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Generative Design for Inventor Users

MFG500594

Alessandro Gasso
Fusion 360 Adoption Specialist

About the speaker

Alessandro Gasso

Alessandro Gasso is currently employed as Fusion 360 / Generative Design Adoption Specialist within the Customer Success Organization at Autodesk, Inc. Over the past 21 years with Autodesk, Ale has worked in various roles including product support specialist for Inventor, the lead for the EMEA Inventor Product Support Team, EMEA technical lead of Inventor software, premium support specialist leading the PSS Manufacturing Team, manufacturing industry technical lead, and Enterprise Solutions leads manager. Ale was the co-author of the Being Inventive Inventor blog, and he has spoken at Autodesk University from 2012 to 2020. Before Autodesk, Ale worked for 7 years as a mechanical designer for a company in the defense industry. Ale is a native of Italy who speaks English, Italian, French, Spanish, and Portuguese, and he holds a master's degree in electromechanical engineering from the University of Naples (Napoli).

Learning Objectives

- Understand the benefits and workflow of Generative Design
- Leverage Generative Design in Fusion 360 alongside Inventor
- Understand how to associatively connect data between Inventor and Fusion
- Post-process and validate an exported Generative Design

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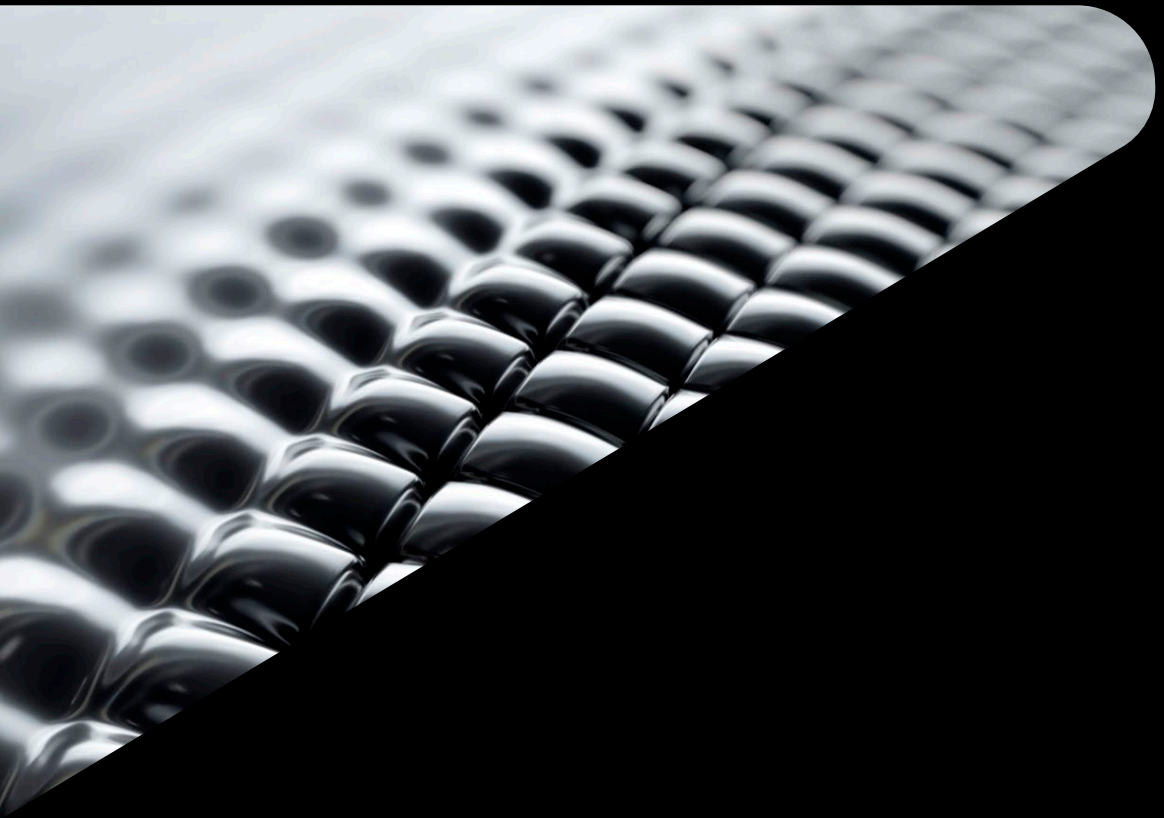
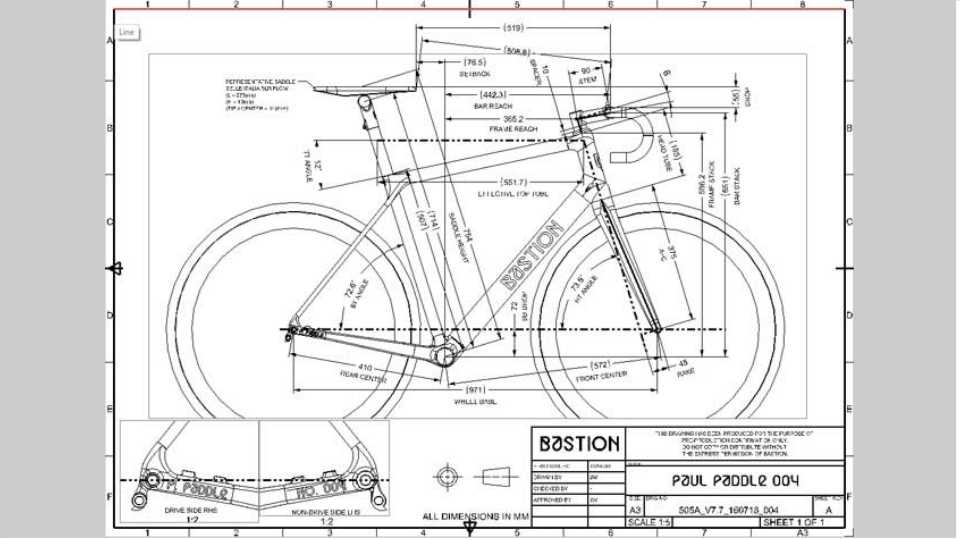


