

Generative Design



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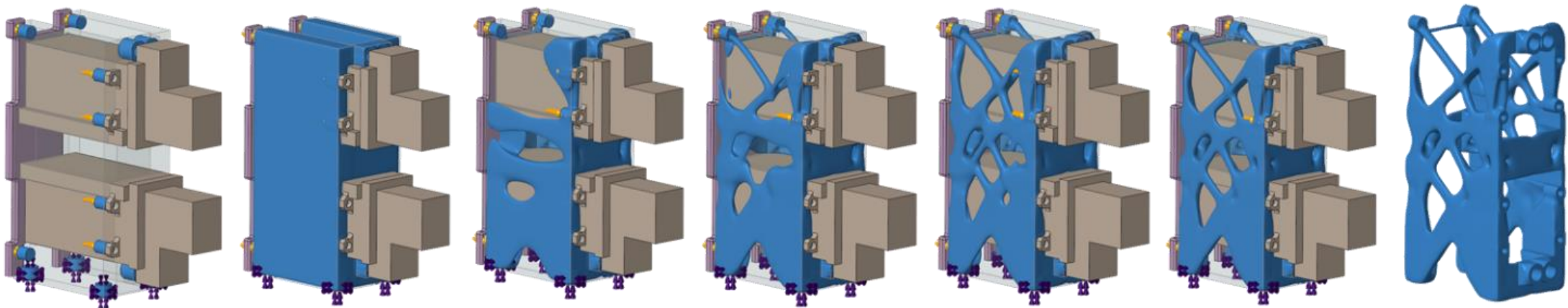
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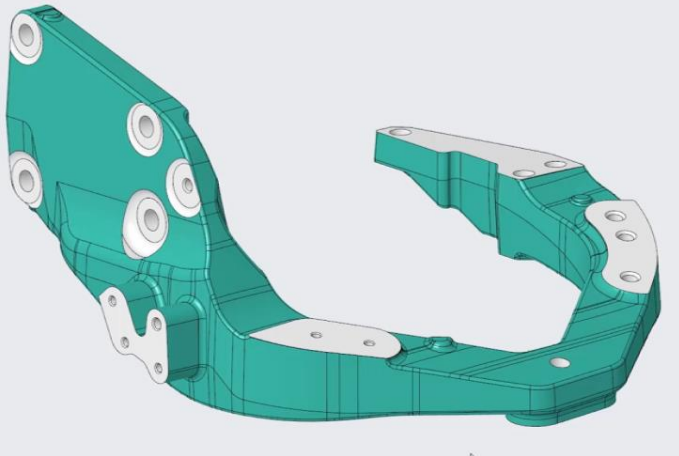
Was ist Generatives Design?

Generatives Design erstellt autonom optimale Designs anhand eines Sets von Systemdesignanforderungen, wie Belastungen, Einspannungen, bevorzugte Materialien dem Fertigungsprozessen

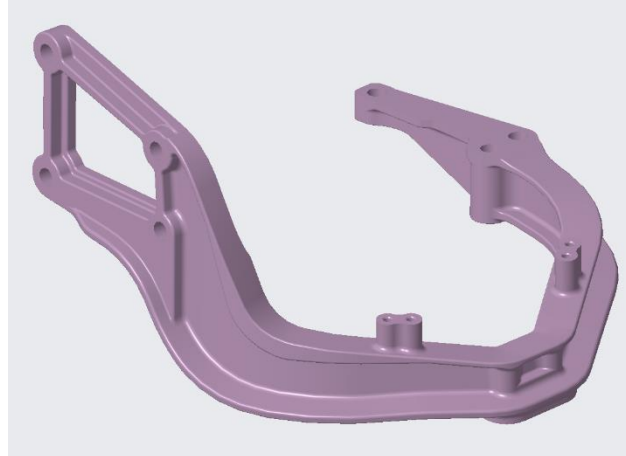
- ✓ Erstellung innovativer, differenzierter Produkte
- ✓ Untersuchung von mehr Alternativen in kürzerer Zeit
- ✓ Kürzere Time-to-Market und niedrigere Produktkosten
- ✓ Optimierung von Produktentwürfen im Hinblick auf Effizienz und Fertigbarkeit



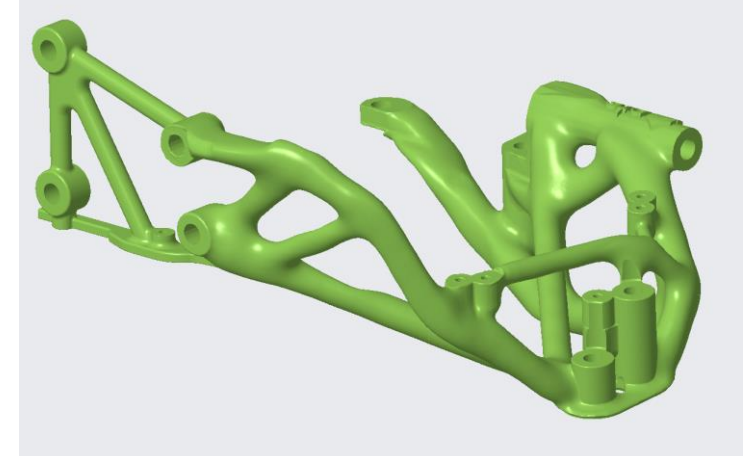
Variant	Material	Weight (kg)	Max Disp (mm)	Max Stress (MPa)	Comments
Original Design	Iron (cast)	20.36	3.5	1393	Stress is 4.3x yield
PSU Design	Iron (cast)	11.86	2.6	1255	Stress is 3.9x yield
Generative Design	Al 356 (cast)	5.00	0.85	250	Stress is 1.5x yield



