TECHNODAT

Optimalizace tištených dílů ve formuli

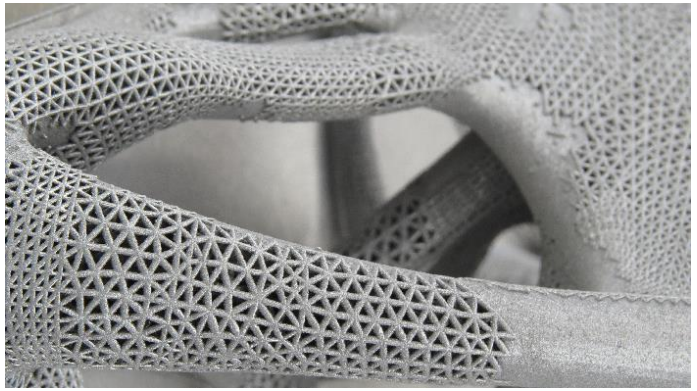
Strojírenské fórum 2018 - Brno

10.5.2018

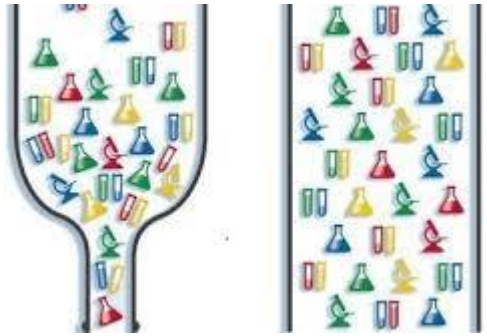
J.Těhník

Agenda

- Představení Technodat, CEA systémy s.r.o.
- Představení Centra aditivní výroby kovů
- Projekt optimalizace dílů pro formuli a vírník
- Postup při optimalizaci dílů
- Vize sdílené virtuální továrny



Technodat EXPERIENCE

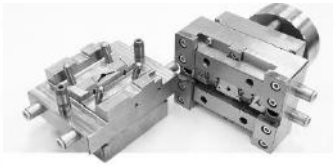


Dlouhodobá spolupráce a partnerství

Transportation & Mobility

Aerospace & Defense

Industrial Equipment



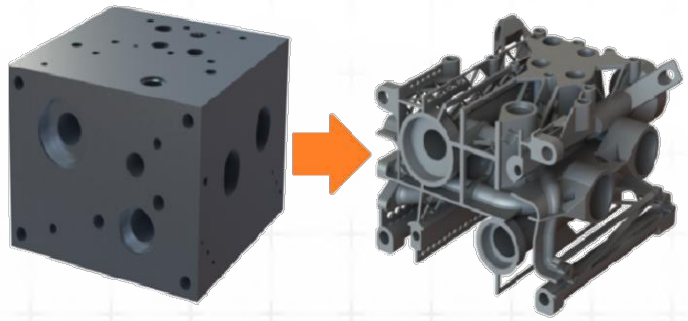
3DEXPERIENCE
www.3dexperience.cz

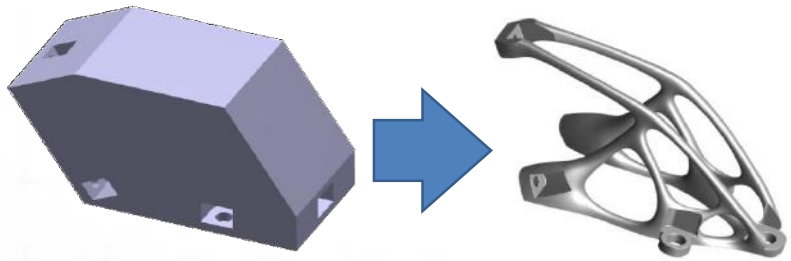
TECHNODAT

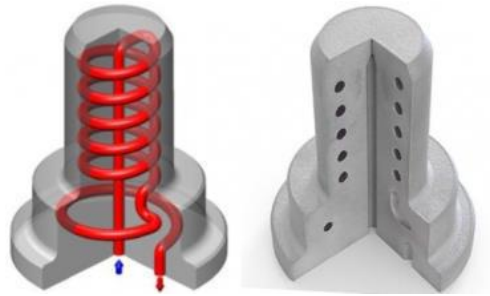
Centrum aditivní výroby kovů

- Spolek CAVK = TECHNODAT 3DS CAVD METAL 3D

- Osvěta, konference, workshopy, analýzy, školení v oblasti MAM
- Optimalizace kovových dílů pro AUTO, AERO, COSMIC a IE



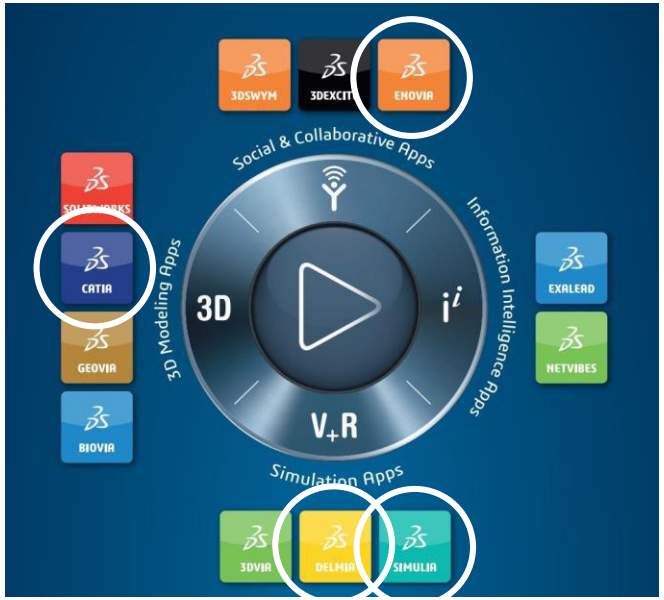




- www.AdditiveManufacturing.cz

Metal Additive Manufacturing
COMPLEX SOLUTION CENTER

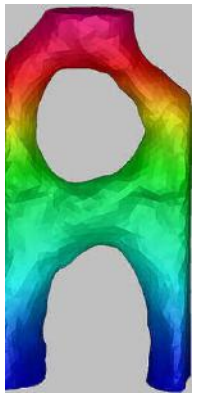
Business Partners Universities



SW

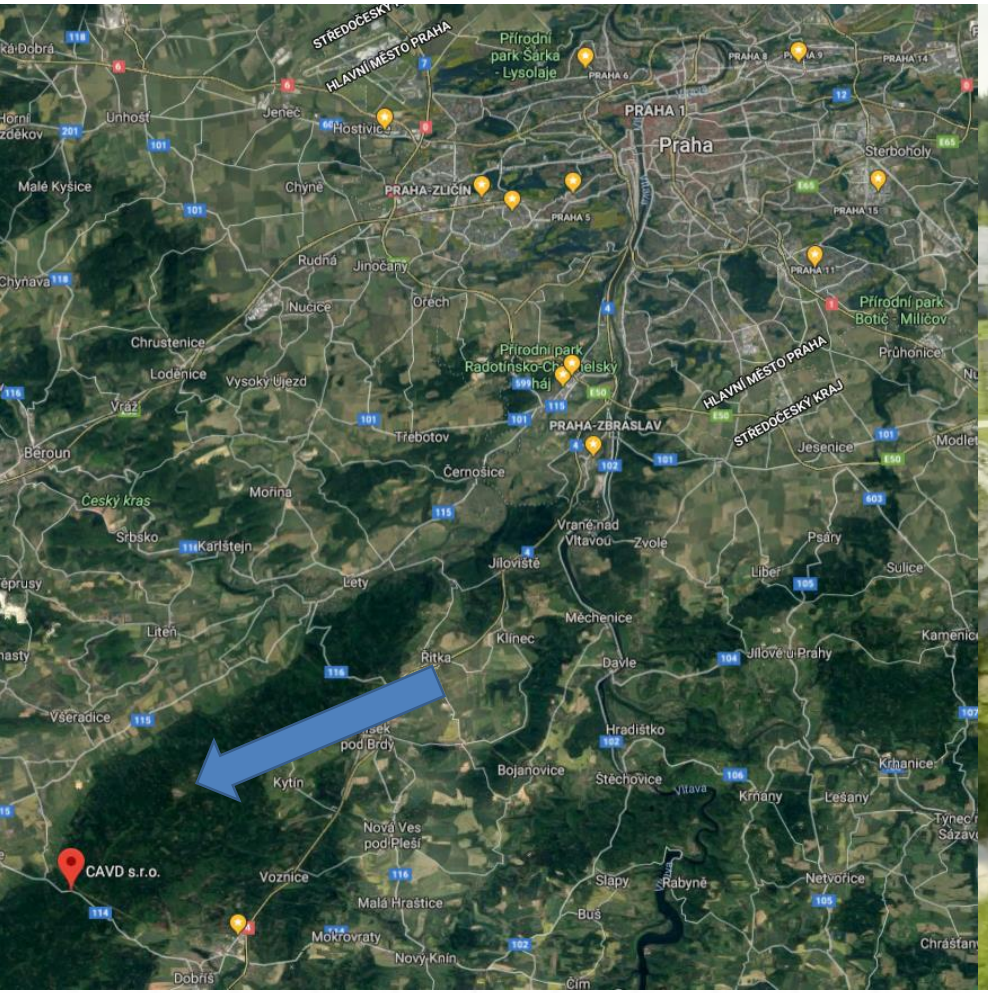
HW

AM product optimization lifecycle



Reverse engineering → Design & Generate → Simulate → Validate laser path → Produce → Post-process Finalwork

CAVD – Ostrov obnovitelné energie



CAVD - Dobříš

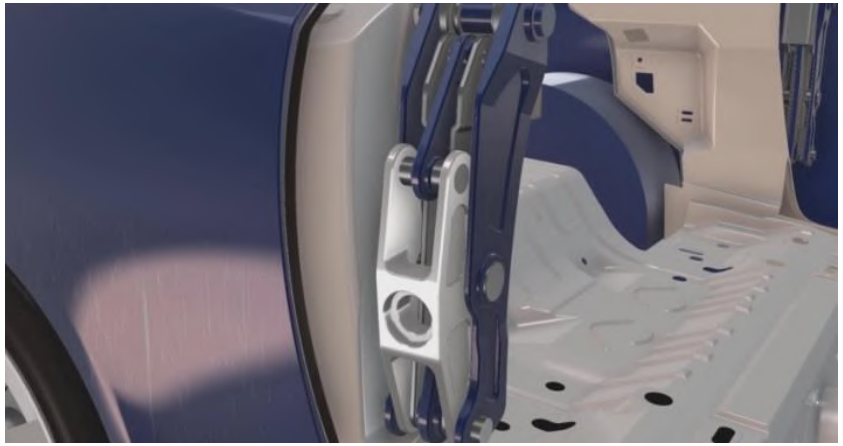
Konference

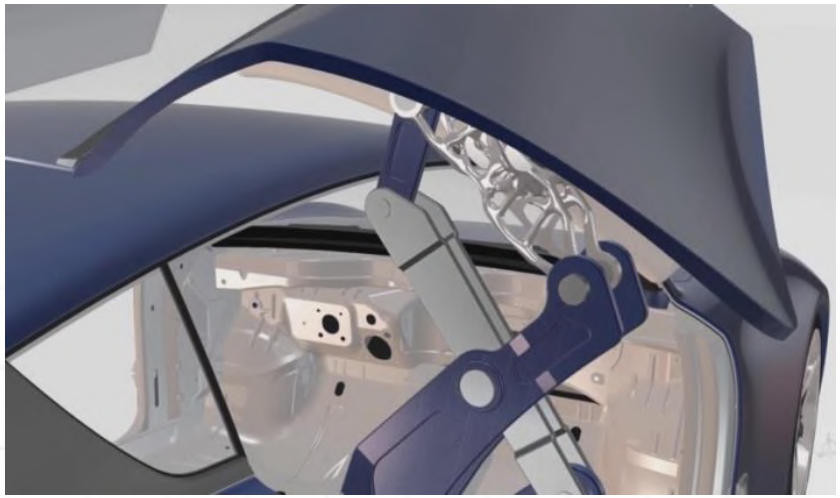
Ing.Petr Zikmund, Ph.D.

