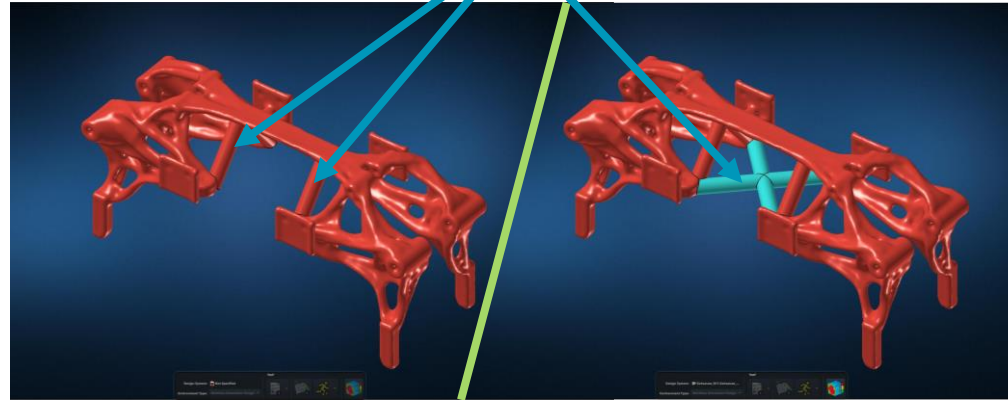
- Complexity of the model is within the customer's set range
- Very lightweight Design
- Very equal stress distribution efficient material usage

Optimization 2 – PA12 Polymer with additional Strut

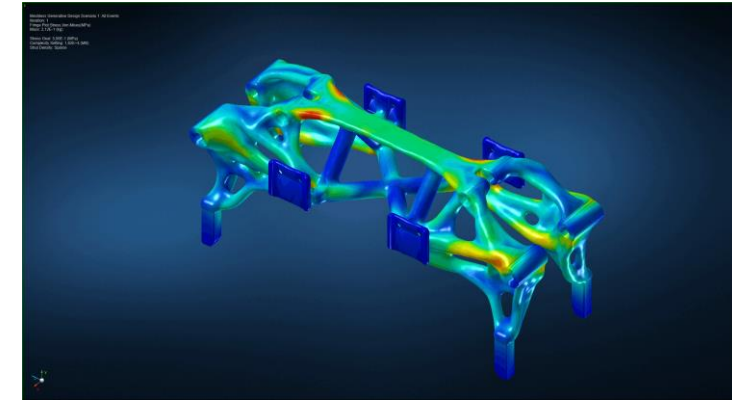
Not enough connection
between the sides



Add new cylinders
& cross structure in the middle



Creation of a new structure

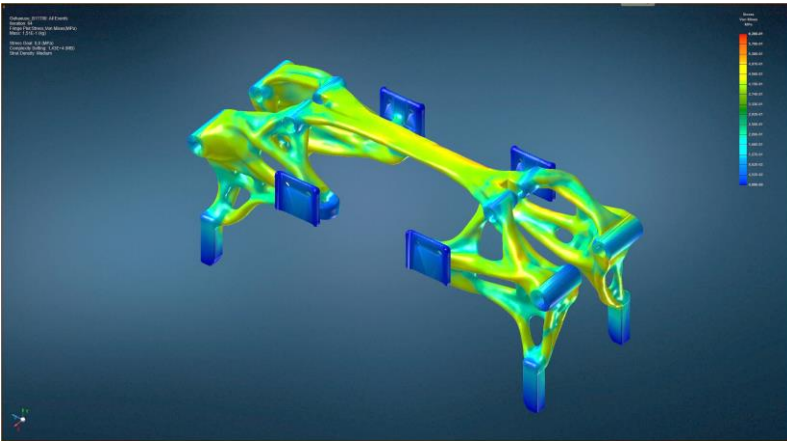


- The customer asked for an additional strut
- Manually added different struts with geometry tools of MSC Apex Generative Design to the existing result
- Run a new simulation with this modification to ensure a proper integration into the overall structure