Original Design



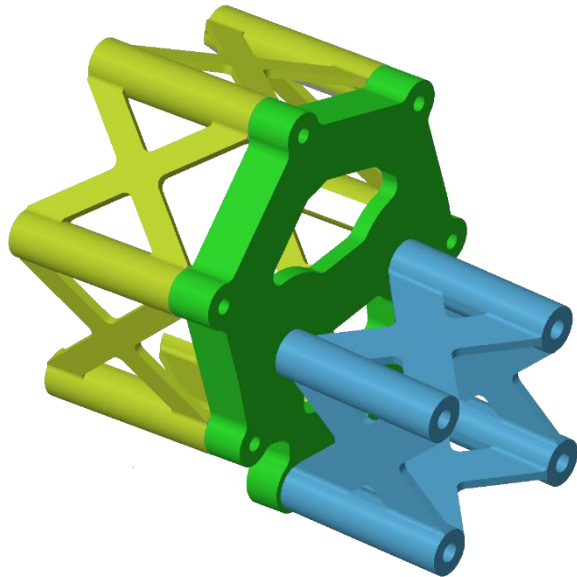
Penn State Design



Final Generative Design

Weight Reduction: 75% Peak Stress Reduction: 82%

Variant	Material	Weight (kg)	Max Stress (MPa)	Comments
Original Design	AL6061	2.45	153 MPa	Stress is 0.55x yield
Generative Design	AL6061	1.06	101 MPa	Stress is 0.38x yield



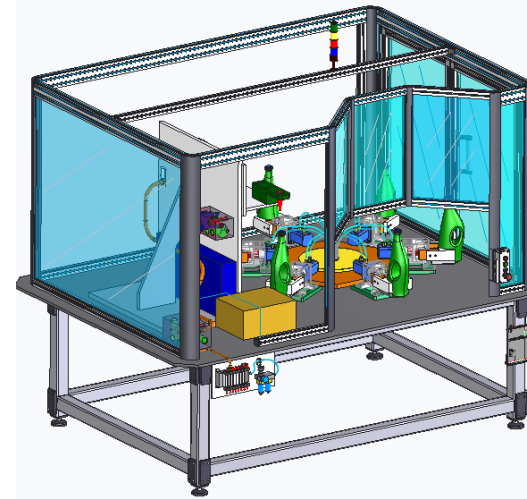
Original Multi-Part Design



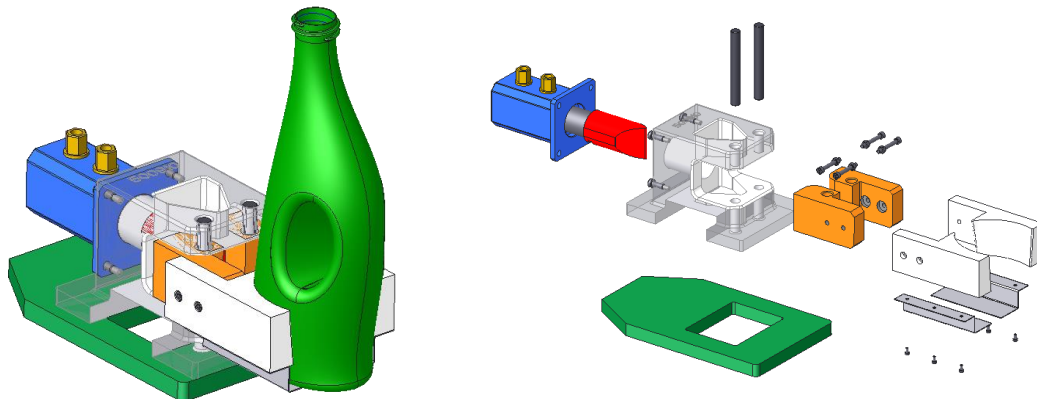
Final Generative Design

Weight Reduction: 56% Peak Stress Reduction: 33%

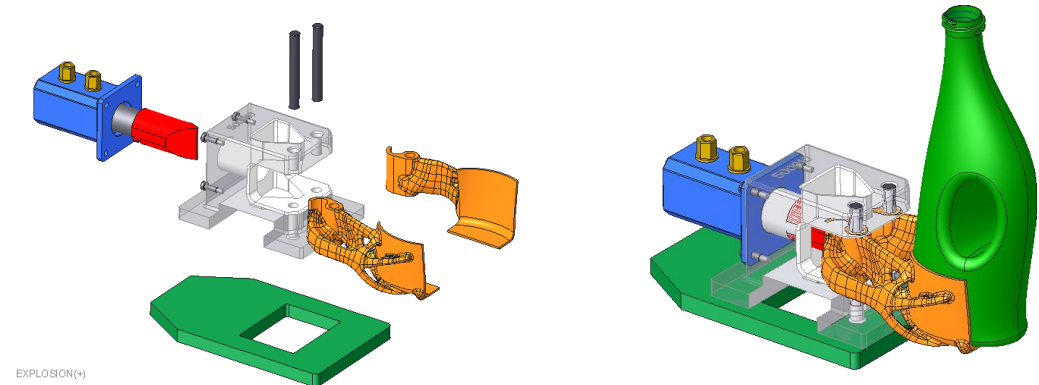
- Reduktion der Teileanzahl
- Reduktion des Gewichts
- Neue Konstruktionsideen
- Verbesserung der Taktzeiten



Ausgangskonstruktion – Greifer aus mehreren Teilen, die miteinander verschraubt sind



Generatives Design Ergebnis – Greifer als ein gedrucktes Teil



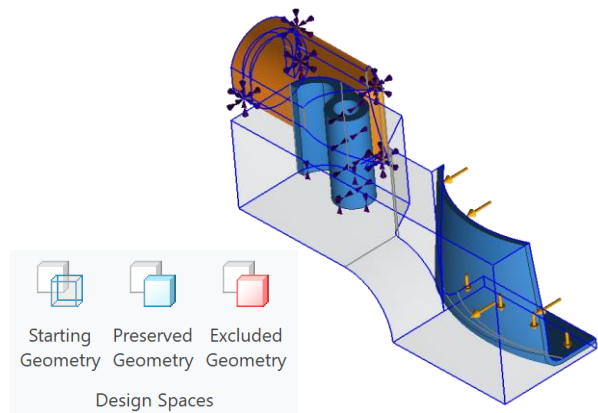
- Definition der Generativen Design Kriterien