Generative Design


BASTION
PAUL PADDLE 004
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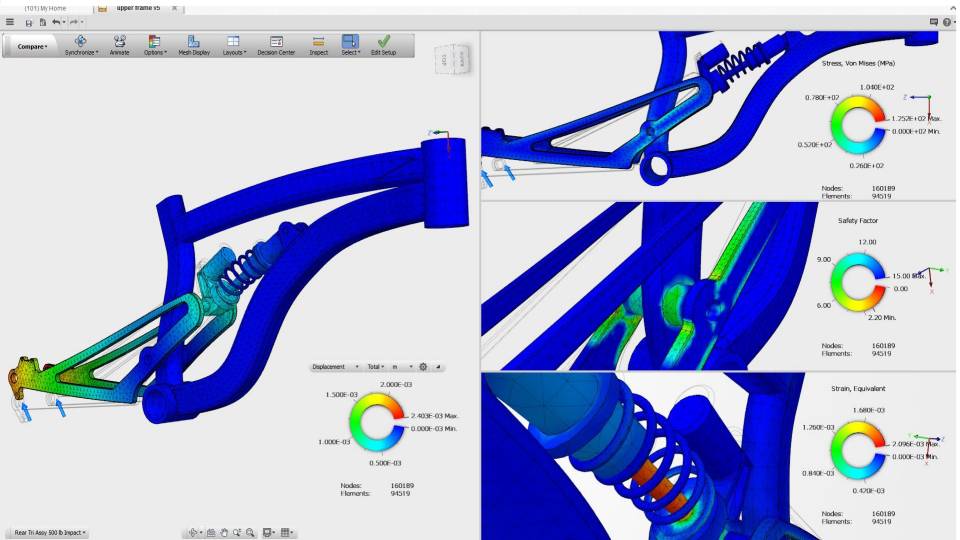
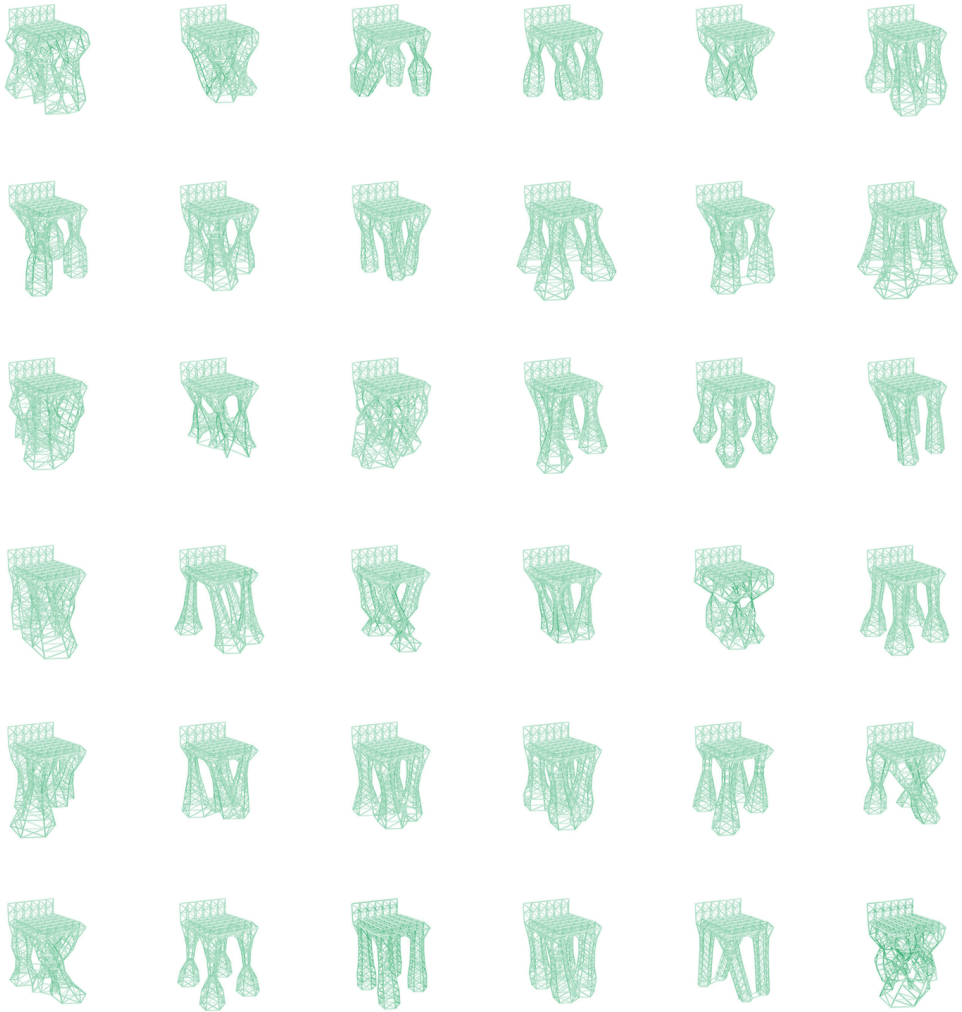
SCALE 1:5
SHEET 1 OF 1
ALL DIMENSIONS IN MM
DRIVE SIDE RHS
NON-DRIVE SIDE LHS


Stress, Von Mises (MPa)
Safety Factor
Strain, Equivalent
Displacement

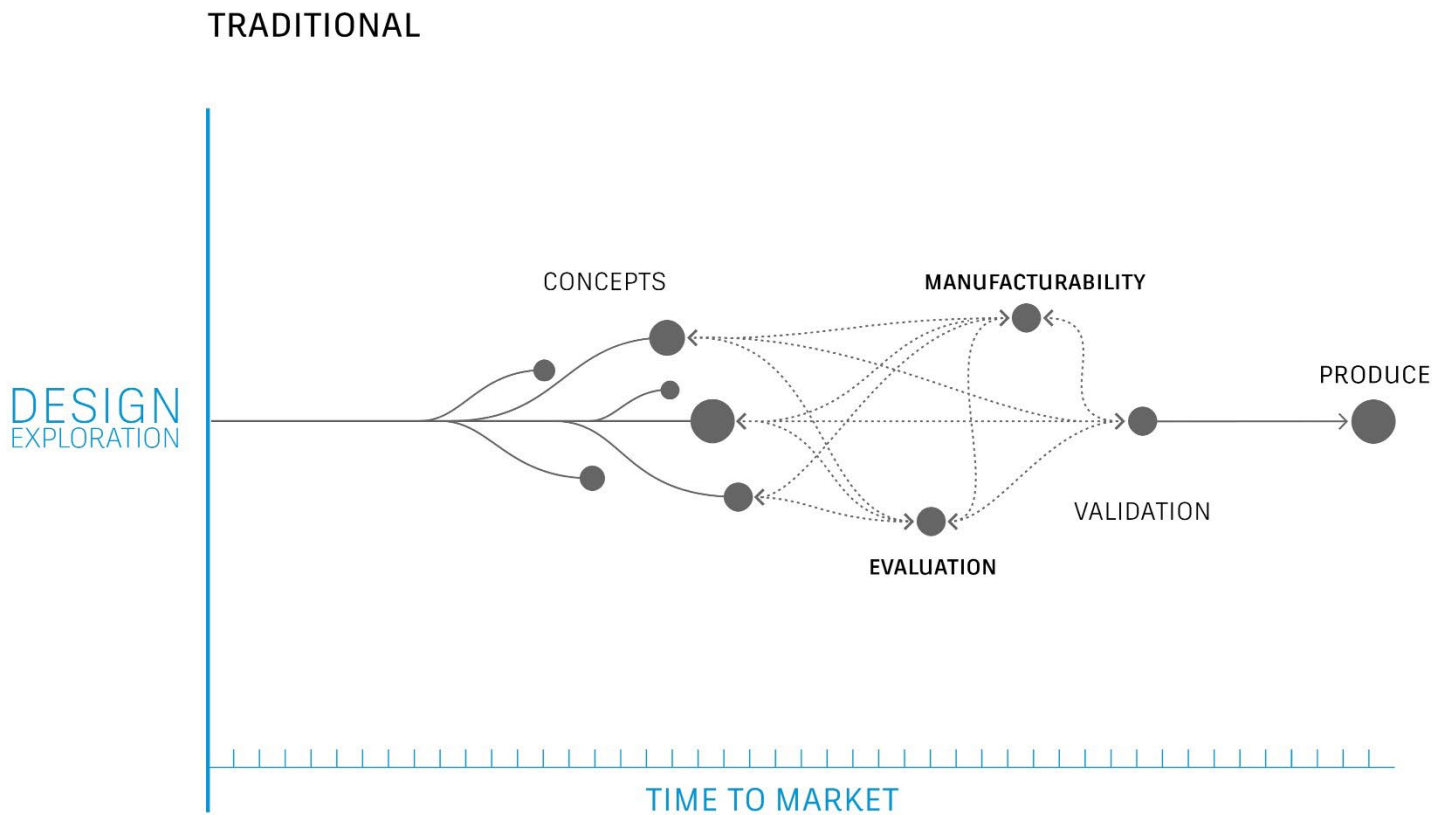
What is Generative Design

Autodesk generative design is a **Manufacturing-aware** technology.