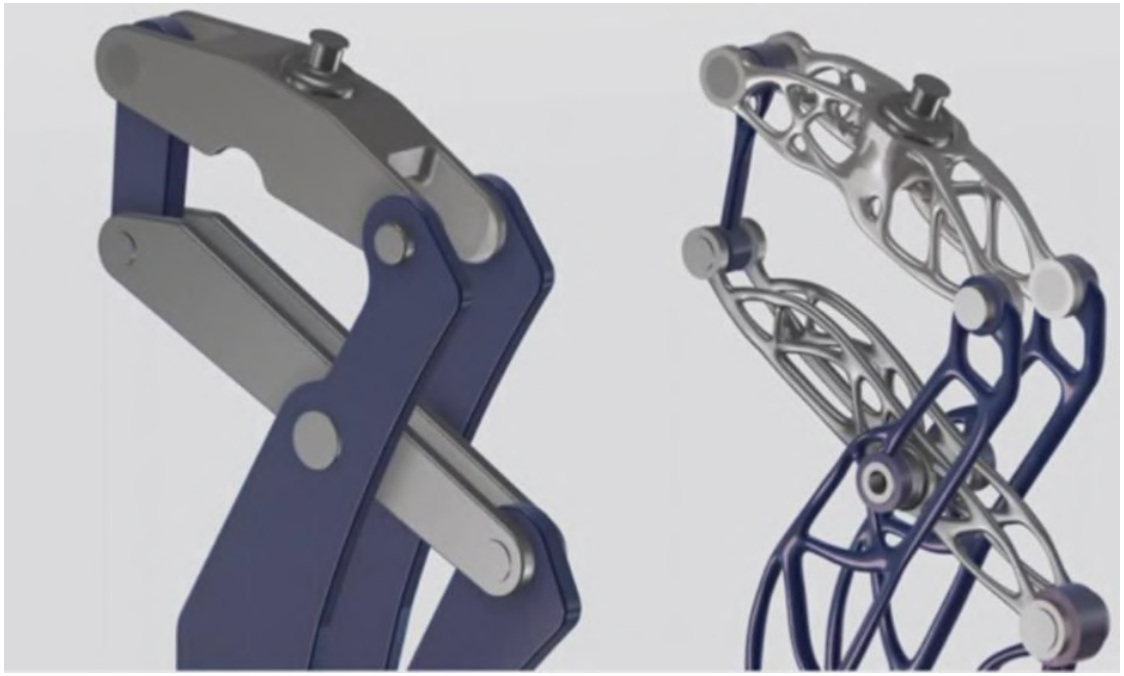
Projekty

CATIA V6 - **3D**EXPERIENCE
Tvorba geometrie

Nové možnosti konstrukce





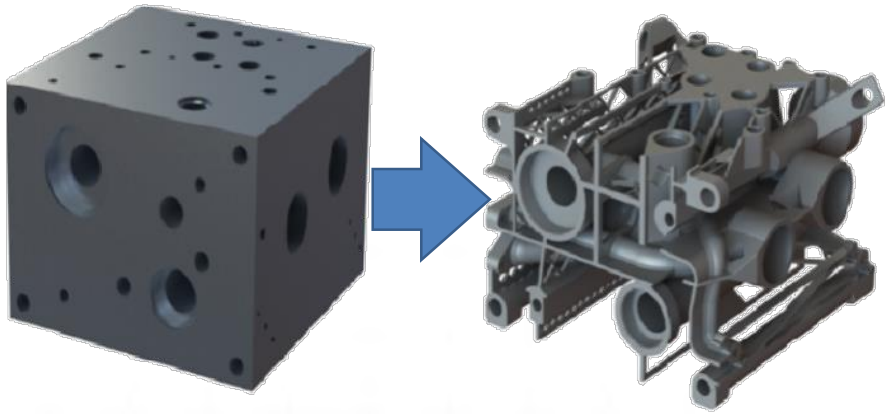


Původní tvar
Hmotnost 790g

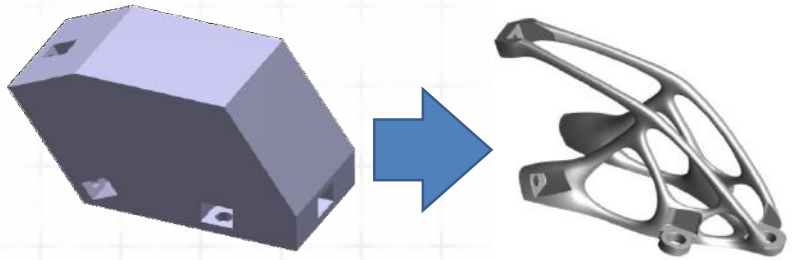
Nový tvar
Hmotnost 380g

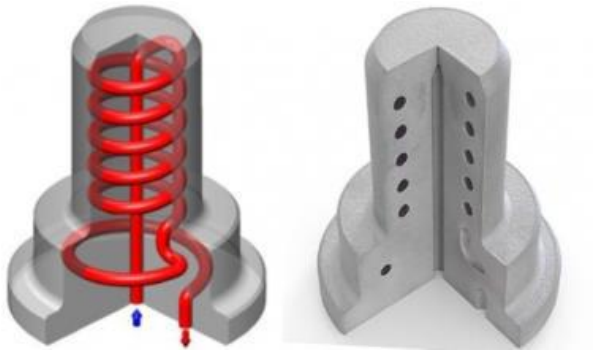
Snížení hmotnosti o 52%

Nové možnosti konstrukce

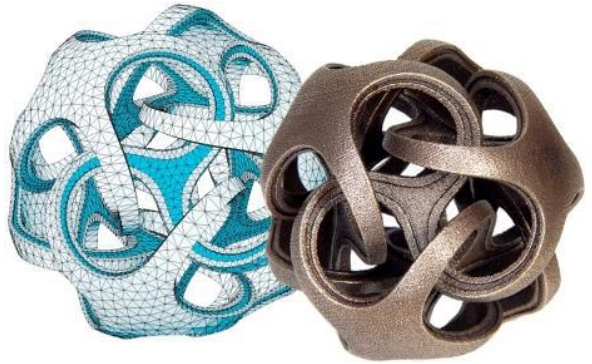


Optimalizace hmotnosti





Komplexní vnitřní tvar

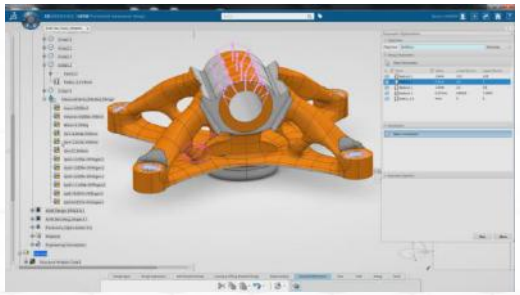
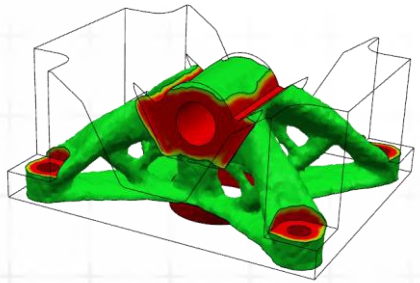
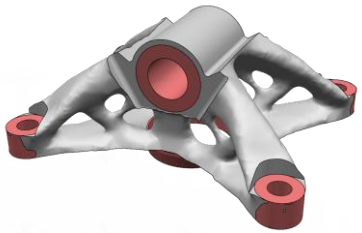
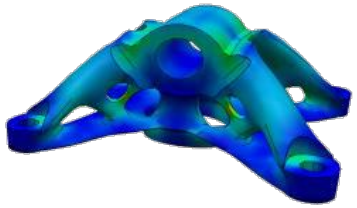


Inovativní design

Functional Generative Design

Modelování, simulace a optimalizace v jednotném prostředí

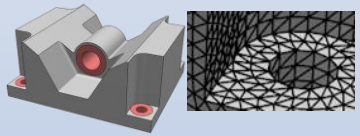
- **Efektivní návrh** produktu
- **Intuitivní pracovní postup** pro konstruktéry
- **Automatické generování** funkčně řízených koncepčních tvarů
- **Bezproblémová spolupráce** mezi konstruktéry, simulačními a výrobními inženýry