Körper

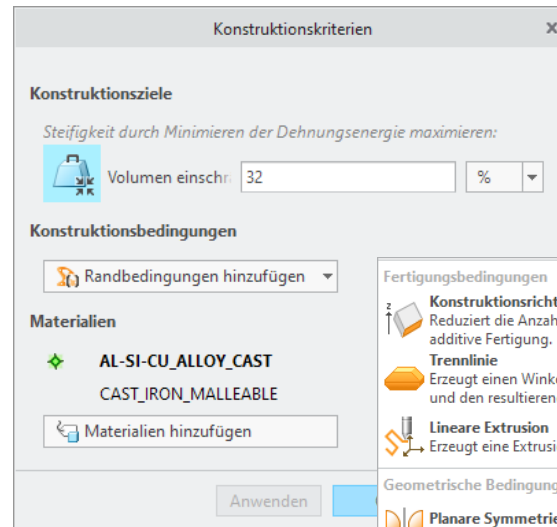
Last &
Randbedingungen

Fertigung & Design
Kriterien

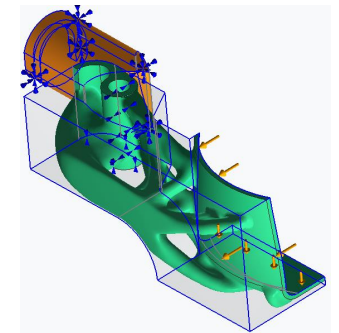
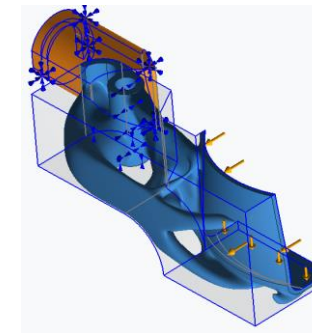
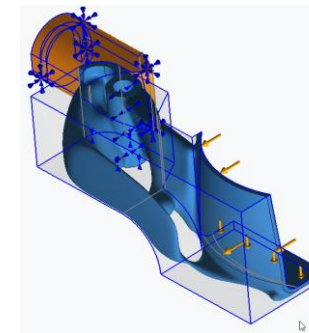
Prozess



- Free_32p
- BuildDir_45_28p
- cast3d_28p
- free26_spread
- BuildDir_38_25p



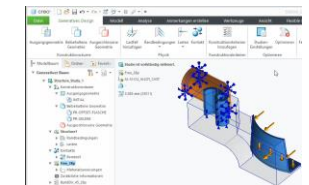
- Fertigungsbedingungen
- Konstruktionsrichtung**
Reduziert die Anzahl der Stützstrukturen für die additive Fertigung.
 - Trennlinie**
Erzeugt einen Winkel zwischen der Öffnungsrichtung und den resultierenden Schrägenflächen
 - Lineare Extrusion**
Erzeugt eine Extrusion der linearen Öffnungsrichtung
- Geometrische Bedingungen
- Planare Symmetrie**
Baut und spiegelt individuelle Geometriehälften
 - Materialverteilung**
Steuert die Materialverteilung



Material

AL-SI-CU_ALLOY_CAST

CAST_IRON_MALLEABLE

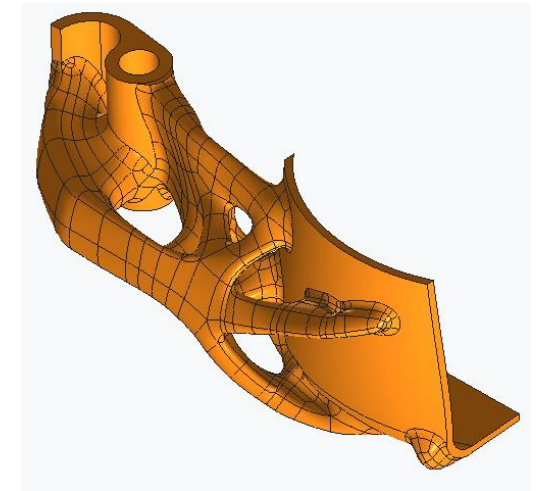
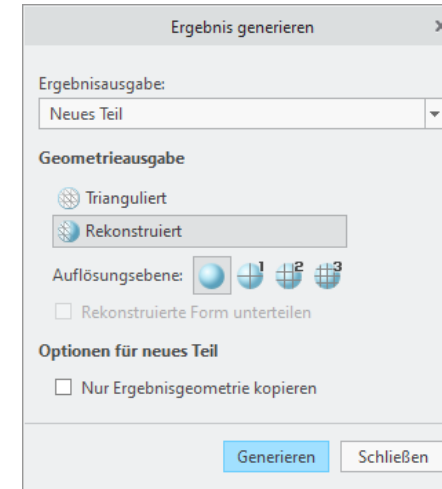
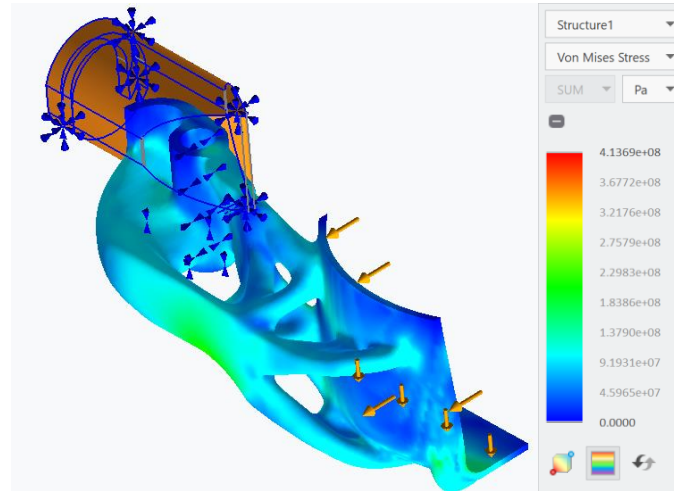
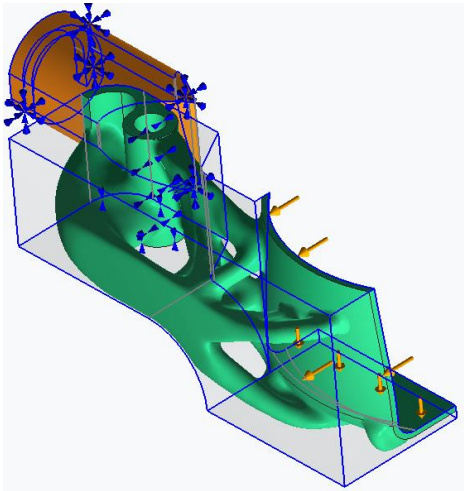