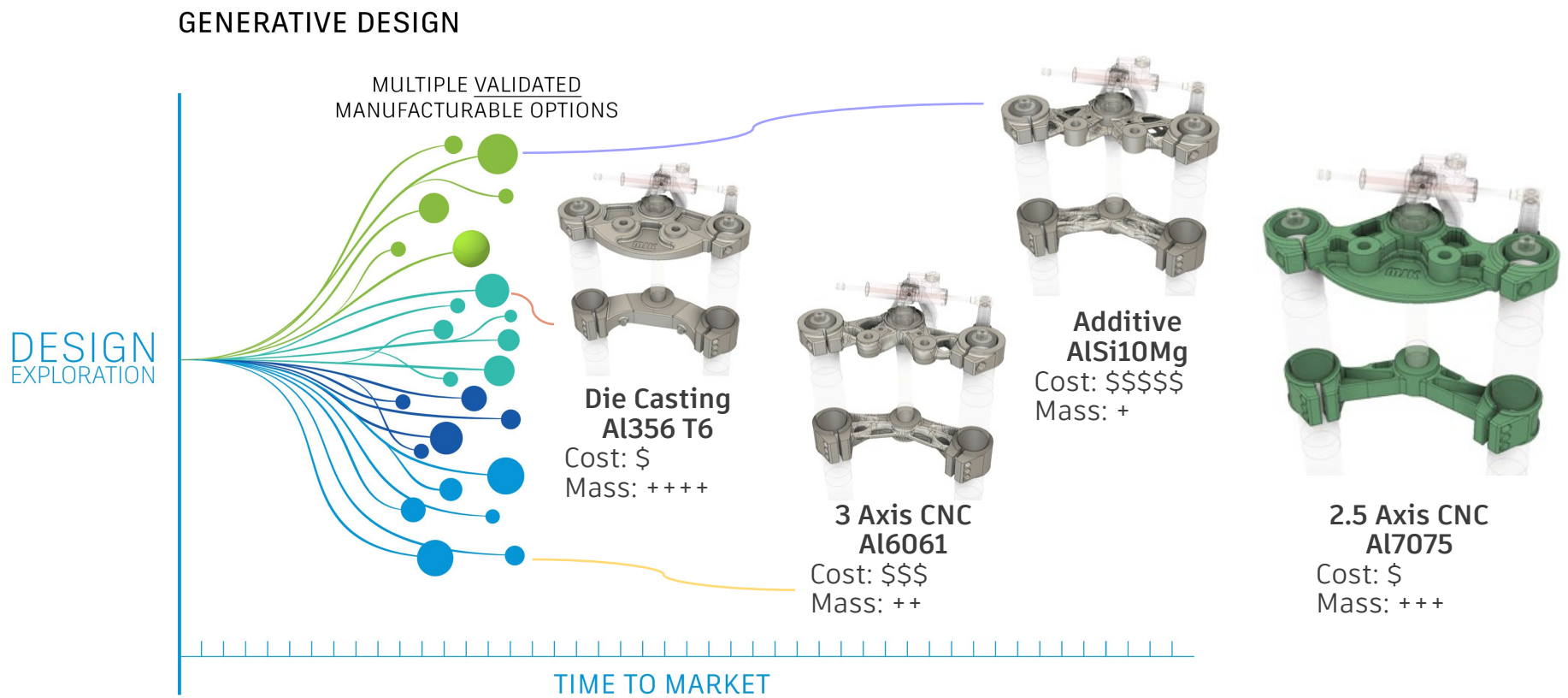
- ✓ **Design Exploration =** 10's, 100's, 1000's of higher performing design options
- ✓ **Manufacturing Aware**
- ✓ **Multiple Materials**
- ✓ **Open Design Space exploration**
- ✓ **Multiple Production methods**
- ✓ **CAD-Ready Geometry**