Optimization – PA12 Polymer

Comparison

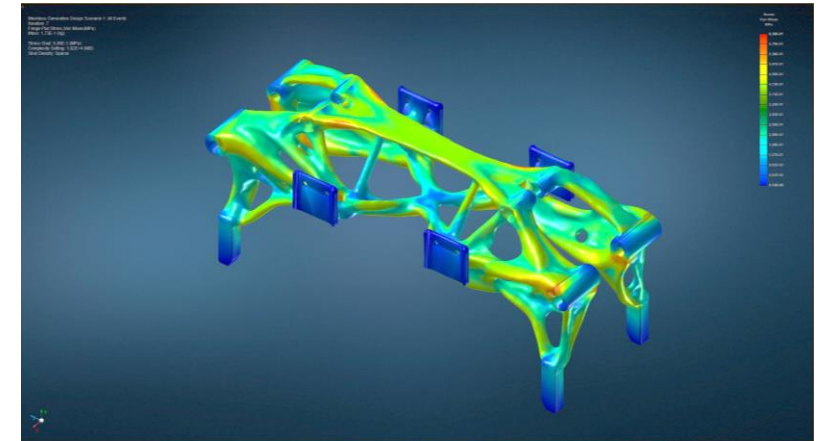
Original optimization result



Similar stresses

+6% heavier

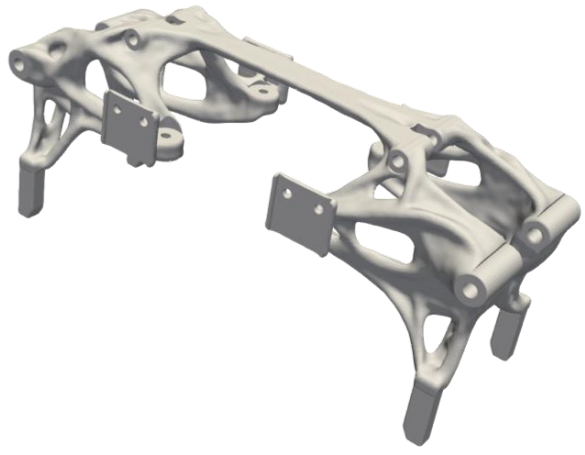
Result with added struts



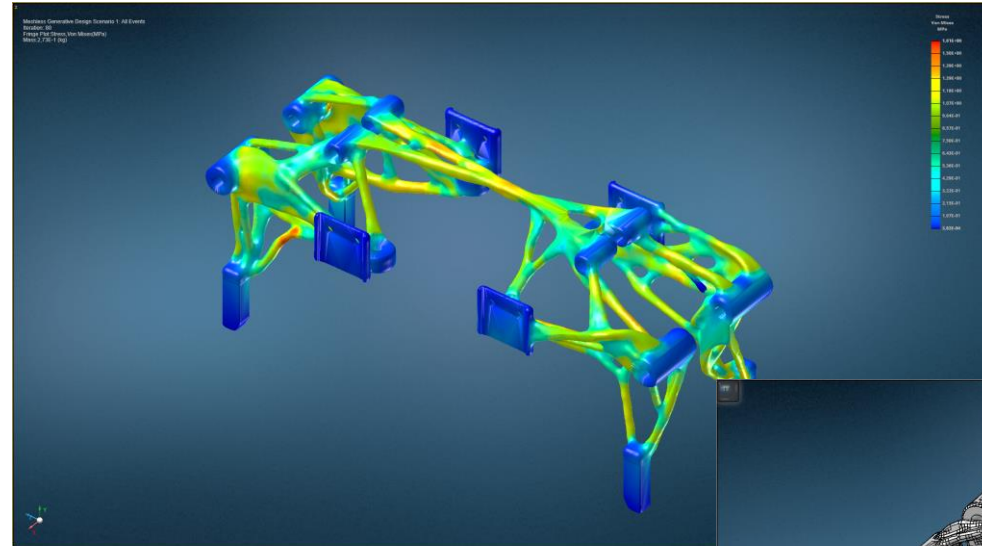
- Added struts almost do not add extra weight
- Surplus material from new struts is taken away somewhere else
- Same stress goal leads to very similar stresses