- Definition der Generativen Design Kriterien

Ergebnis der
Optimierung

Anzeige der Spannungen
& Verschiebungen

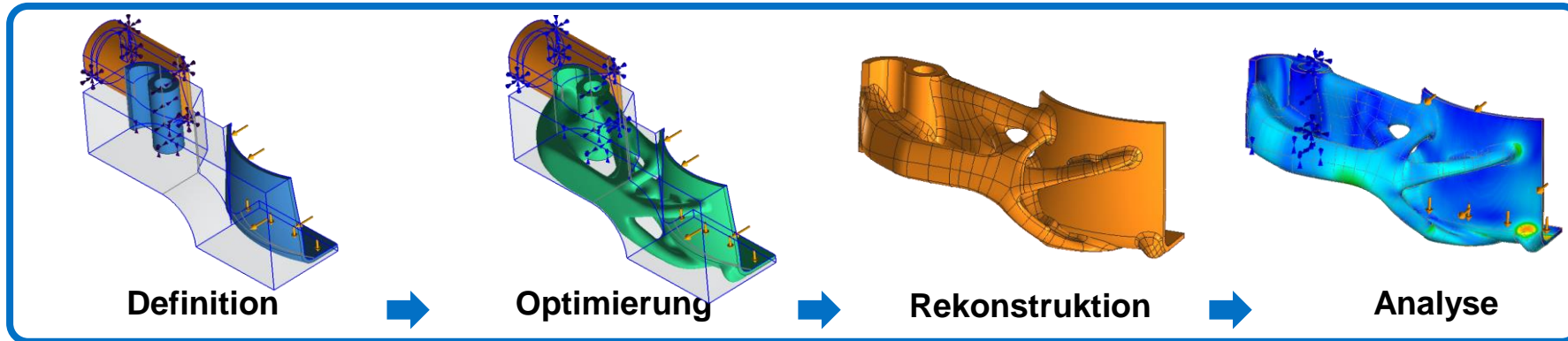
Konstruktion generieren
Trianguliert oder als B-Rep



Liefert beste Design in kürzester Zeit



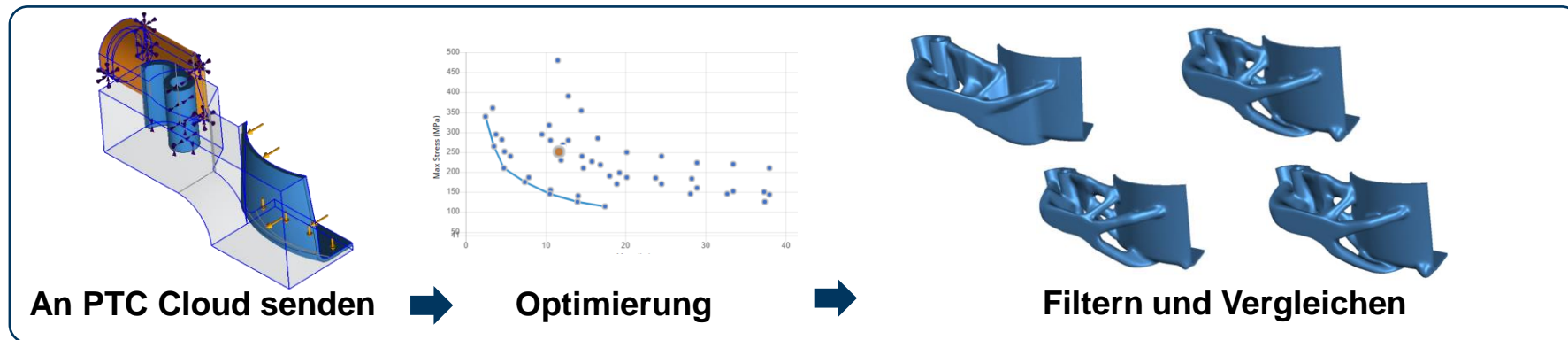
Creo Generative
Topology Optimization
(Creo 7.0.0.0)



- Neue Applikation, voll integriert in Creo
- Gewohnte Vorgehensweise und Benutzeroberfläche
- Ersetzt Creo-Top-Opt