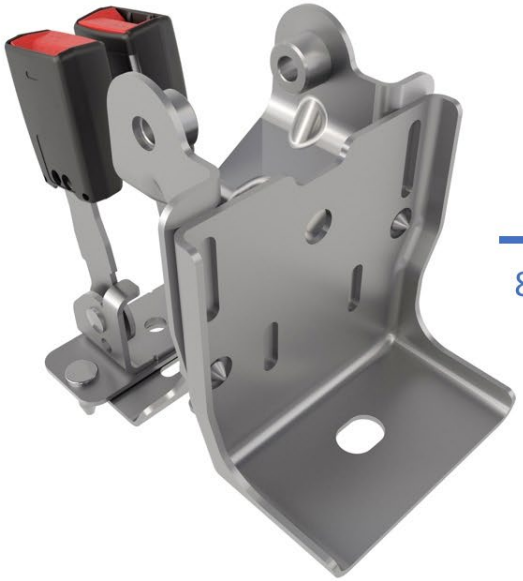


How Generative Design help the product development process



How Generative Design help the product development process



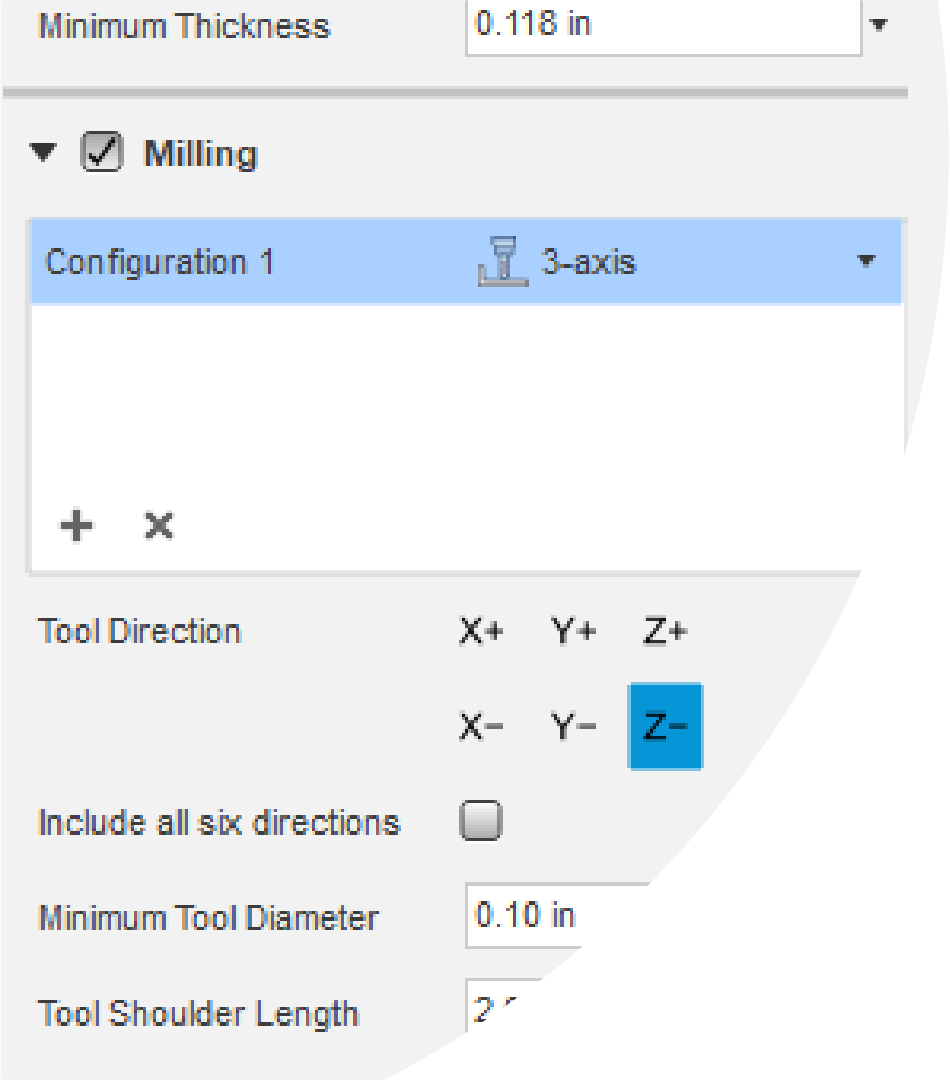


Generative Design & Additive Manufacturing

150 Design Options

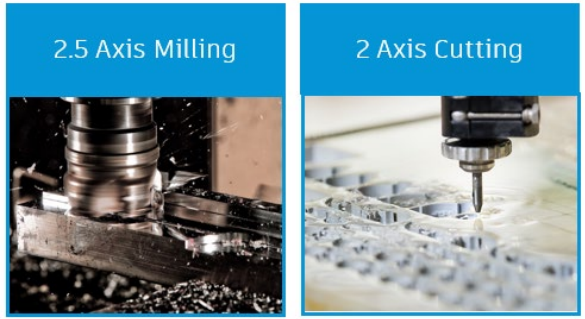
8 components into 1 part
40% lighter
20% stronger

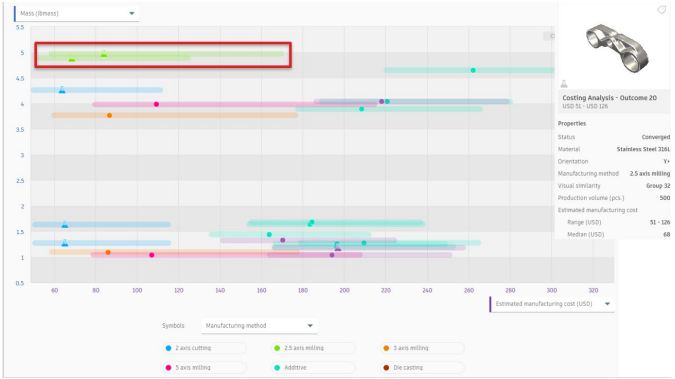
GENERAL MOTORS

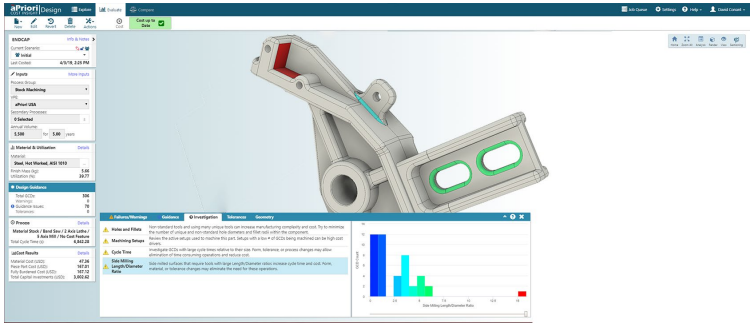


Generative Design is NOT exclusive to Additive Manufacturing

Design for MFG + Cost Analysis

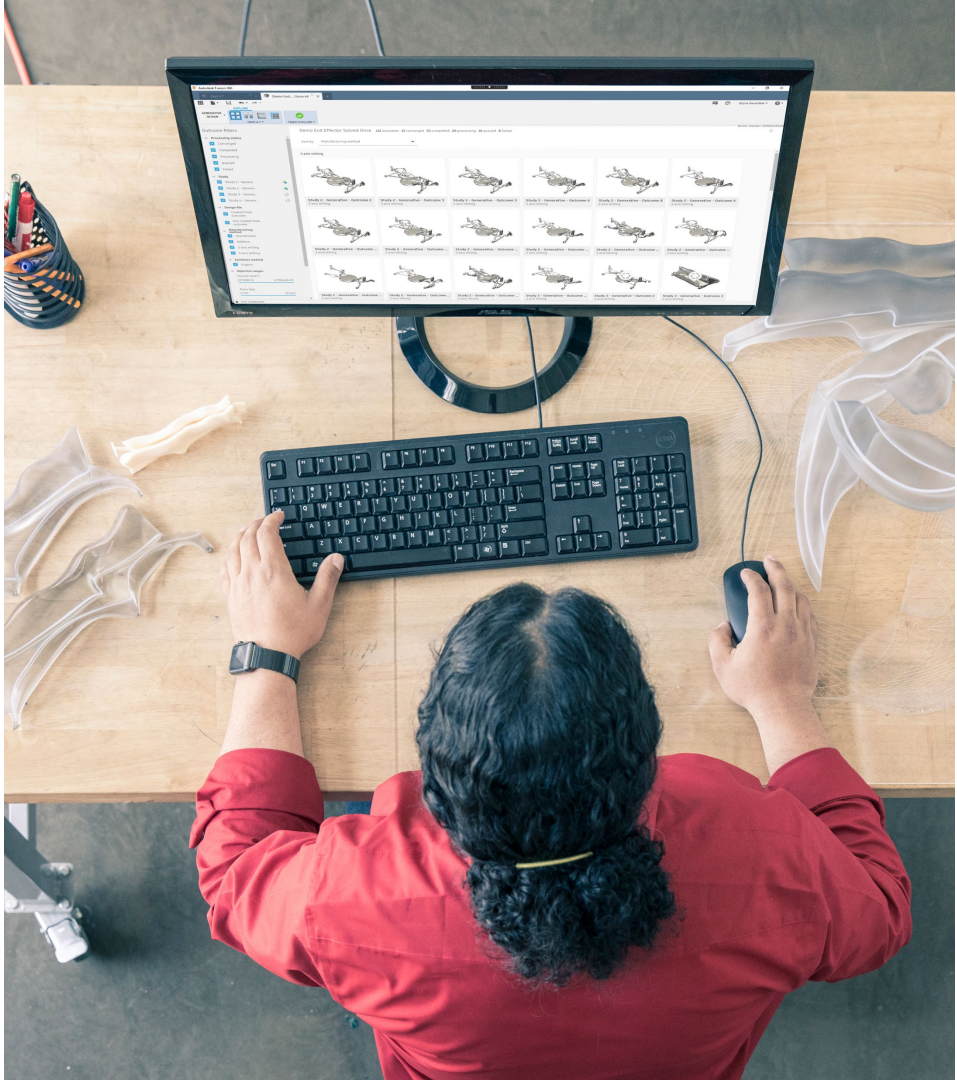






Challenges Today

- Limited time to ideate
- Increasing demand for engineering expertise
- Design and manufacturing disconnect
- Late-stage changes are cost prohibitive