Optimization 3 – Aluminium

Previous design used as start design



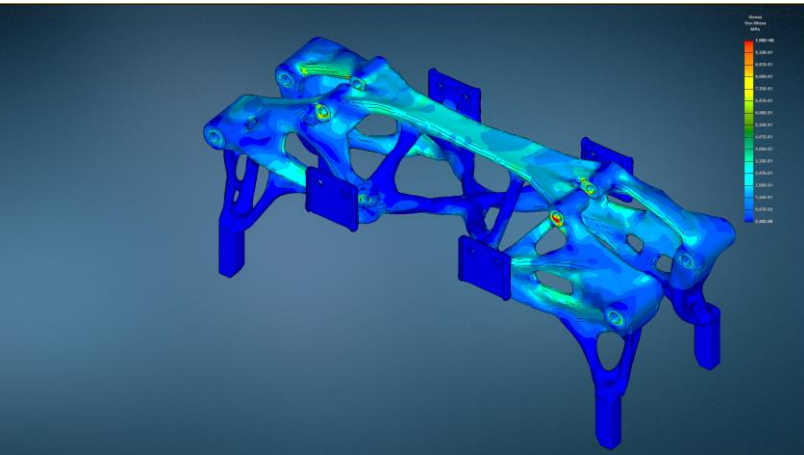
- Customer asked for a metal design
- Used previous polymer design as a start design
- Part too big for their metal machine
- Divided in the middle and added manually an adaptor with the software
- Run a few iterations to have it properly integrated and adapted



Verification Stress Analysis Product Grab

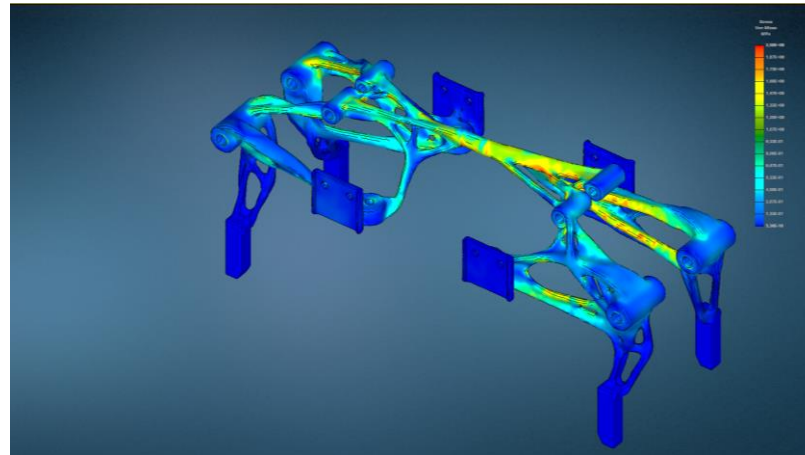
MSC Apex Structures

Polymer design with strut



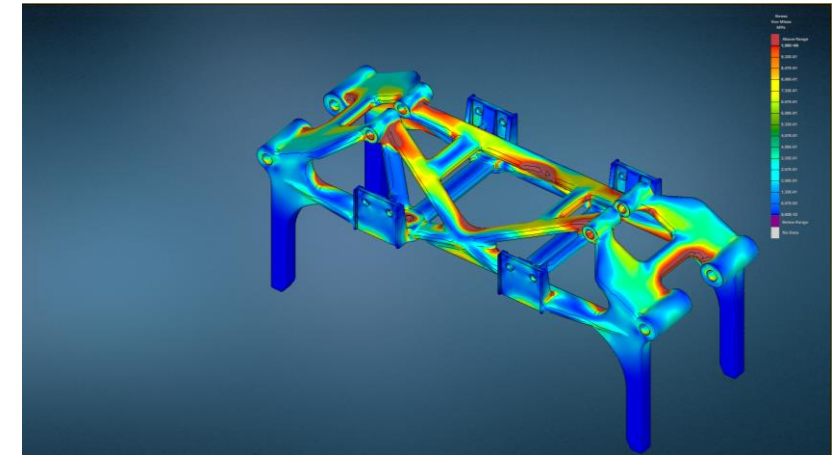
Evenly distributed stress
Overall lower stress
Leads to higher fatigue strength