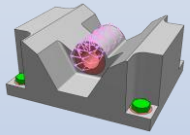

Pracovní postup

1 Funkční specifikace

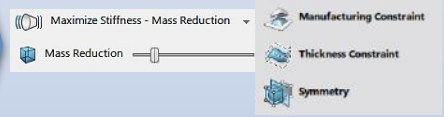
Tvorba vstupní hraniční geometrie



Definice zatížení a okrajových podmínek



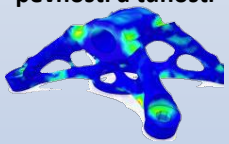
Definice parametrů optimalizace



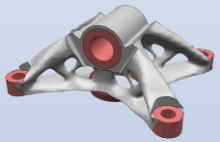
2 Návrh konceptu a porovnání variant

Tvorba variant

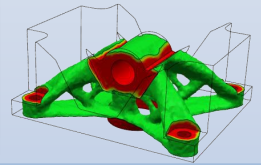
Předběžná kontrola pevnosti a tuhosti



Generování tvaru



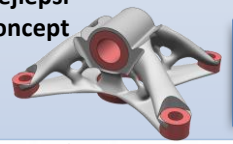
Posouzení konceptu



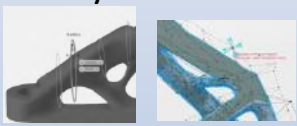
Varianty konceptu

3 Modelování výsledného tvaru

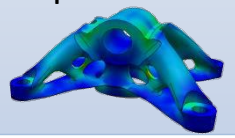
Nejlepší koncept



Tvorba výsledného solidu

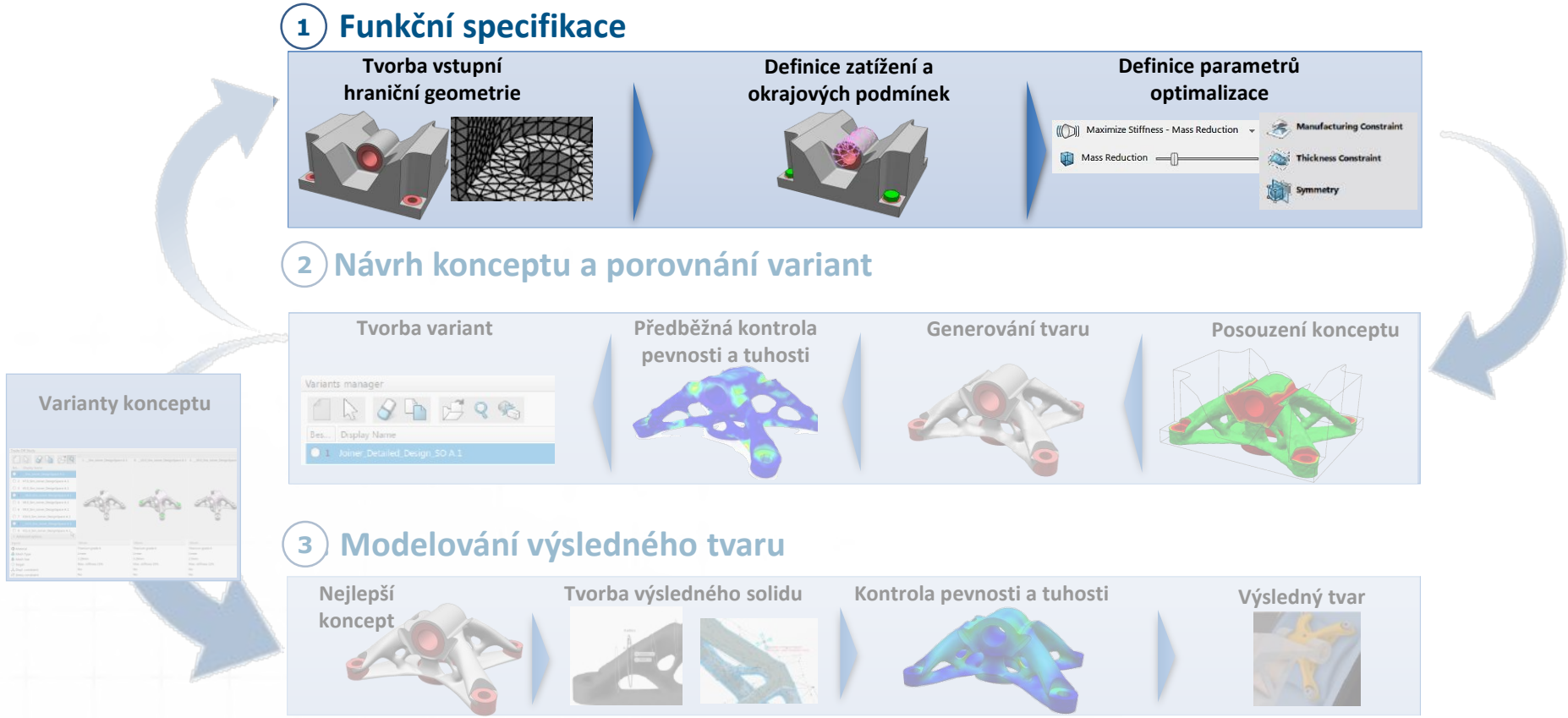


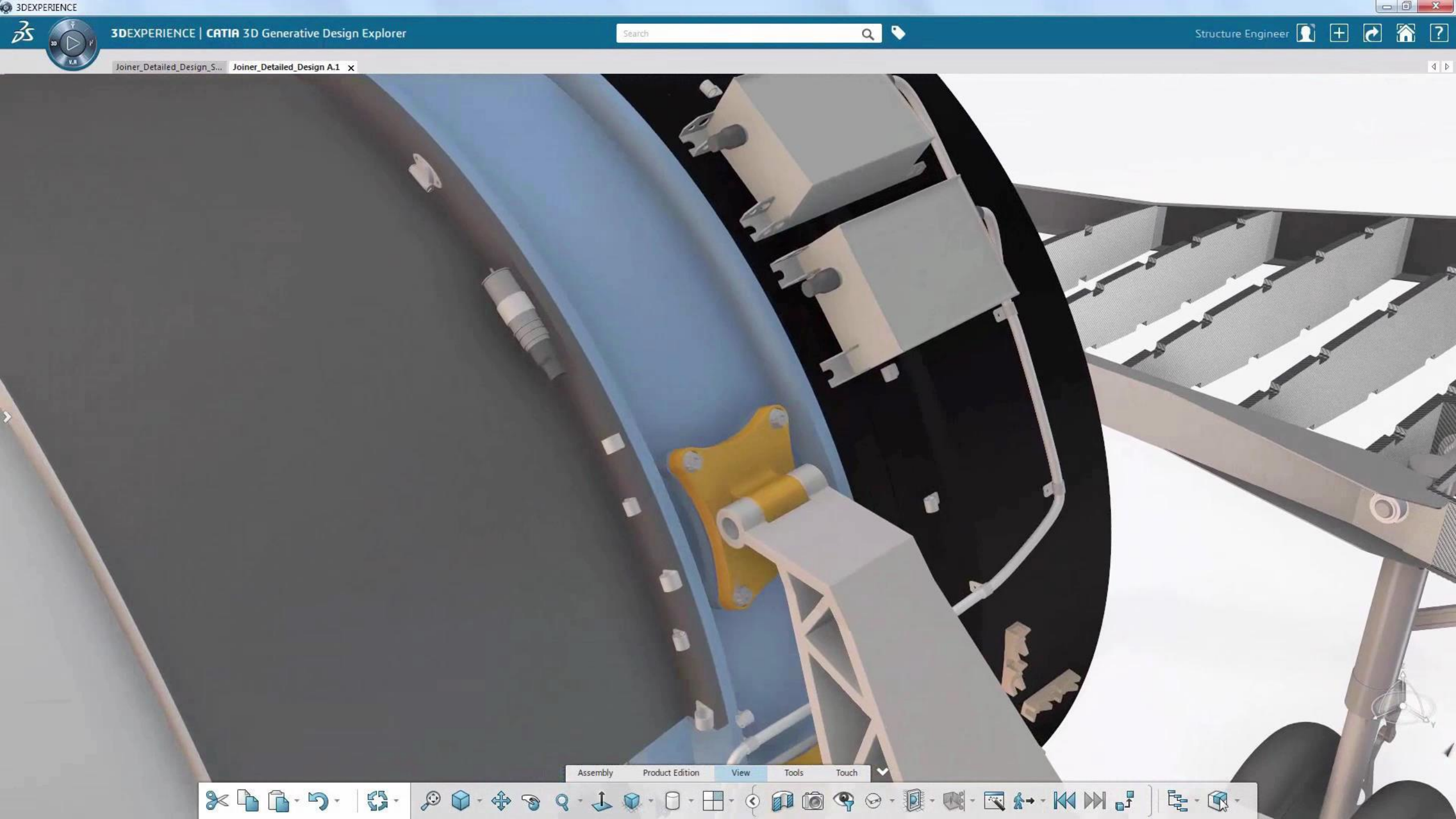
Kontrola pevnosti a tuhosti



Výsledný tvar

Funkční specifikace




3DEXPERIENCE
3DEXPERIENCE | CATIA 3D Generative Design Explorer
Search
Structure Engineer
Joiner_Detailed_Design_S...
Joiner_Detailed_Design A.1
Assembly
Product Edition
View
Tools
Touch

Návrh konceptu, porovnání variant

3DEXPERIENCE

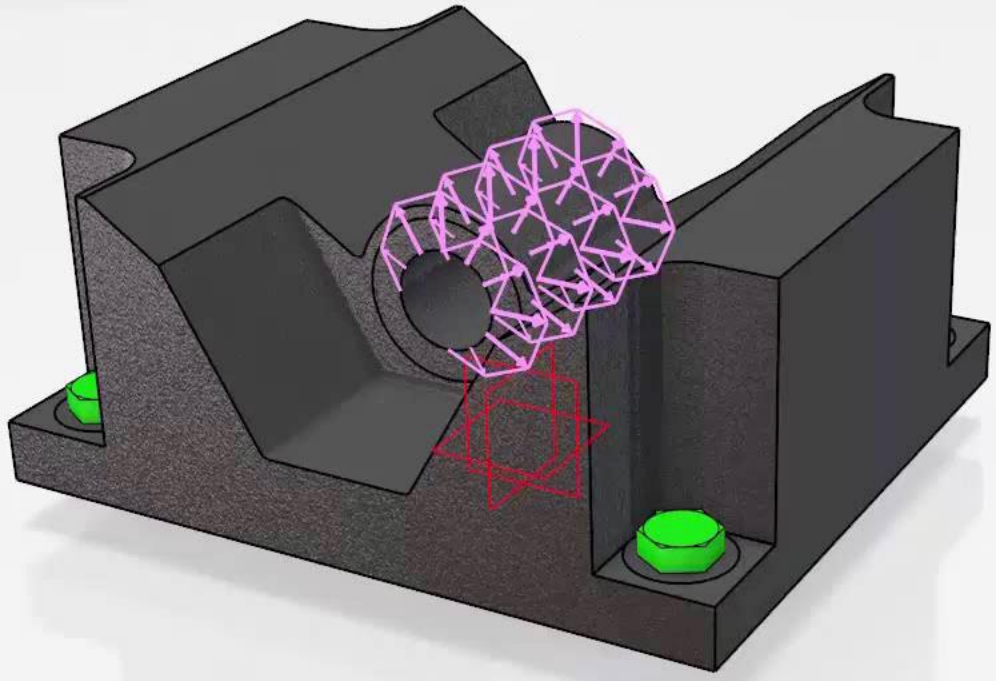
3DEXPERIENCE | CATIA 3D Generative Design Explorer

Search

Structure Engineer

Joiner_Detailed_Design_S... Joiner_Detailed_Design A.1

Výpočet



Exploration Assistant

- Design Space Setup
- Analysis Setup
- Targets
- Constraints
- Shape Controls
  - Manufacturing Constraint
  - Thickness Constraint
  - Symmetry
- Concept Shape
- Design Validation