Creo Generative
Design Extension



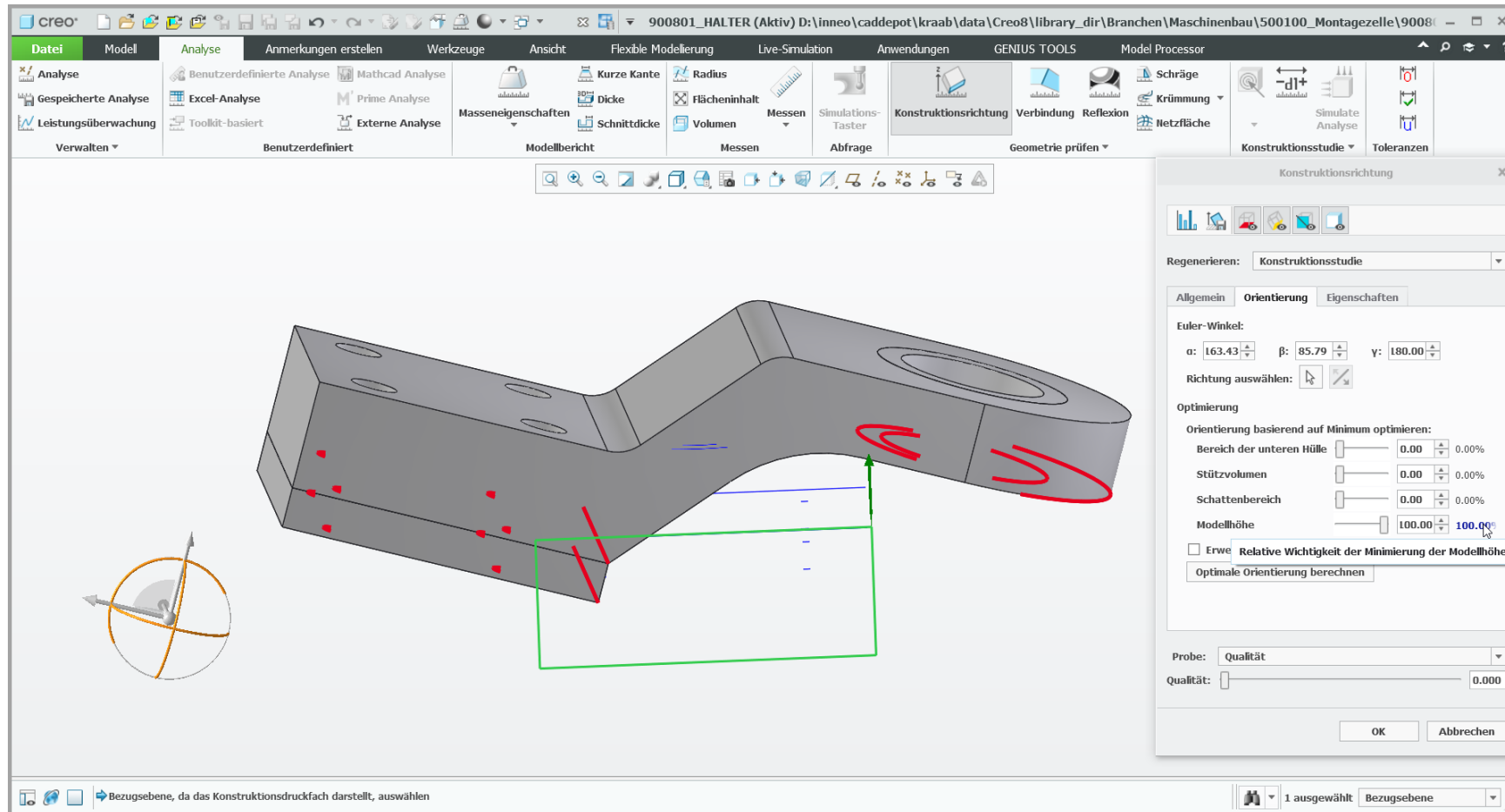
- Optimierung mehrerer Fallstudien
- Bereitstellung der high-performance computing HPC
- Simultanes Generieren mehrerer Designzustände