Aluminum design



Higher Stress Goal for AlSi10Mg
Scale 0-2 MPa

Customer's design

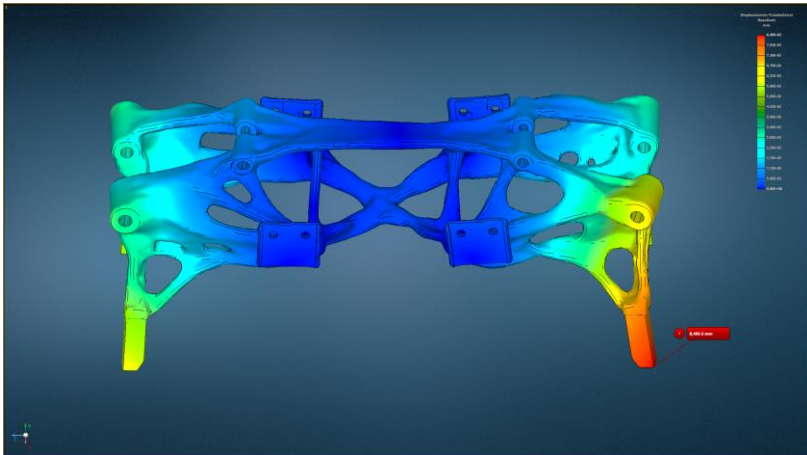


Local Stress risings for the
customer's design

Verification Deviation Analysis Product Grab

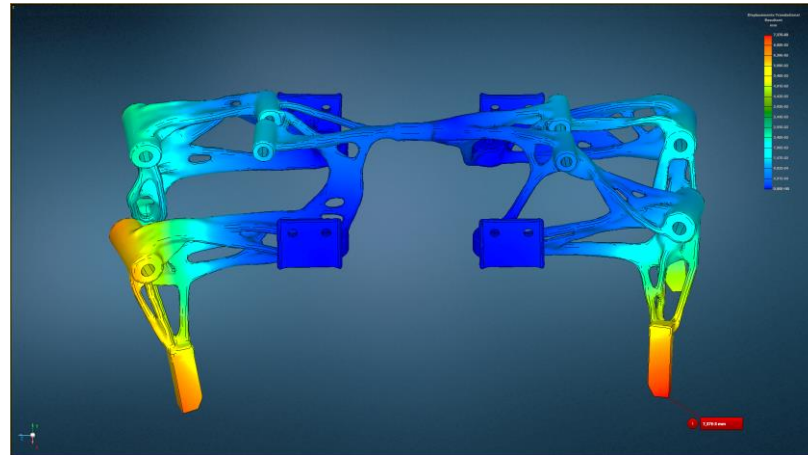
MSC Apex Structures

Polymer design with strut



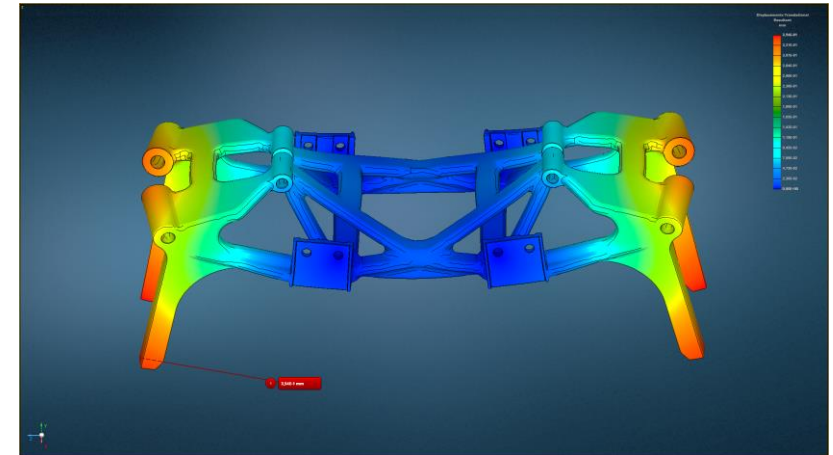
Max. Displacement 0.0849 mm

Aluminum design



Max. Displacement 0.00737 mm

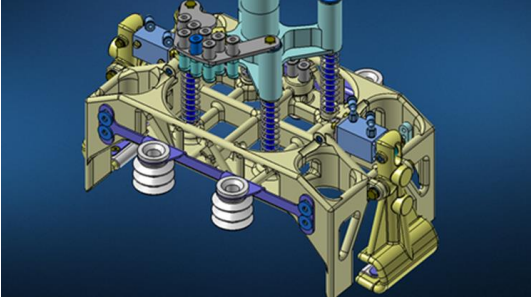
Customer's design



Max. Displacement 0.354 mm

Apex GD: Multiple Variants for Gripper