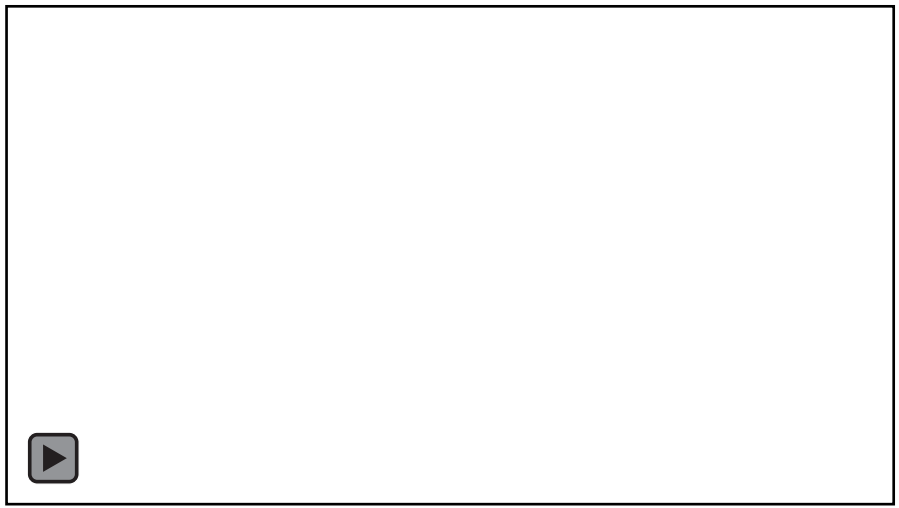
Why Generative Design?

Top benefits and outcomes customer realize

Improve profit margins

Improve time to market

Win more business



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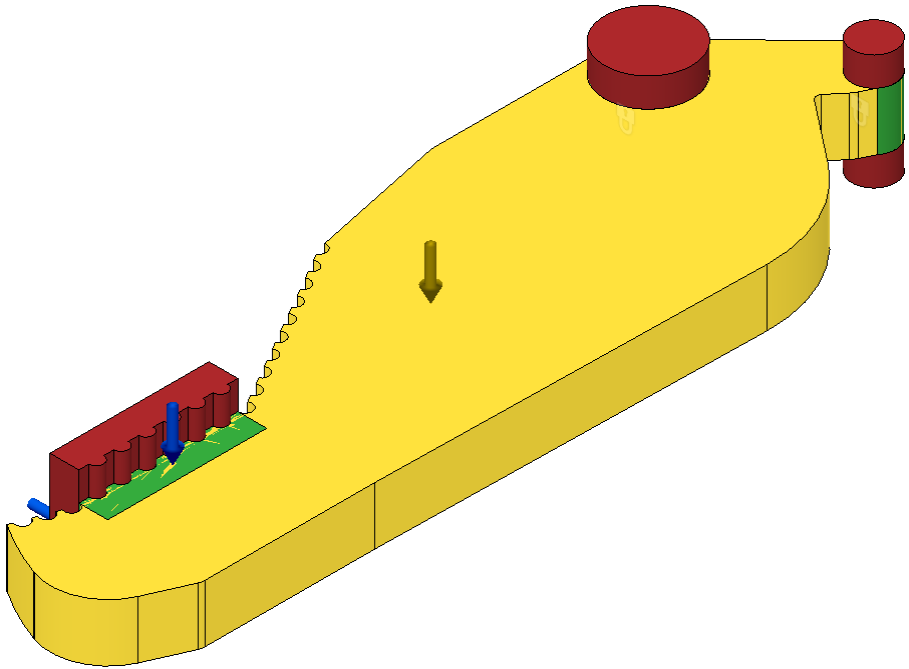
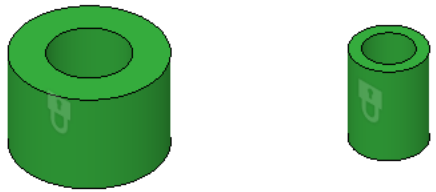
How Generative Design works

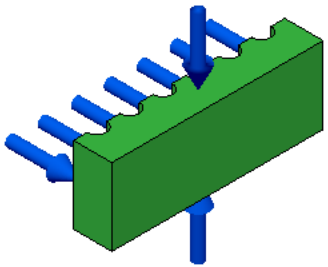
How Generative Design works



Preserve Geometry

"Keep-ins"

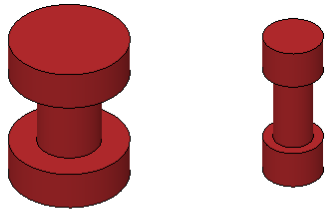


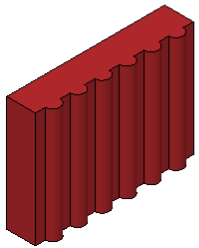


Obstacle Geometry

“Keep-outs”

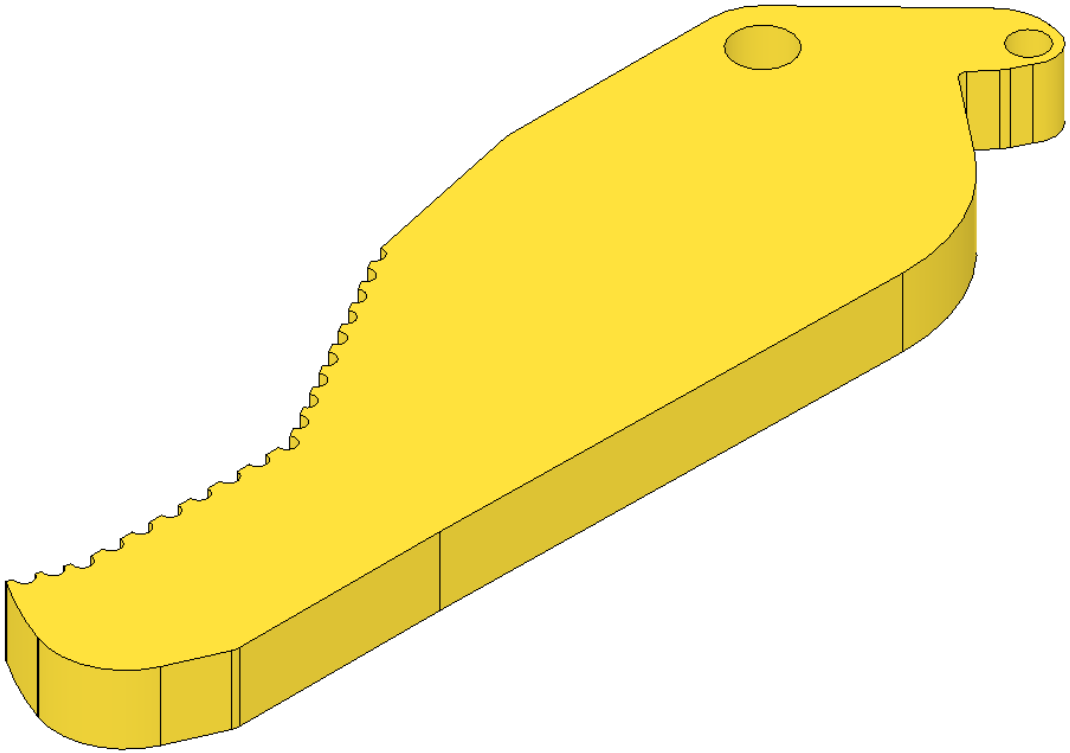
- clearances
- fastener and tool access
- motion/state
- assembly