Beschleunigung der neuen
Produkteinführung

Verbessertes Wissen des
Fertigungsverfahrens

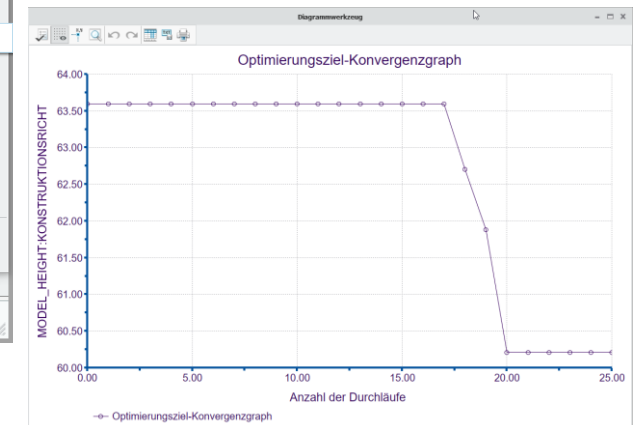
Finden neuer Designideen

Analyse der Konstruktionsrichtung

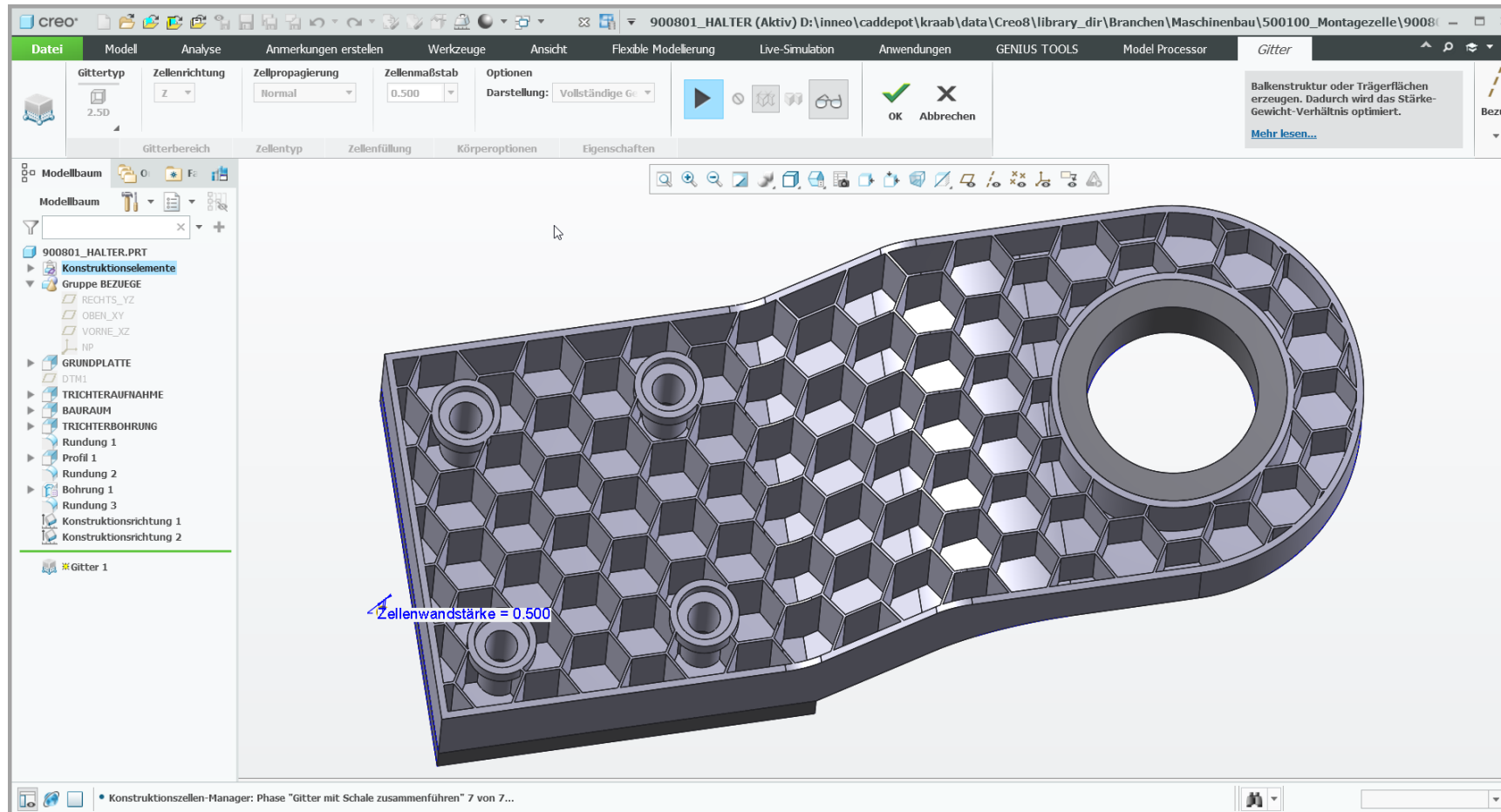


Analyse für die optimale Konstruktionsrichtung für den 3D Druck in Bezug zu:

- Bereich der unteren Hülle
- Stützvolumen
- Schattenbereich
- Modellhöhe

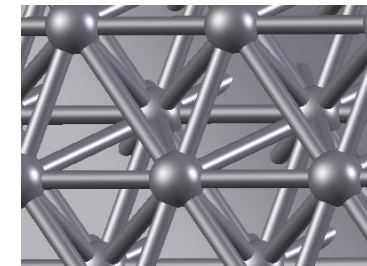


Konstruktion der Gitterstruktur

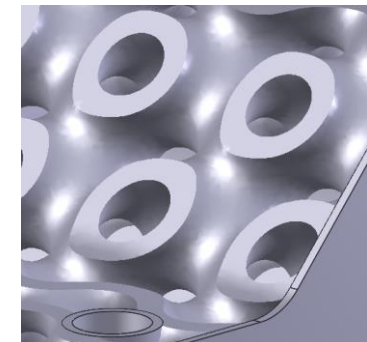


Ersetzen von Volumengeometrie
durch unterschiedliche
Gitterstrukturen
2,5 D Waben (Großes Bild)

Balken

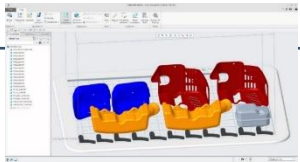


Formelsteuert

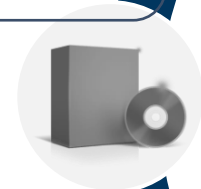


Design for AM Process considerations

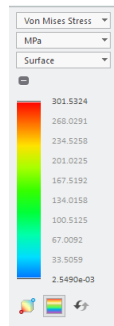
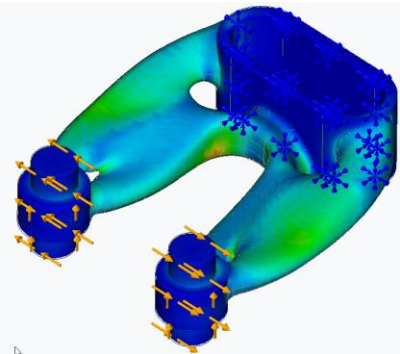
- Tray assembly specific to printer
- Pattern and nest components
- Support structure generation