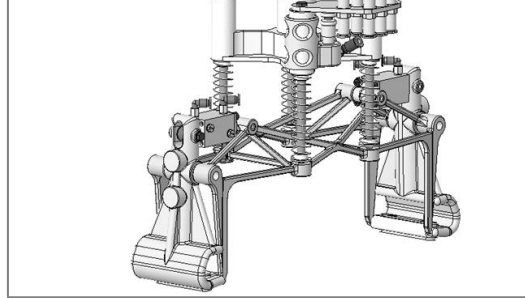
Original Design



Design shall become more lightweight and better tailored for AM



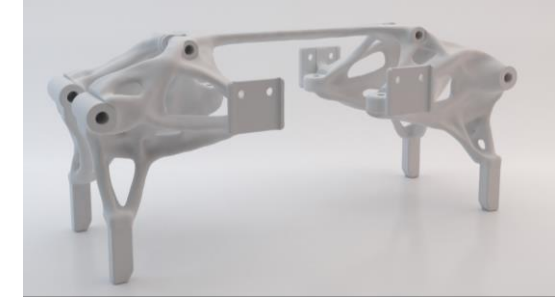
Classic Legacy Optimization



Optimized result is not stiff enough



Apex GD: Plastic Optimization



Set-up optimization model and optimized with plastic material



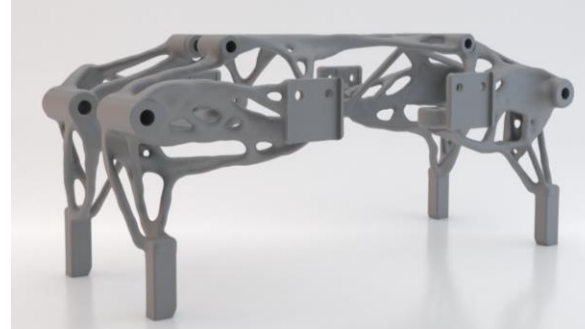
Plastic Optimization with extra strut



Additional strut was added in the middle because customer demanded so. Almost same weight as surplus material was removed elsewhere with new strut