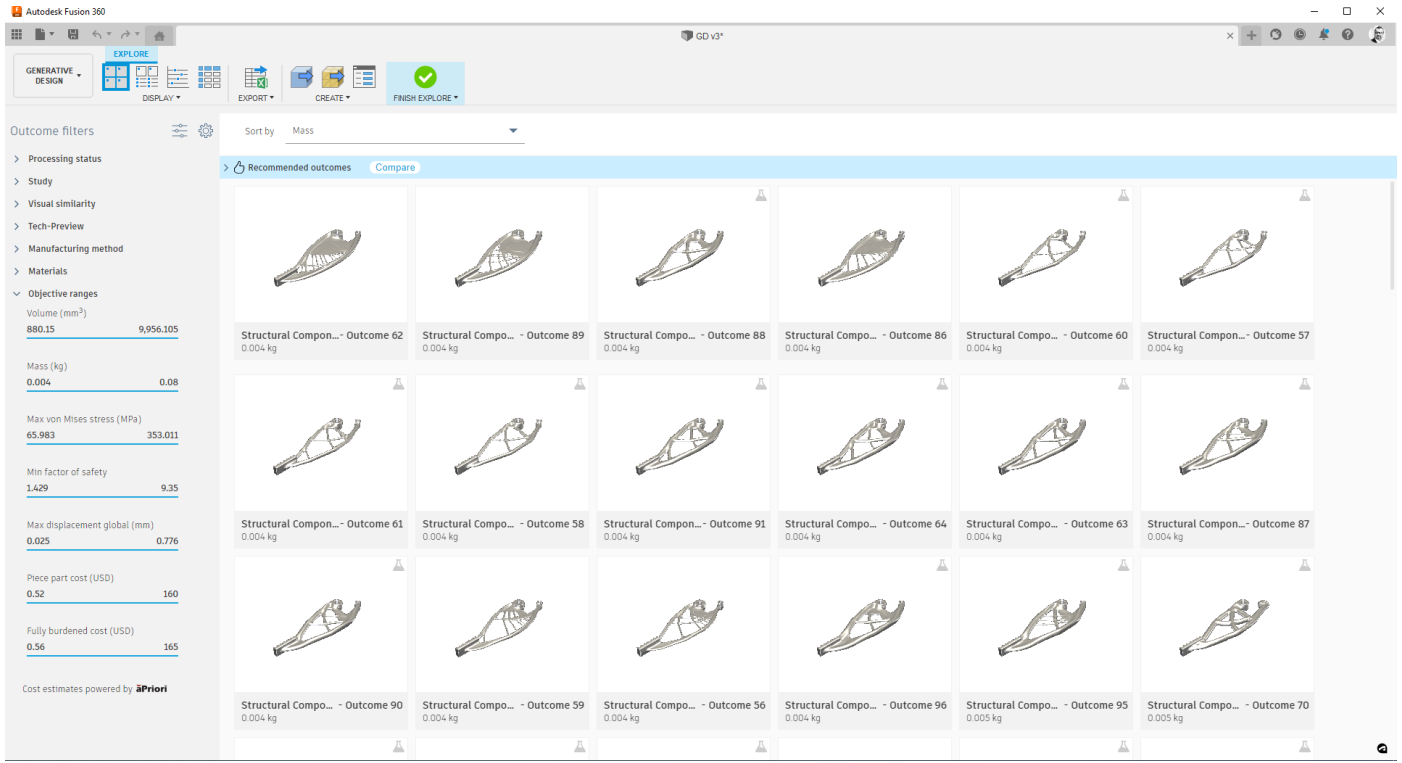
Starting Shape

"Optional"



Design Conditions, Design Criteria, Materials

Outcomes


Autodesk Fusion 360
GD v3*
GENERATIVE DESIGN
EXPLORE
DISPLAY
EXPORT
CREATE
FINISH EXPLORE
Outcome filters
Sort by
Mass
Processing status
Study
Visual similarity
Tech-Preview
Manufacturing method
Materials
Objective ranges
Volume (mm³)
880.15
9,956.105
Mass (kg)
0.004
0.08
Max von Mises stress (MPa)
65.983
353.011
Min factor of safety
1.429
9.35
Max displacement global (mm)
0.025
0.776
Piece part cost (USD)
0.52
160
Fully burdened cost (USD)
0.56
165
Cost estimates powered by aPriori
Recommended outcomes
Compare
Structural Compon... - Outcome 62
0.004 kg
Structural Compo... - Outcome 89
0.004 kg
Structural Compo... - Outcome 88
0.004 kg
Structural Compo... - Outcome 86
0.004 kg
Structural Compo... - Outcome 60
0.004 kg
Structural Compon... - Outcome 57
0.004 kg
Structural Compon... - Outcome 61
0.004 kg
Structural Compo... - Outcome 58
0.004 kg
Structural Compon... - Outcome 91
0.004 kg
Structural Compo... - Outcome 64
0.004 kg
Structural Compo... - Outcome 63
0.004 kg
Structural Compon... - Outcome 87
0.004 kg
Structural Compo... - Outcome 90
0.004 kg
Structural Compo... - Outcome 59
0.004 kg
Structural Compo... - Outcome 56
0.004 kg
Structural Compo... - Outcome 96
0.004 kg
Structural Compo... - Outcome 95
0.005 kg
Structural Compo... - Outcome 70
0.005 kg

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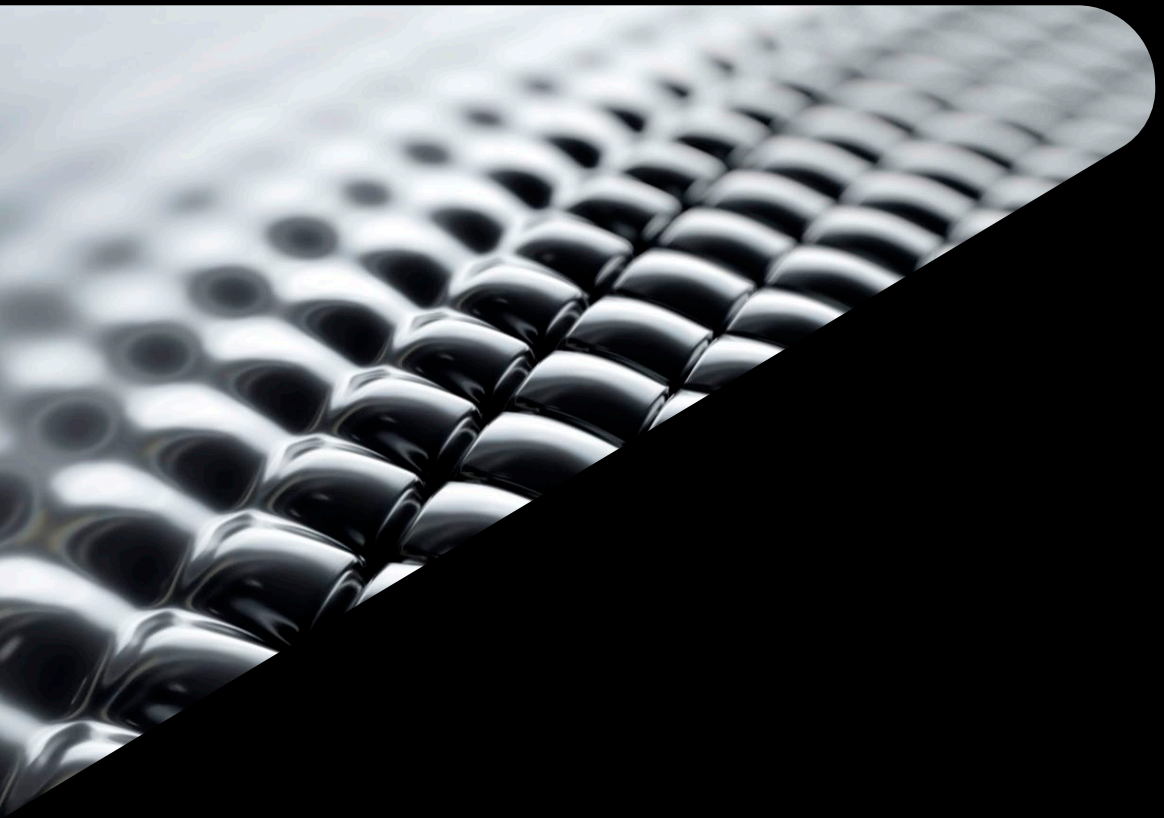
Trade-off