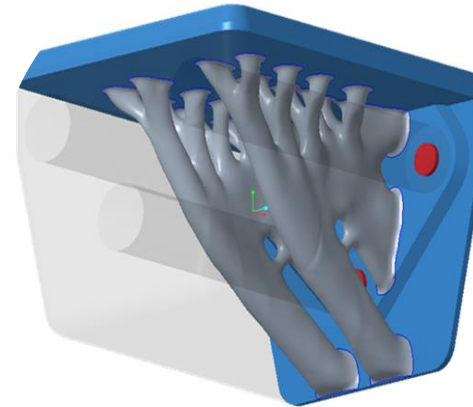
3DP CHECK



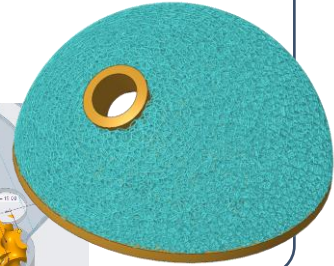
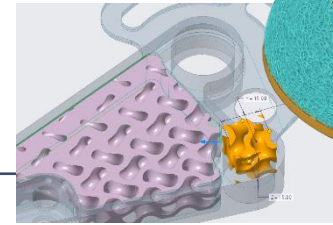
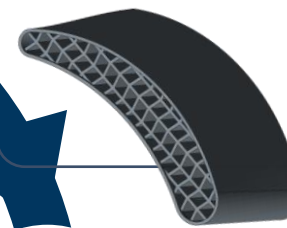
- Validate Geometry in real time using Creo Simulation Live



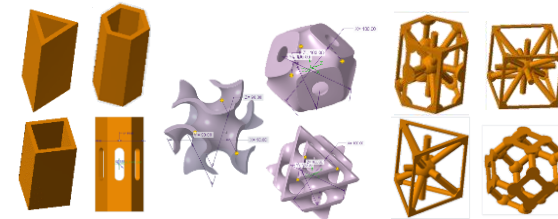
DESIGN



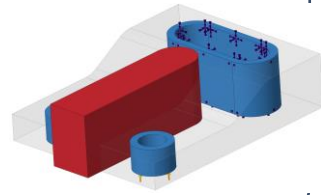
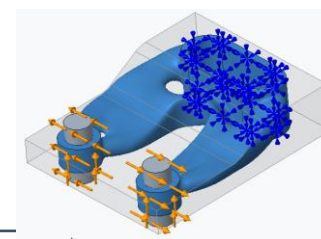
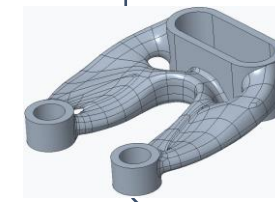
- Lattice Creation & Optimization
 - 2.5D, beam based, stochastic and Formula driven
- Build Direction analysis



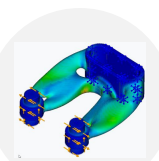
OPTIMIZE



- Generative Topology Optimization
- Generates optimal designs from a set of system design requirements.
- Geometry reconstruction

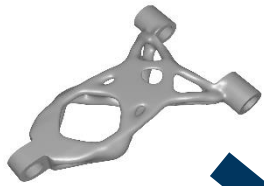


VALIDATE

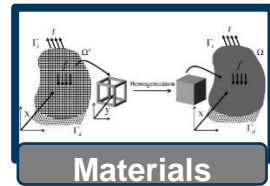
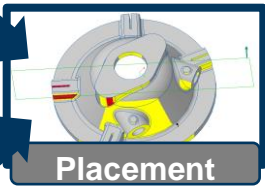