Structural Analysis Case.1

Design Space | Design Exploration | View | Tools | Debug | Touch

Modelování výsledného tvaru

Z
X
Y

SIMULIA – Simulace, optimalizace

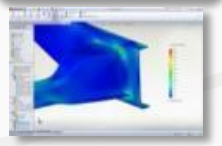
SIMULIA

Simulace Podporují Inovace

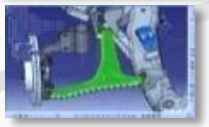
3DS Technologie | Rozšířené Portfolio

Simulace pro Produkt, Přírodu a Život

SolidWorks Simulation



CATIA Analysis



CAD Design Simulace

Abaqus

MKP Multifyzika Simulace

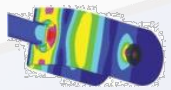
Isight

Procesní Integrace & Optimalizace Designu

Tosca

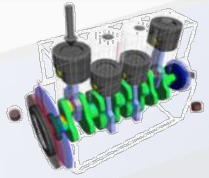
Ne-parametrická Optimalizace

fe-safe



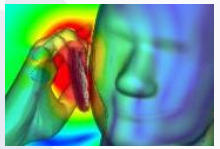
Únava

Simpack



Multi-Body Dynamics

CST

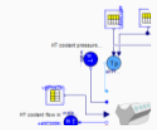


Elektro-magnetické Simulace

Geensoft

Dymola

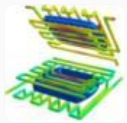
Systémové Simulace



SFE

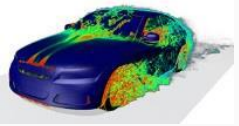
Konceptuální Inženýrství

Simpoe



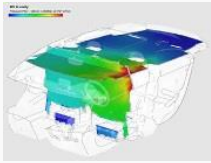
Vstřikování plastů

Xflow



CFD

Wawe6



Akustika

3DEXPERIENCE®

SIMULIA

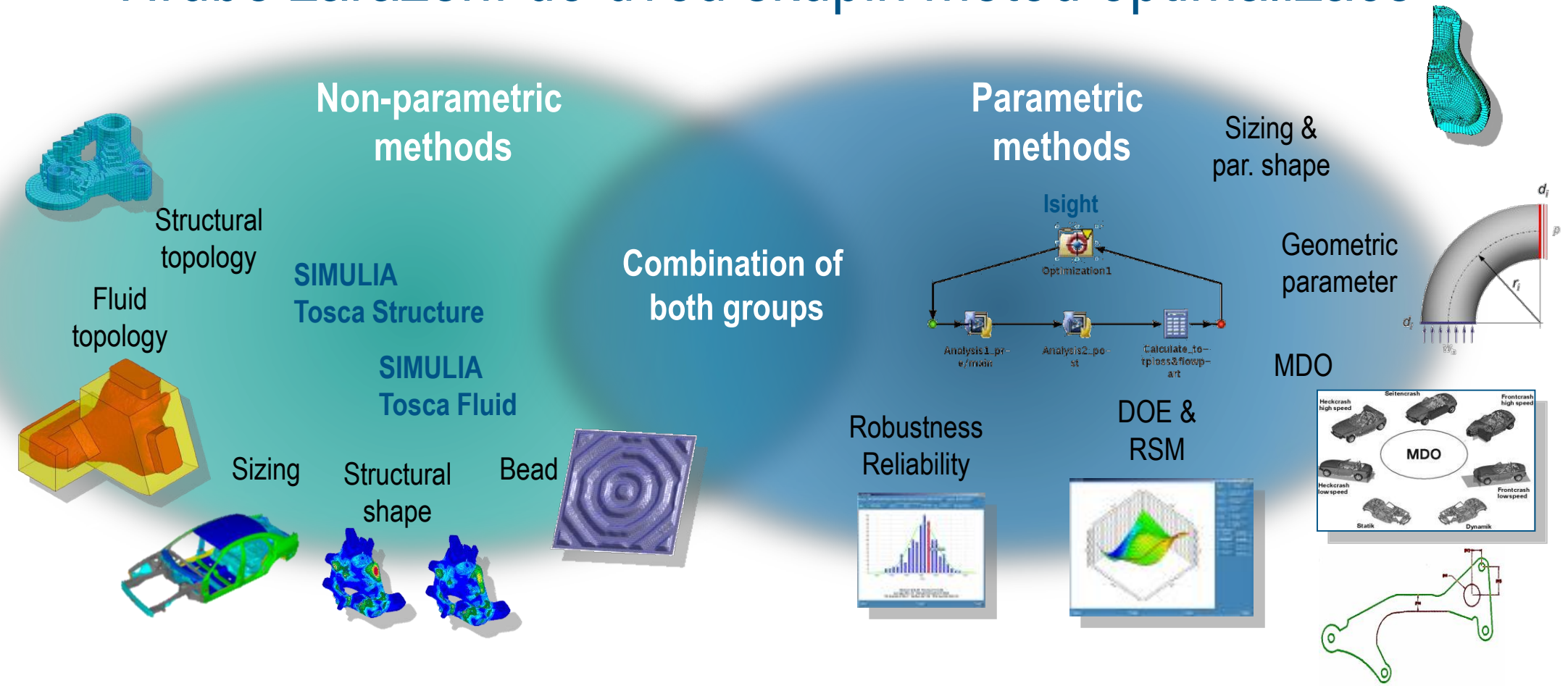
Sjednocení virtuálního a reálného světa pro všechny průmyslové odvětví

SolidWorks

CATIA

SIMULIA

Hrubé zařazení do dvou skupin metod optimalizace



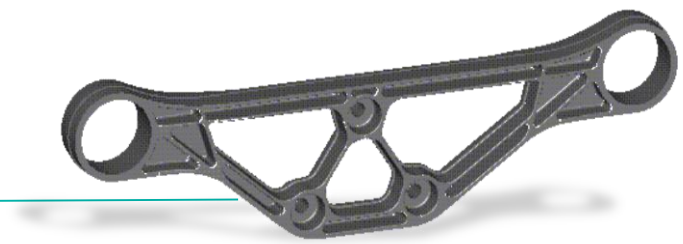
Obě skupiny mají své silné stránky → Možná metoda závisí na dané optimalizační úloze

Topologická optimalizace s Tosca Structure.topology

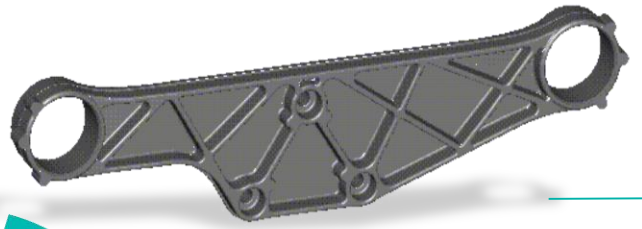
- Topology optimization calculates an optimized design in a given design space for all specified loads and boundary conditions
- The result is a design proposal for the following detailed design process
- Benefits
  - Significantly shorter development time
  - The design process starts with a very good design proposal
  - Precondition for a final design with high quality
  - Saves material, weight and fuel

Courtesy of Audi

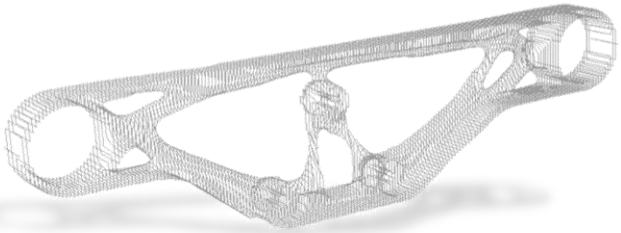
Topologická optimalizace příčného spojení pro AUDI



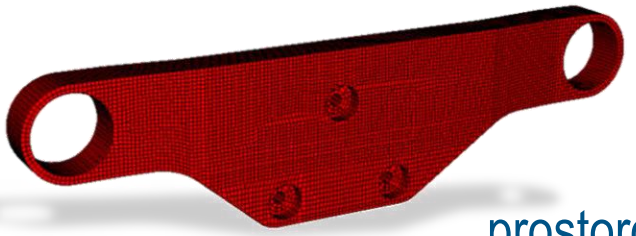
Re-design



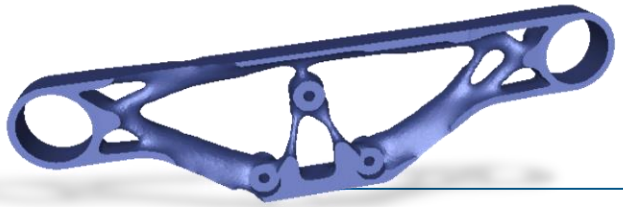
Existující design



Rozklad do vrstev



Návrh prostorového modelu

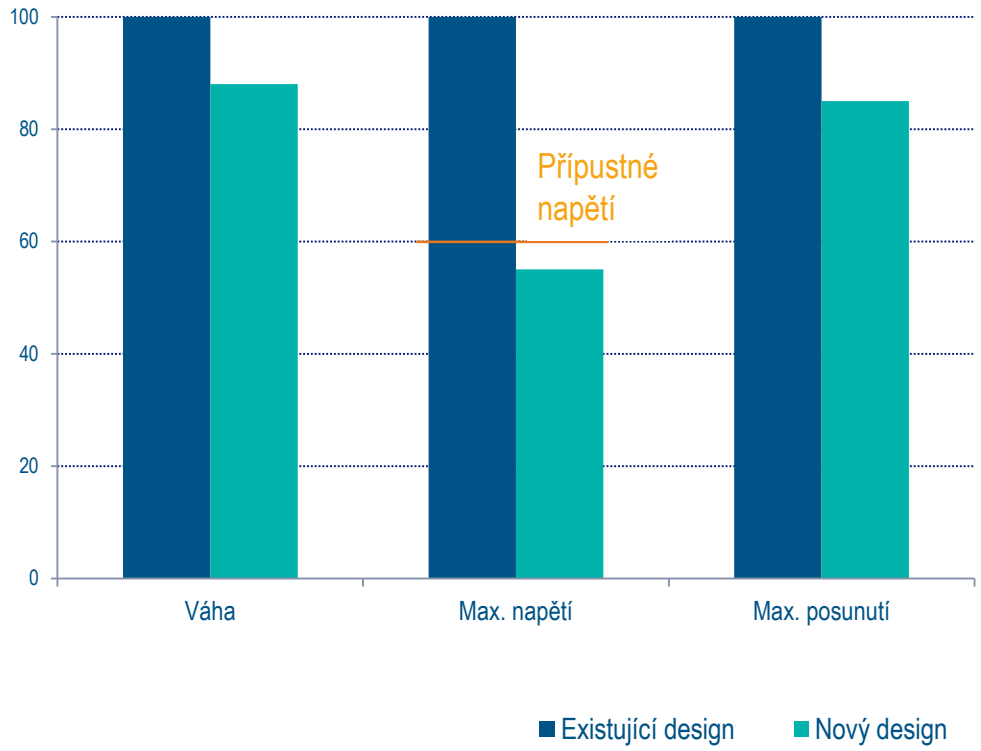


Topologická Optimalizace

Courtesy of Audi

Porovnání

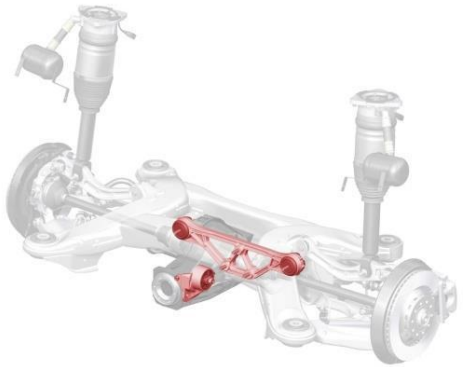
Existující design – nový design



Výsledek

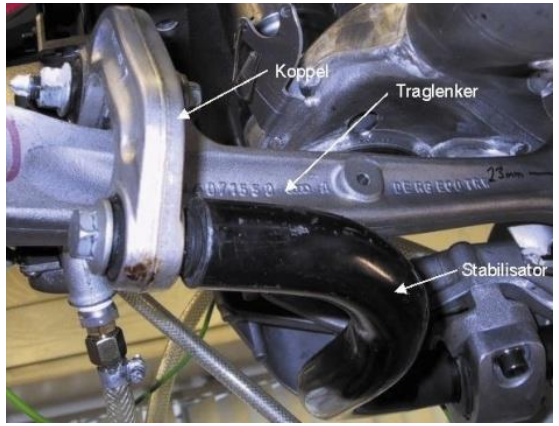
- Zrychlení procesu vývoje
- 45% redukce napětí, 10% redukce hmotnosti
- 1. prototyp prošel všemi mechanickými testy!