	HUMAN DESIGNED	3-AXIS GENERATIVE	2.5-AXIS GENERATIVE
FOS	5.7	3.0	3.0
Mass	389.7g	186.7g	204.2g
Cycle Time	51 min	123min	35min

	HUMAN DESIGNED	3-AXIS GENERATIVE	2.5-AXIS GENERATIVE
Design Time	**3.5 Hours**	**20 Minutes**	**20 Minutes**
Options	**3**	**100**	**100**



Topology Optimization vs Generative Design

Standard Topology Optimization vs Generative Design

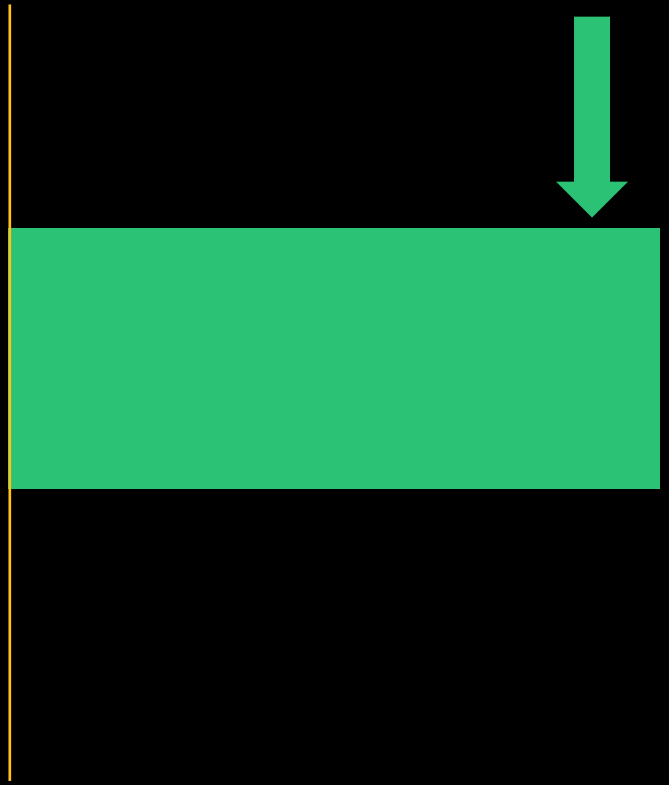
Standard Topology Optimization

- **SIMP Method**
  (Solid Isotropic Microstructure with Penalization)
- Using the FEA (finite element method) engine, we define which voxel is necessary for a certain load
- In this method, it is possible to obtain only one solution for a given condition

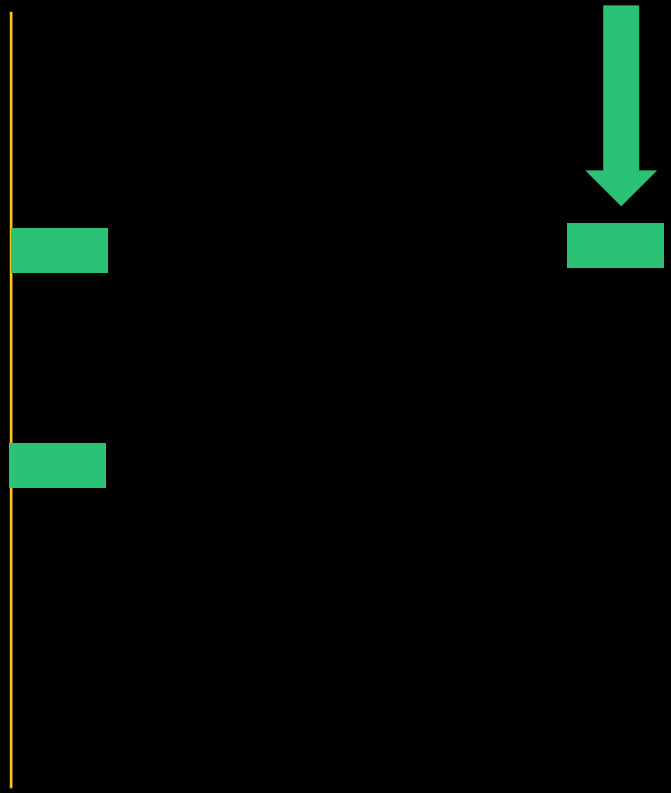
Generative Design

- **Level Set Method**
- Define the minimum distortion parameter by repeatedly calculating the solver by moving the surface boundary of the part in the direction perpendicular to the load path
- It is possible to request multiple proposals
- Gray zone is excluded and results are clean
- It can output with Solid, Mesh, T-Spline