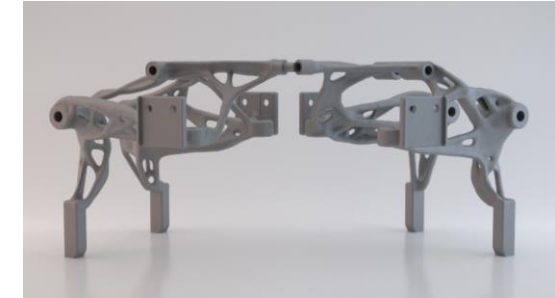
AlSi10Mg Optimization



Previous Design used as Start-Design



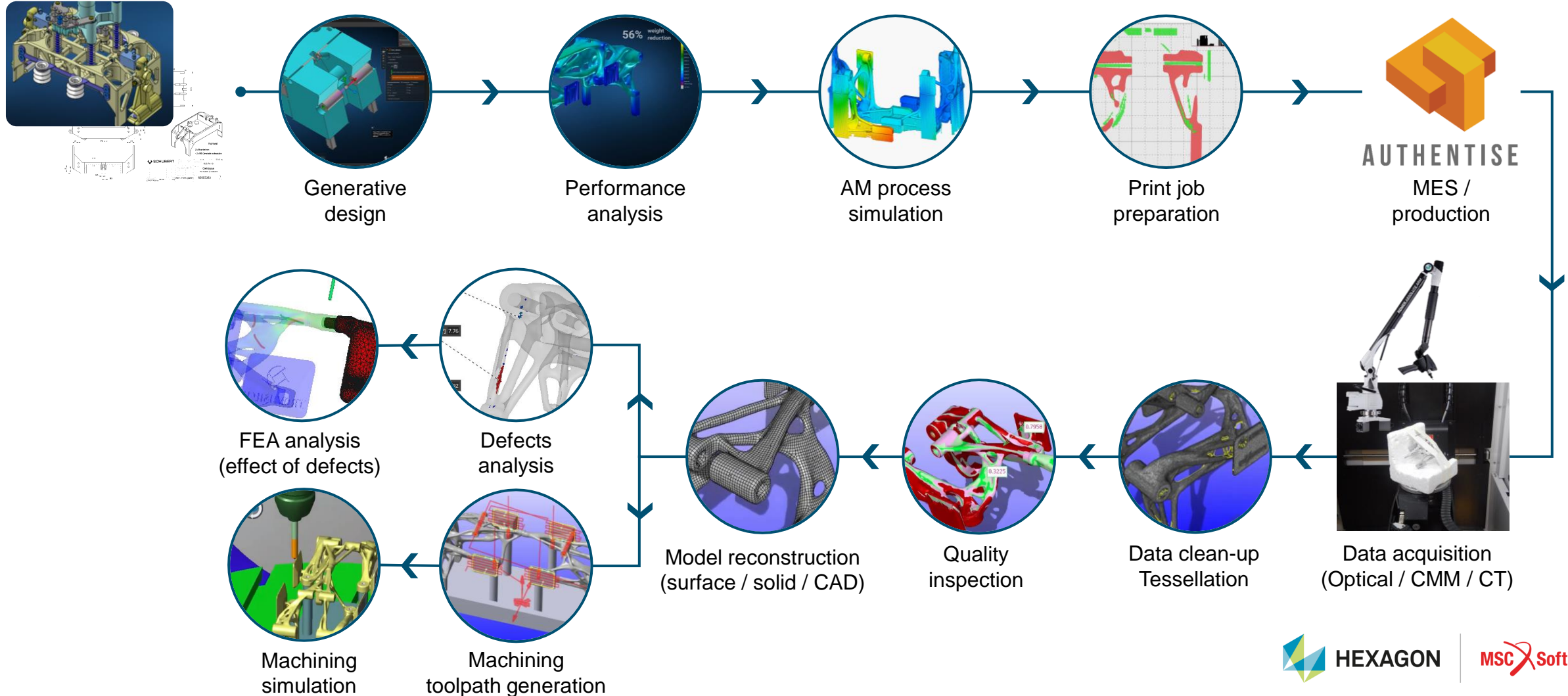
AlSi10Mg Optimization – 2 parts connected



Divided part for manufacturing, added connection and restarted optimization for smooth connection between adapter and remaining structure

End-to-End Workflow

From Design to machining



Simulation for Saving Costs and Time

Get to know the world of Generative Design....

Further information at mscsoftware.com/apexGD



White Paper

More



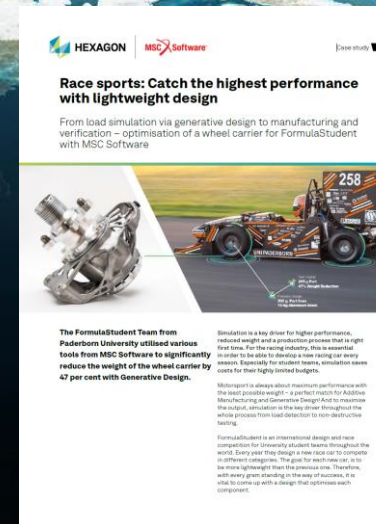
eBook

More



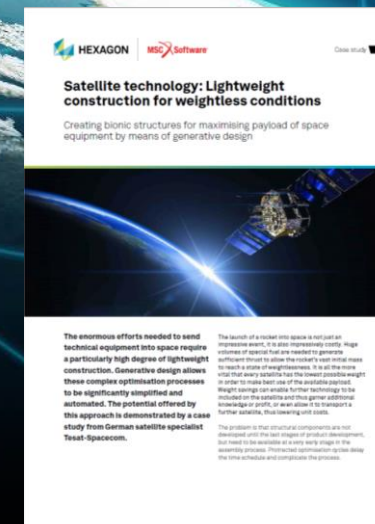
Case Study

More



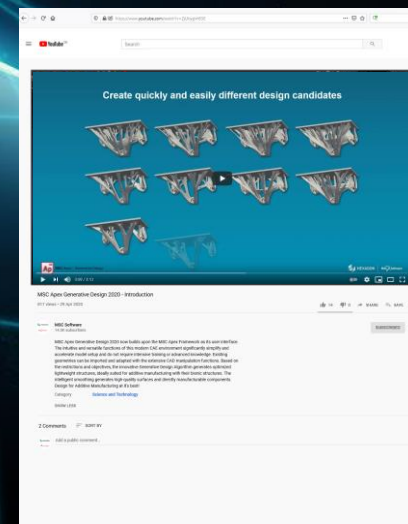
Case Study

More



Case Study

More



Video

More

Thank you

Contact us for making your product development more efficient

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