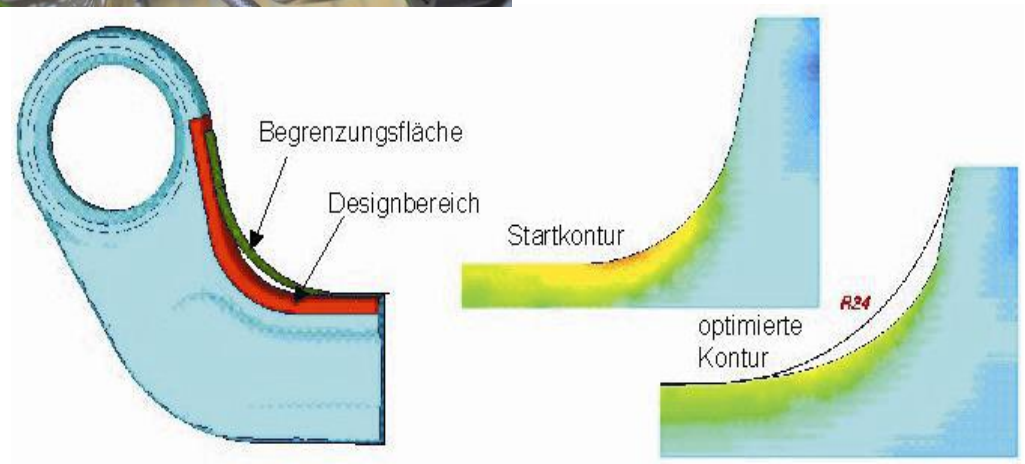
(Image ATZ MTZ extra)



Co je ne-parametrická tvarová optimalizace?

Příklad: stabilizátorový spoj Audi A8





Problem

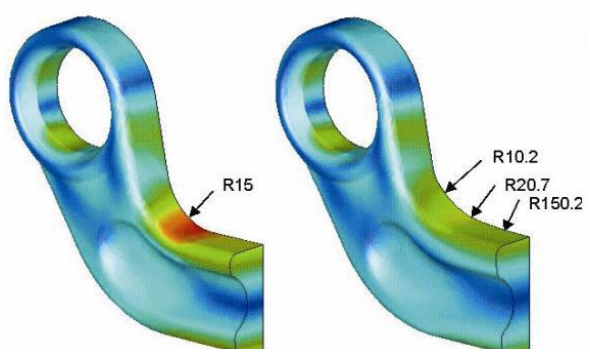
- Changes to the front axle causes that coupling link no longer fulfilled stiffness requirements (see test and simulation results)
- Stress reduction of 25% required!

Possible solutions

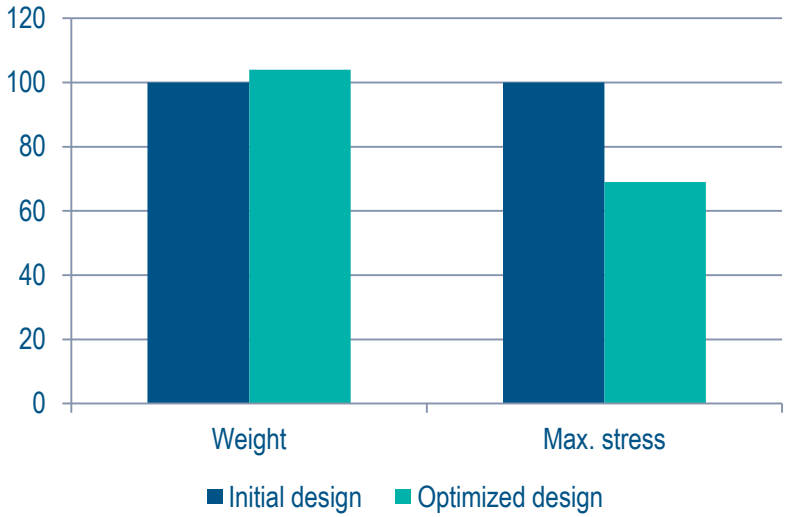
1. Non-parametric shape optimization using Tosca Structure
2. Change of the radius of the contour

Co je ne-parametrická tvarová optimalizace?

Výsledek: stabilizátorový spoj Audi A8



Initial geometry Optimized coupling link

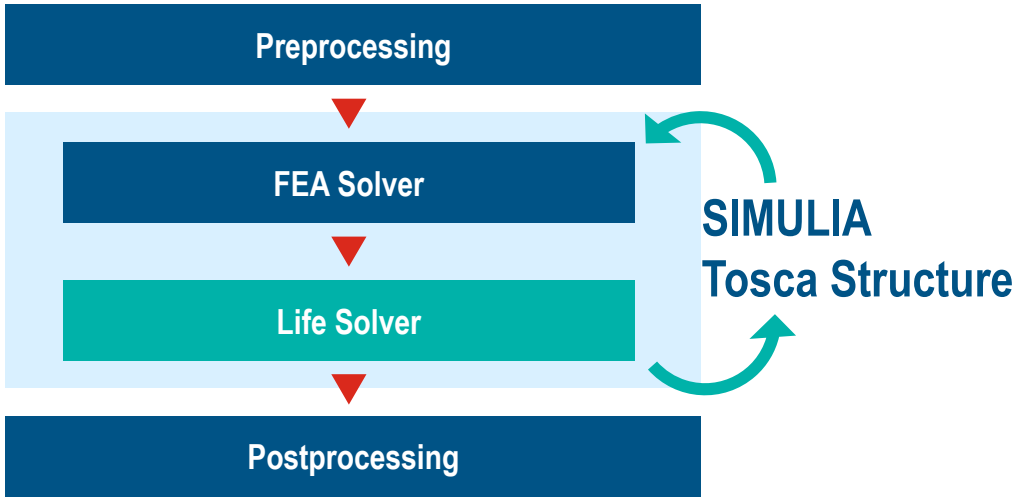


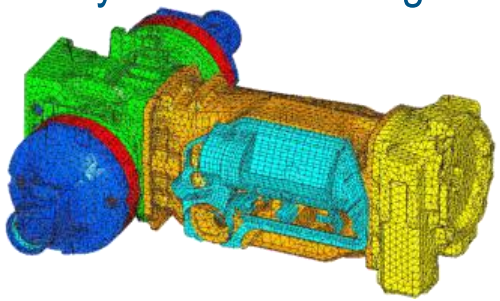
Result

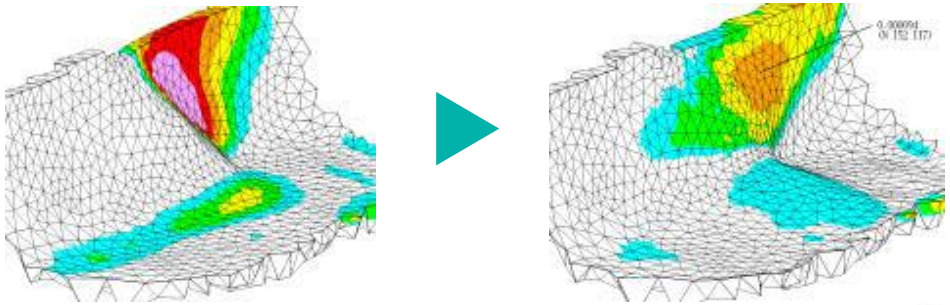
- Verification of result by recalculation with Pro/Mechanica:
  - Tosca Structure result (freeform surface):
    Stress reduction by 30%
  - Modified radius:
    Stress reduction only by 18%
- Transfer into CAD and reconstruction
- Assembly in the new A8

SIMULIA Tosca Structure.durability (životnost)

- Shape optimization based on results of fatigue simulation
  - Minimization of the damage in the components surface
  - Specification of a volume constraint
  - Combination of fatigue results and static misuse load scenarios possible
- Direct use of fe-safe and FEMFAT
- With customizations: Falancs, nCode DesignLife, Femsite. Virtual.Lab Durability or in-house fatigue code