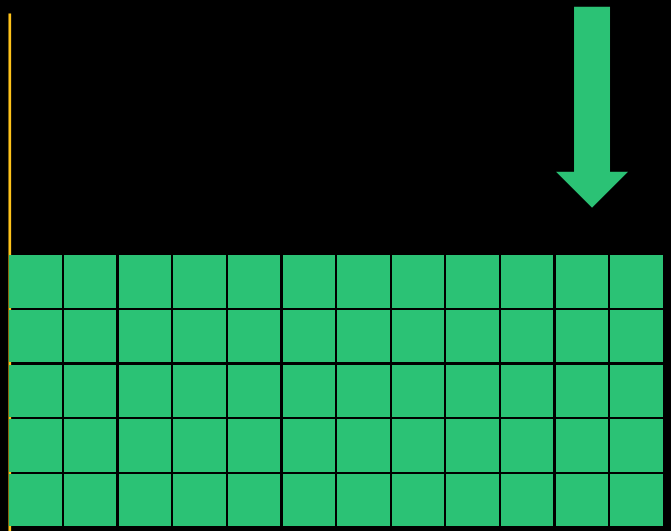
SIMP method



Level set method

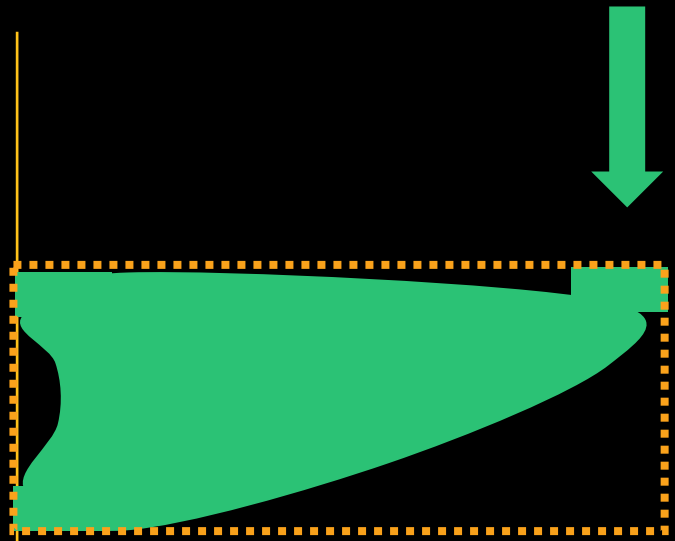


SIMP method



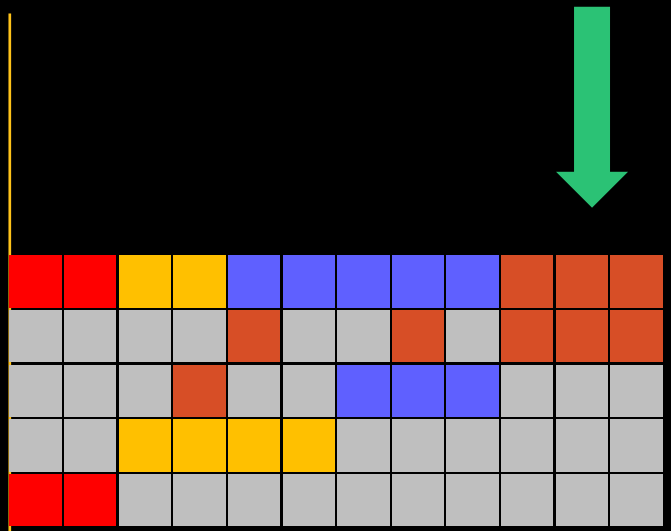
Divide Solid Volume to Blocks

Level set method



While repeatedly calculating one chunk, it gradually transform

SIMP method

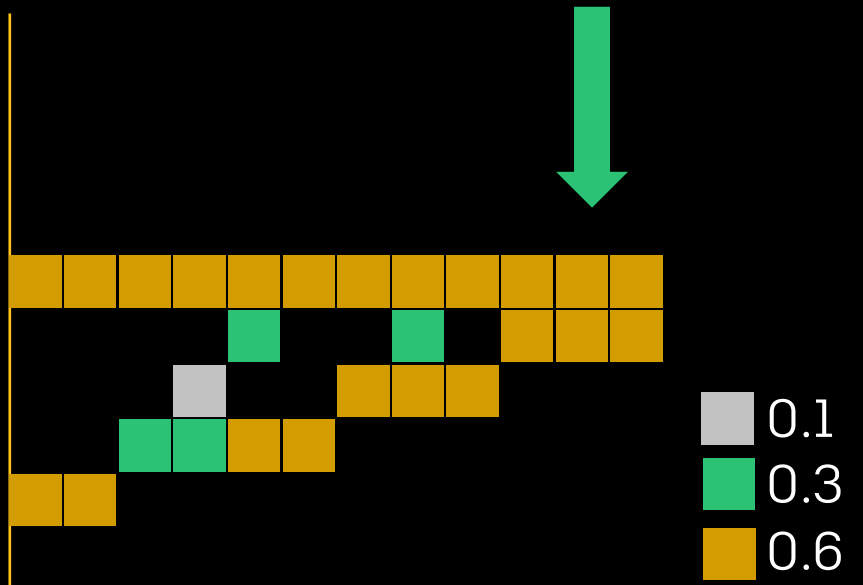


Based on how much stress is applied to each block, it removes ones not under any stress

Level set method

It repeatedly calculate and remove parts that do not apply force

SIMP method



It is required to set threshold between 0 to 1. Based on the value, it is possible to end up having a gray zone.

Level set method

Since it is mono-form from the beginning, it is difficult to make a break

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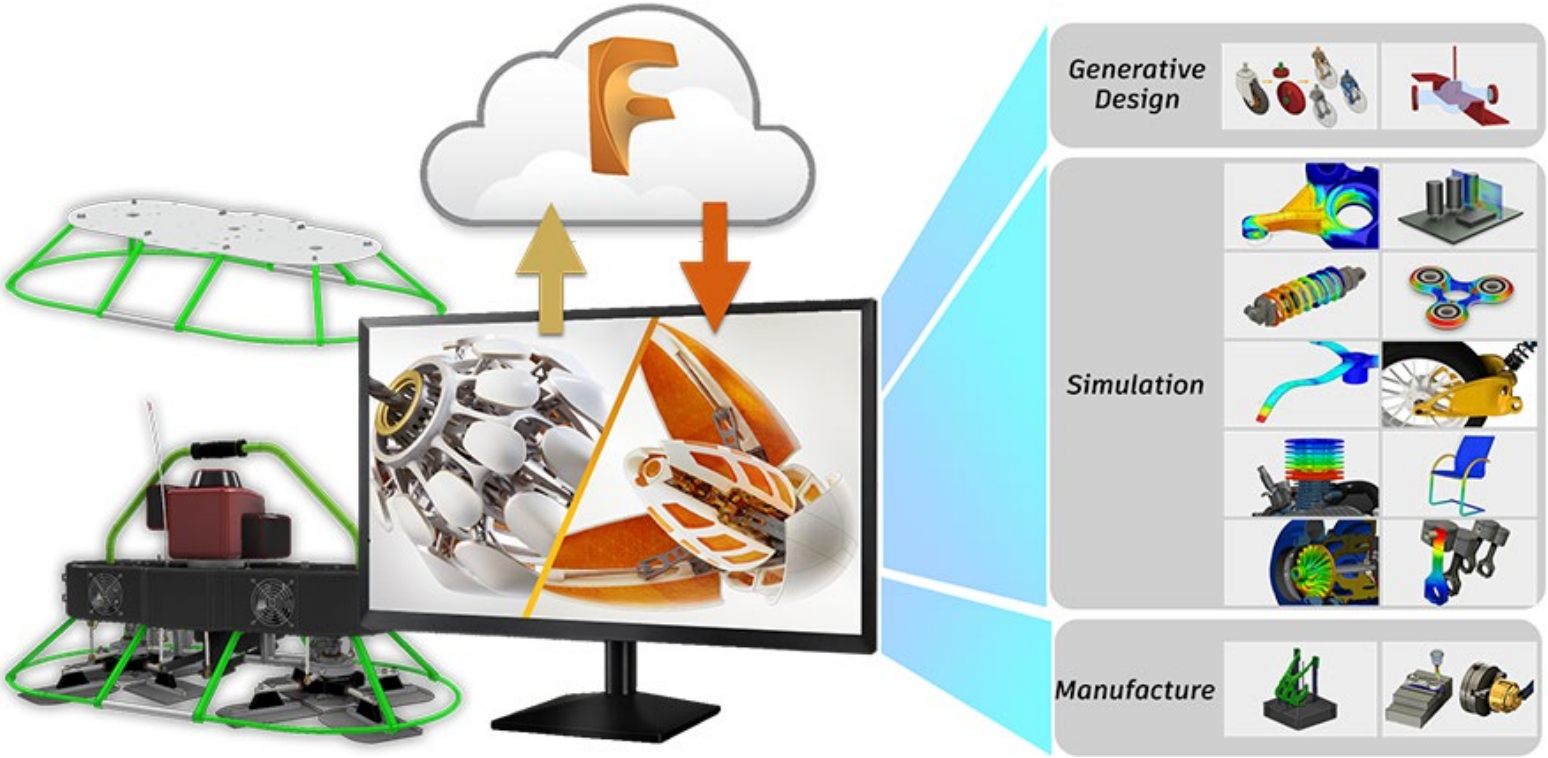
Inventor and Generative Design

From Inventor to Fusion 360

Send to Fusion 360 - Setup - Generate – Explore - Validate



From Fusion 360 to Inventor

Desktop Connector

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Live Demo

Learning Objectives

- Understand the benefits and workflow of Generative Design
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