Seamless flow for the design-to-print process... and post-process

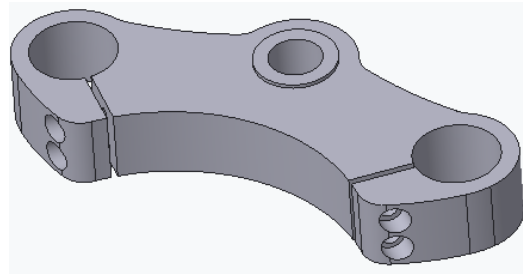
Generative



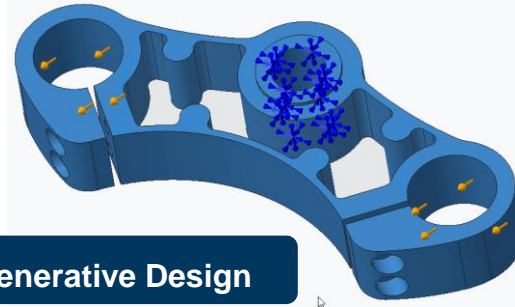
Legacy



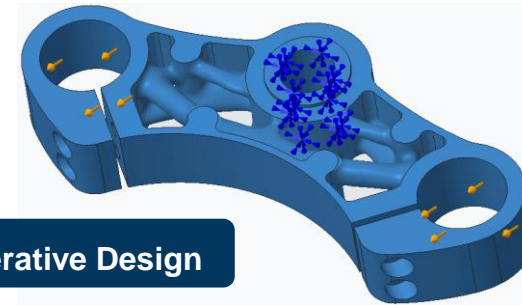
Additive manufacturing – demo workflow



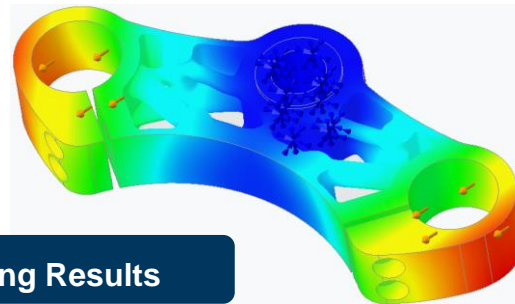
Starting Geometry



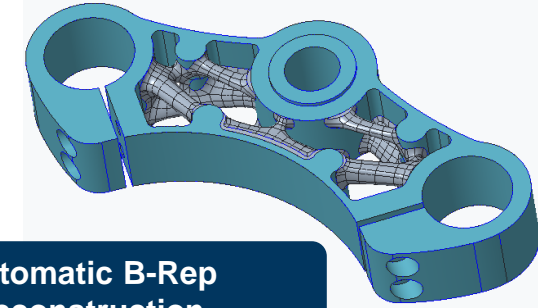
Define Generative Design



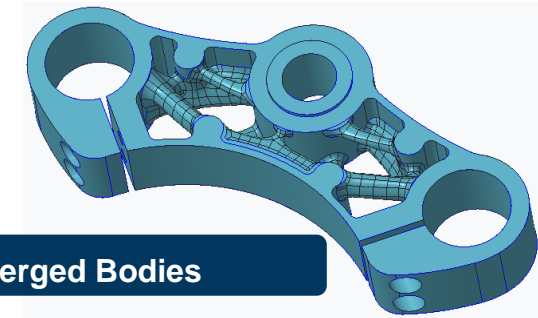
Run Generative Design



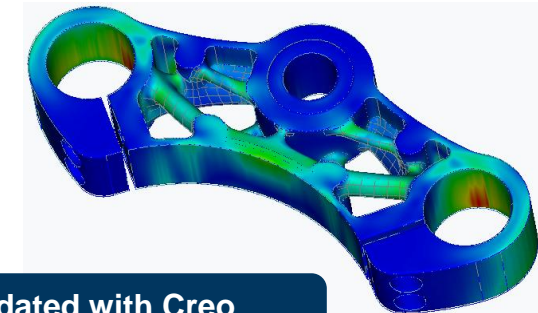
Checking Results



Automatic B-Rep
Reconstruction

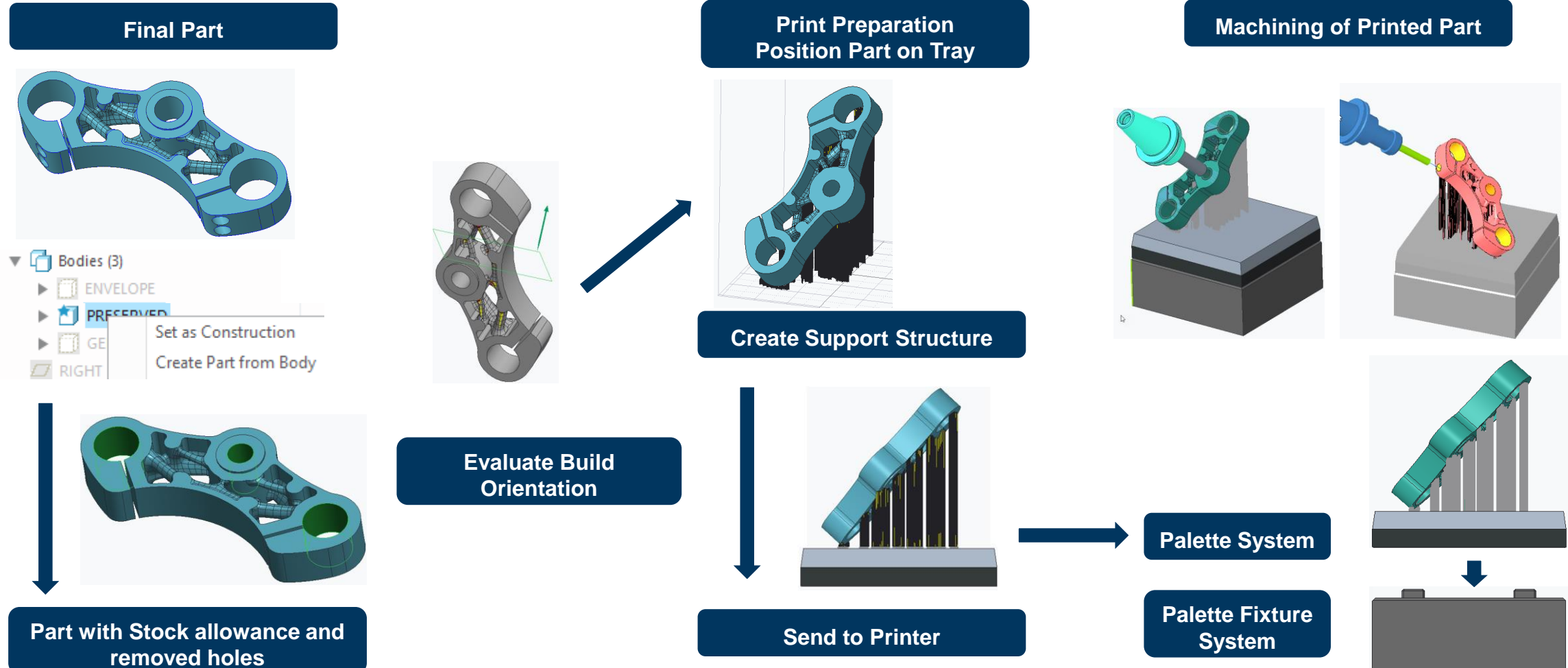


Merged Bodies

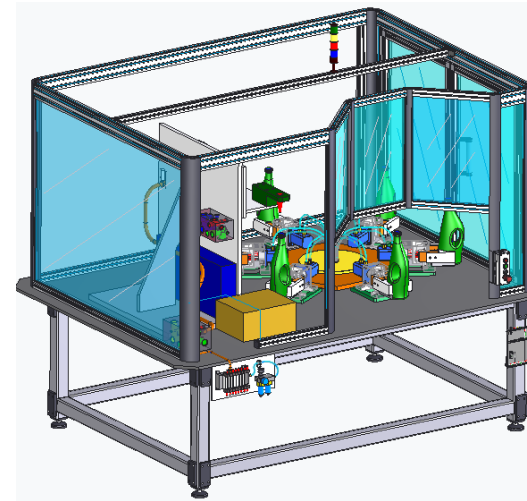


Validated with Creo
Simulation Live

Additive manufacturing – demo workflow



- Reduce number of components
- Reduce weight to improve kinematic of machine
- Improving tact time
- Increase Productivity



Original Design – Gripper design based on multiple parts, screwed together

Generative Design example – Gripper design as a single part