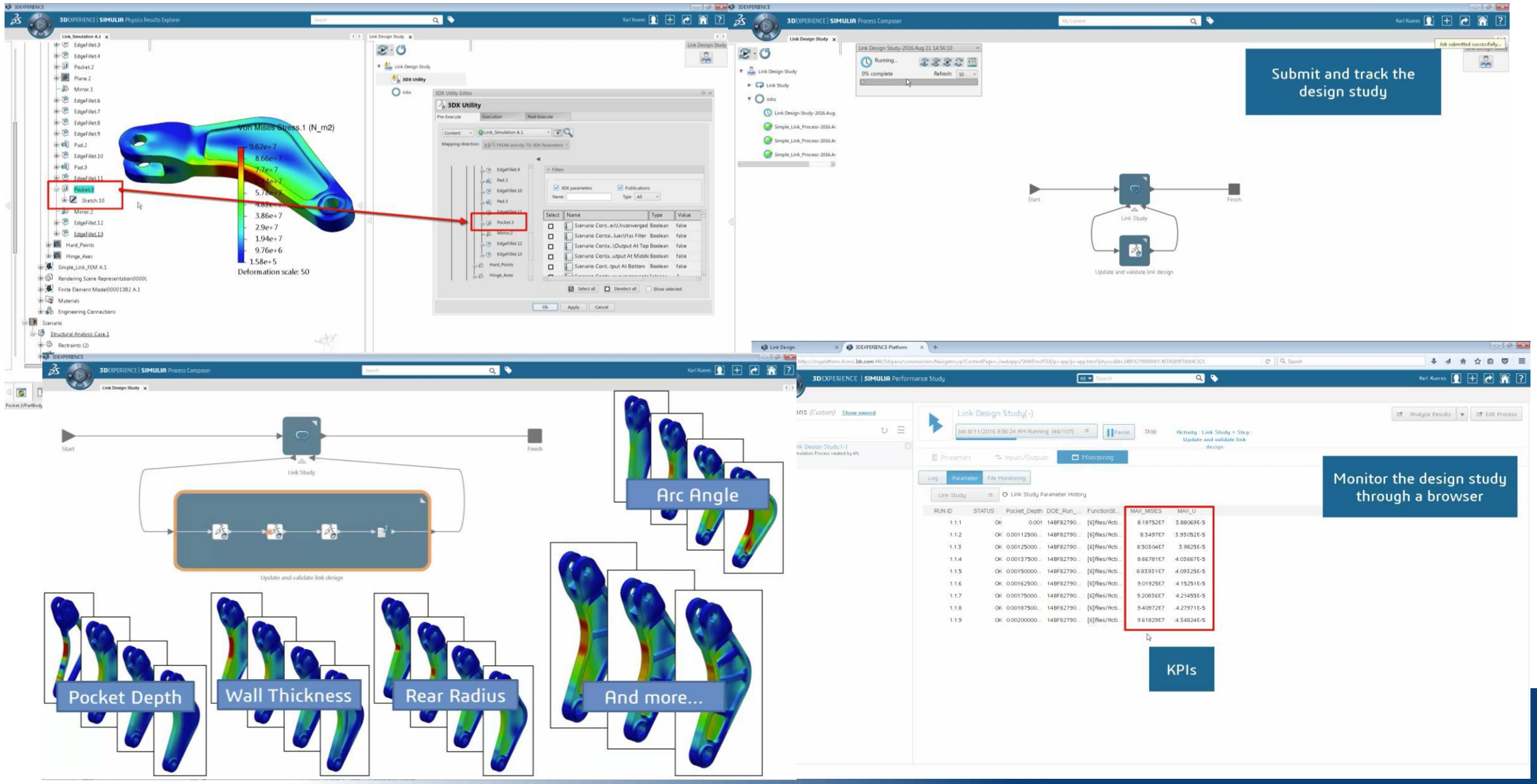




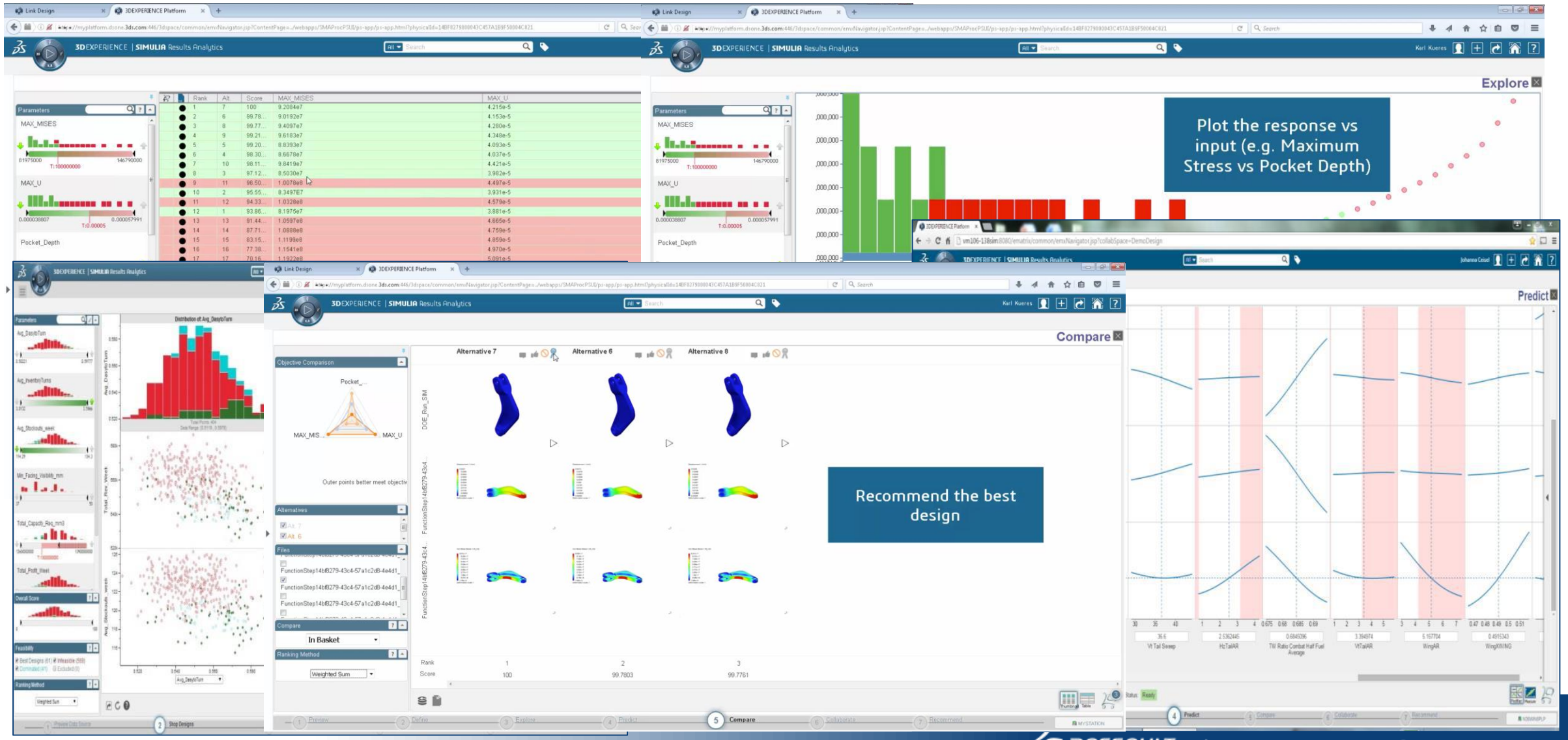


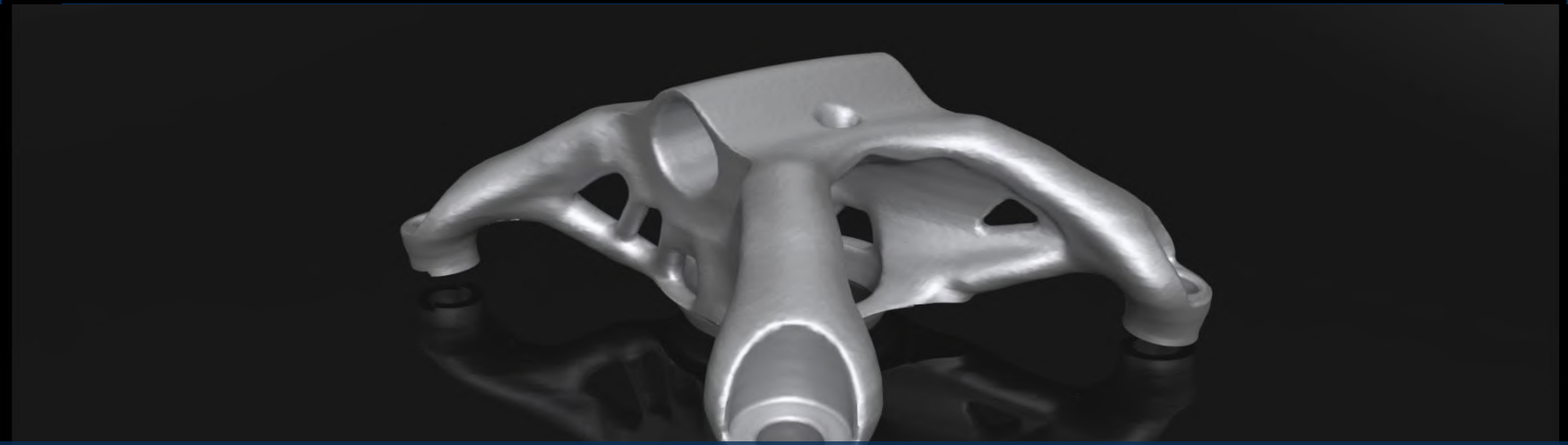
Images courtesy of MAGNA POWERTRAIN

Parametrická optimalizace



Výsledek a vizualizace automatické parametrické optimalizace





Aditivní Výroba

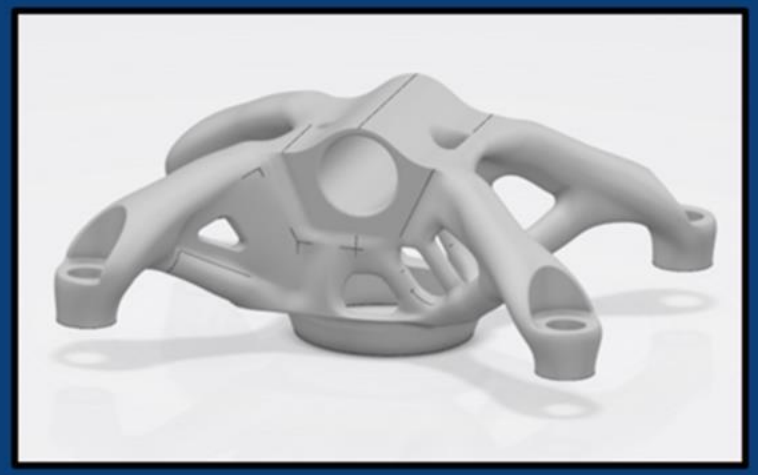
Bio-inspirovaný generativní design

Od konceptů až po funkční části

Optimalizováno pro materiál, proces a v rámci možností stroje

Odstranění mezer mezi navrženou a vyrobenou součástkou

"As-Designed" Part

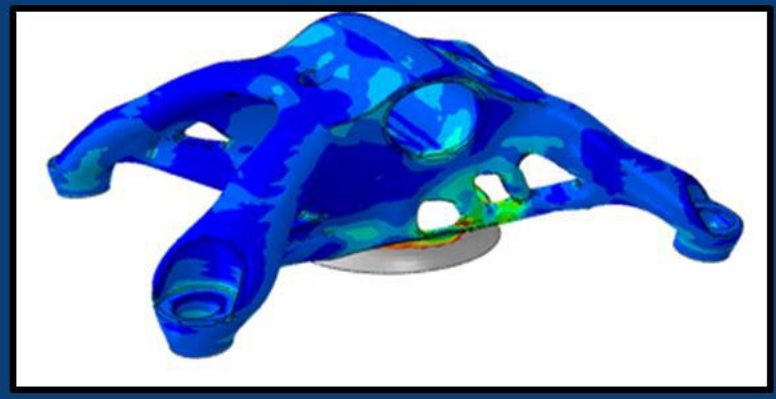


- Part is designed without consideration of manufacturing process
- Standard material property assumptions

=

"As-Manufactured" Part

- Our AM solution can predict the residual stress and distortion in the "As-Manufactured" part
- Thermal evolution and cooling rate can also be predicted

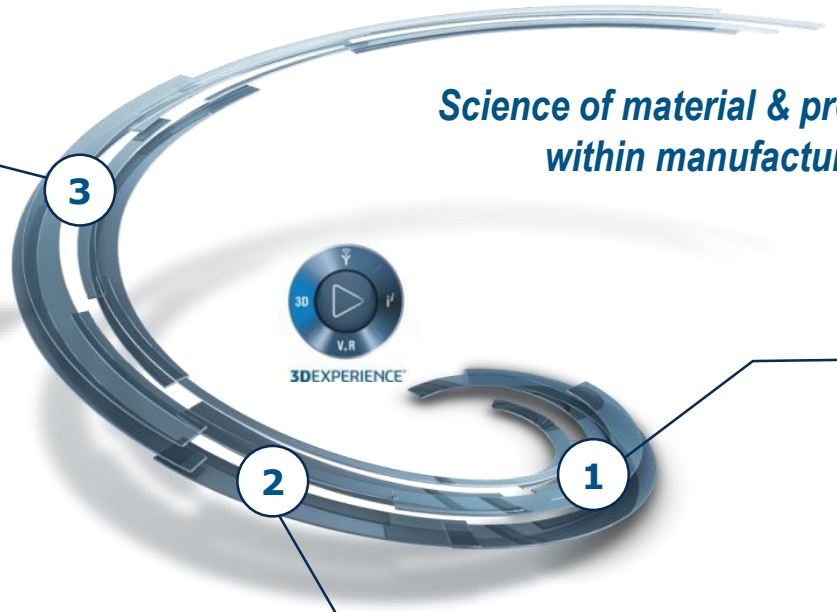


Aditivní výroba | Výrobní proces

Process Optimization

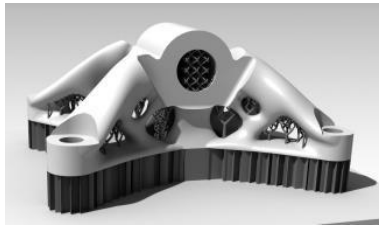
- *Predictive Analytics to:*
- *Reduce Part Stress and Distortion*
- *Minimize Print Time*
- *Increase dimensional accuracy*
- *Prescriptive Analytics to:*
- *Optimize manufacturing constraints*

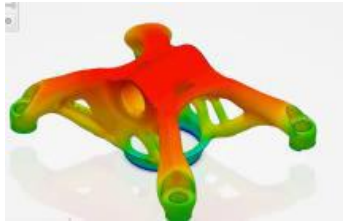
Science of material & predictive simulation within manufacturing process

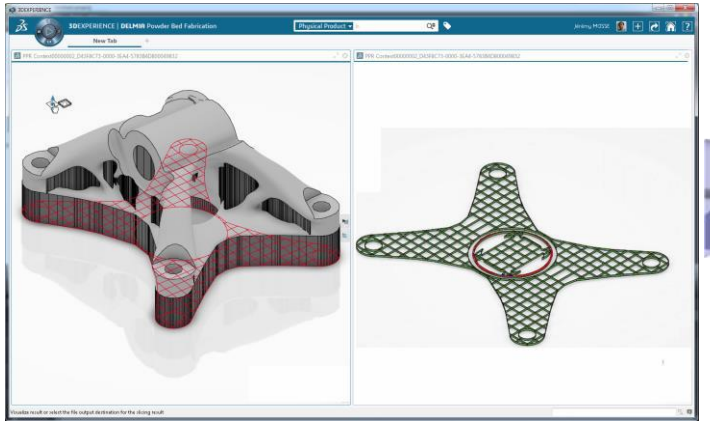


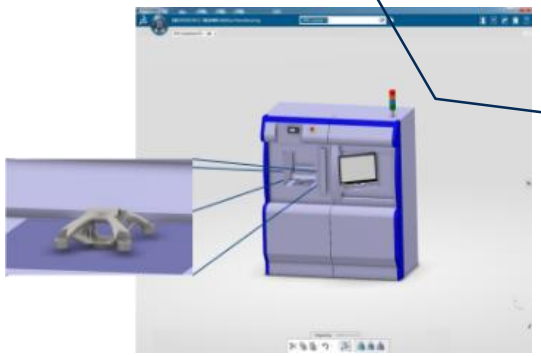
Process Planning

- *Define the production steps to dispatch across the manufacturing assets*
- *Optimization of the production time and resources utilization (station …Machine)*



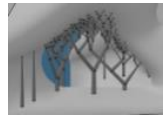






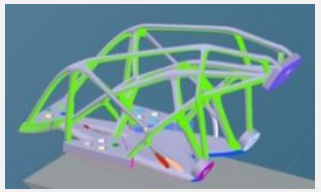
Generative Additive Process with Physic simulation

- *Select a predefined "Process Template"*
- *Generate the position & orientation of the part on the machine , supports and laser path according to Material (powder properties) Machine capability and Design Intent/Characteristics*
- *Progressive material addition analysis*
- *Thermal residual stresses / Part Distortions*
- *Generate the outputs for Fabrication (3MF, Machine Code, Models for other operations …)*

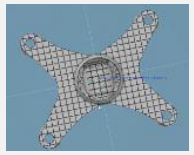


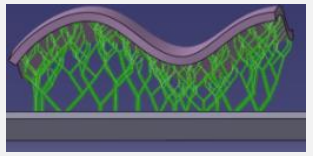
Podporné struktury: Design a Simulace

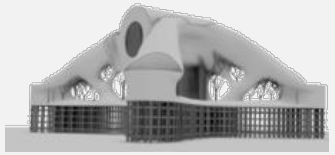
- Support creation by zones or manually
  - Automatic recognition of zones, edges and points where supports are needed
  - Minimize creation of supports on functional surfaces



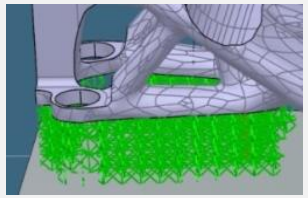
- Multiple support types through a library
  - Linear supports
  - Tree supports
  - Lattice supports



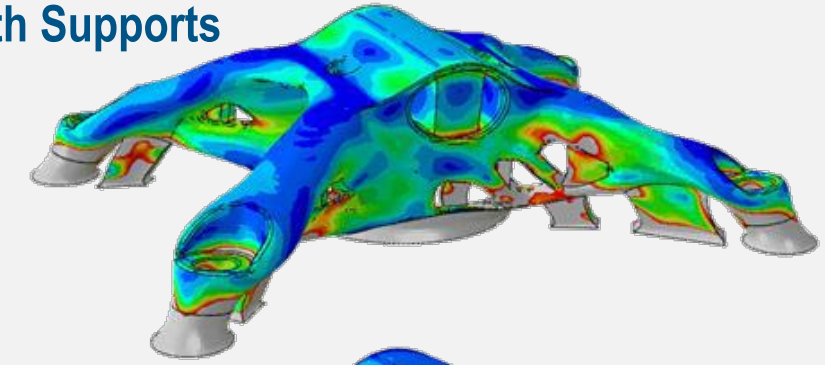




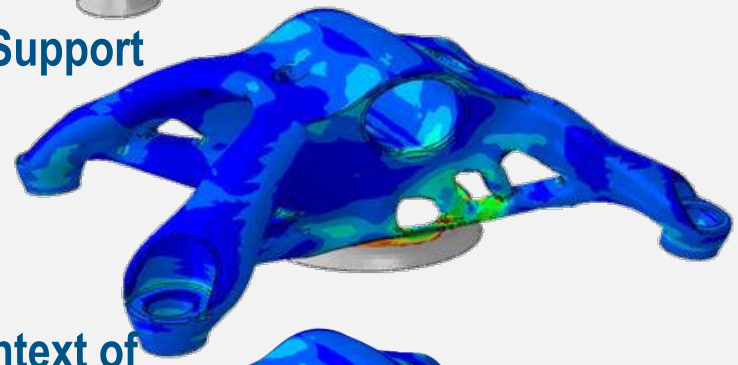
- Supports optimization through simulation
  - Optimize the support generation for an area
  - Removal of useless supports
  - Add supports for heat transfer



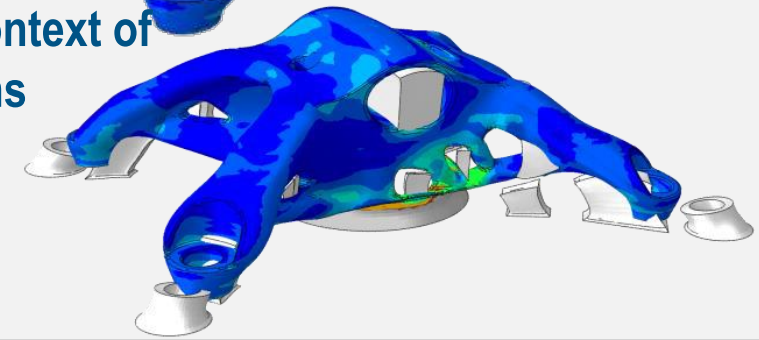
Simulation with Supports



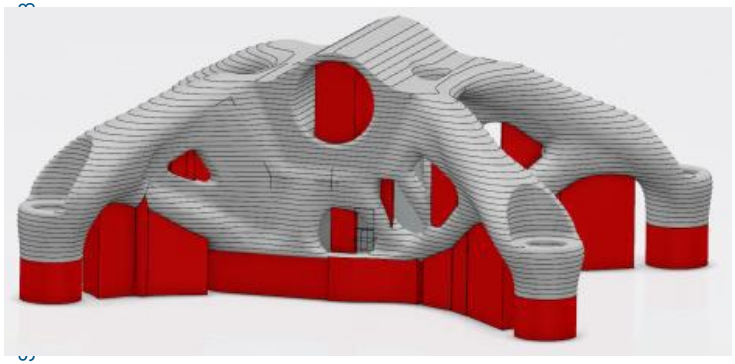
Springback after Support Removal

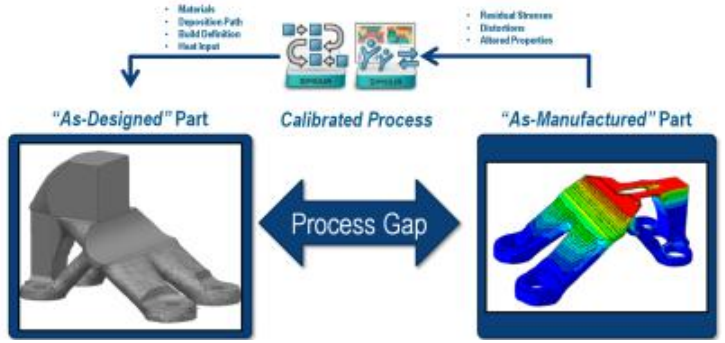


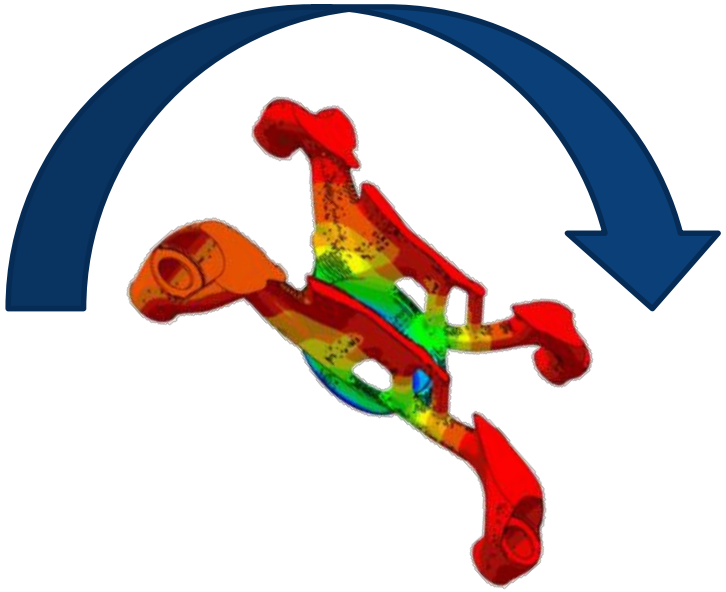
Springback in Context of Support Locations



Celkový optimalizační proces

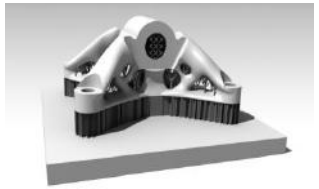






DELMIA – Příprava technologie výroby

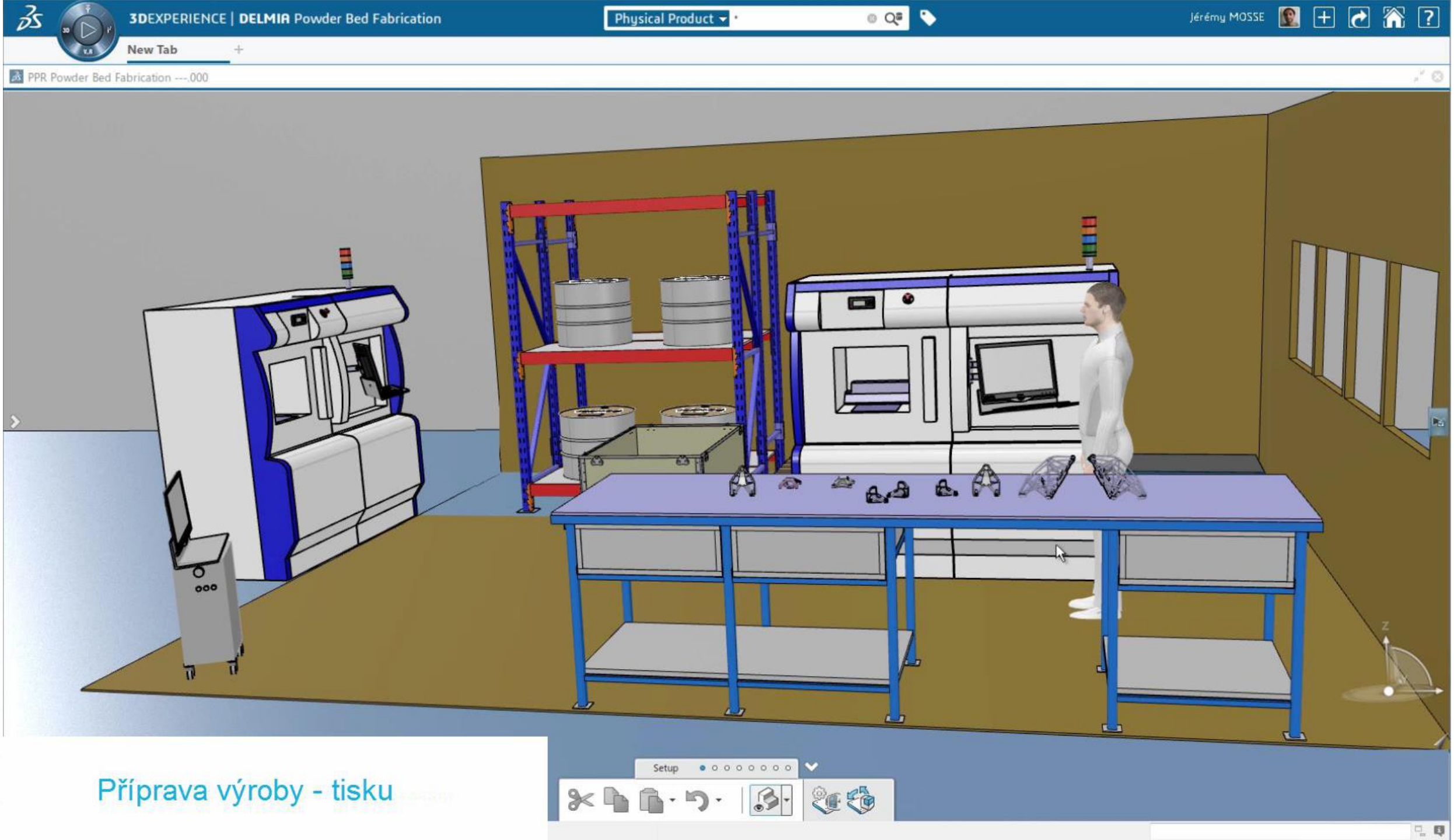
Additive Manufacturing Programmer



Klíčové funkce

- Rychlá příprava a vizualizace technologie
- Tvorba podpůrných struktur
- Generování dráhy tavícího paprsku
- Podpora technologie Powder Bed

- Výstupní formát pro stroje Renishaw
- Výstupní formát 3MF

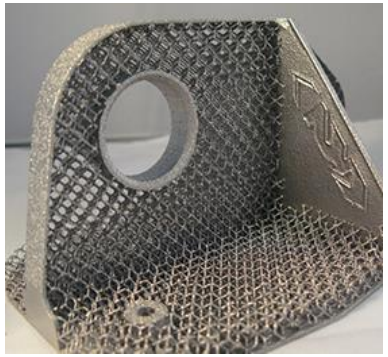


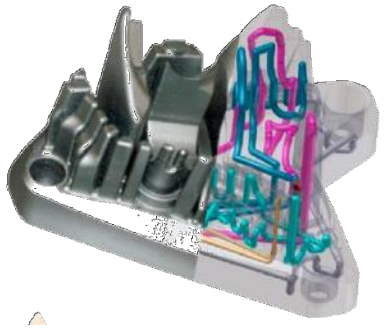
Příprava výroby - tisku

Additive Manufacturing - závěr

Přínosy aditivní výroby

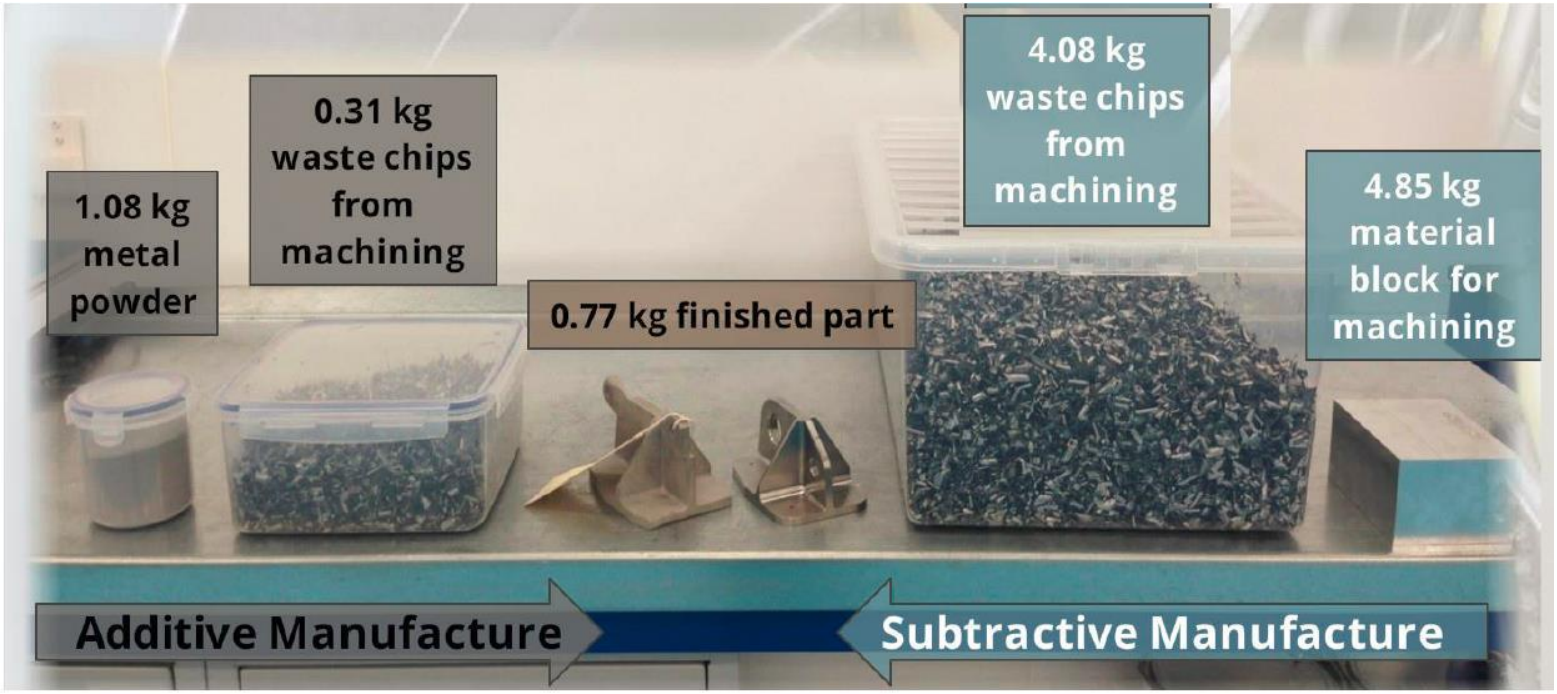
- ✓Inovativní design výrobků
- ✓Lehčí a optimalizovanější tvar
- ✓Efektivní využití materiálů s minimálním odpadem
- ✓Komplexní vnitřní detaily
- ✓Vylepšený přenos tepla (chlazení)
- ✓Krátké dodací lhůty
- ✓Výroba přímo z CAD bez speciálních nástrojů





Přínosy aditivní výroby

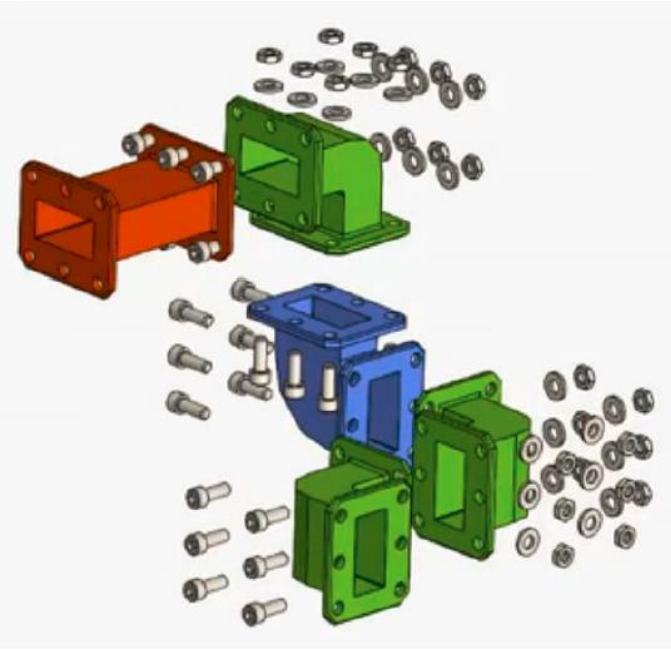
- Méně materiálu
- Méně energie
- Méně odpadu
- Méně zdrojů
- Méně transportu
- Méně uhlíku

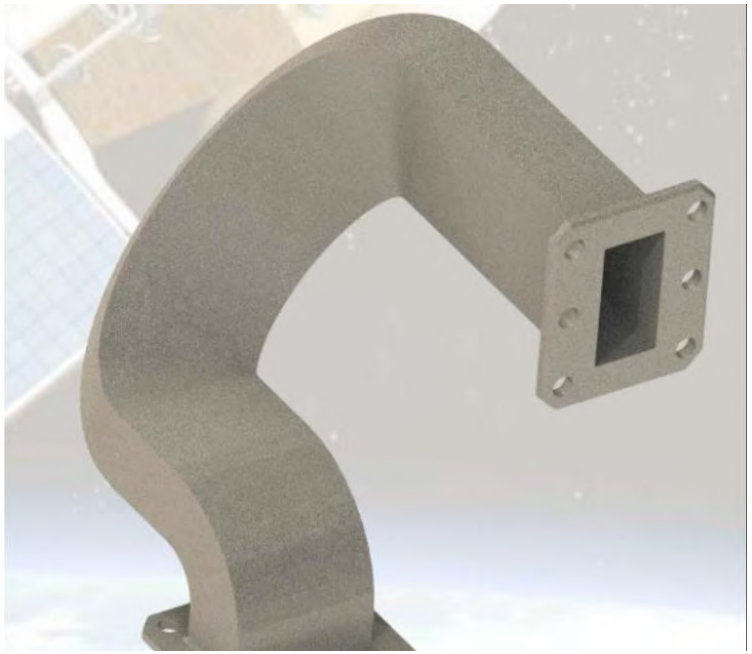


S laskavým svolením GKN Aerospace

Přínosy aditivní výroby

- Snížení hmotnosti
- Zvýšení výkonu
- Snížení počtu náhradních dílů





S laskavým svolením Renishaw

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