

# Landing Gear Design Optimization Using Generative Design

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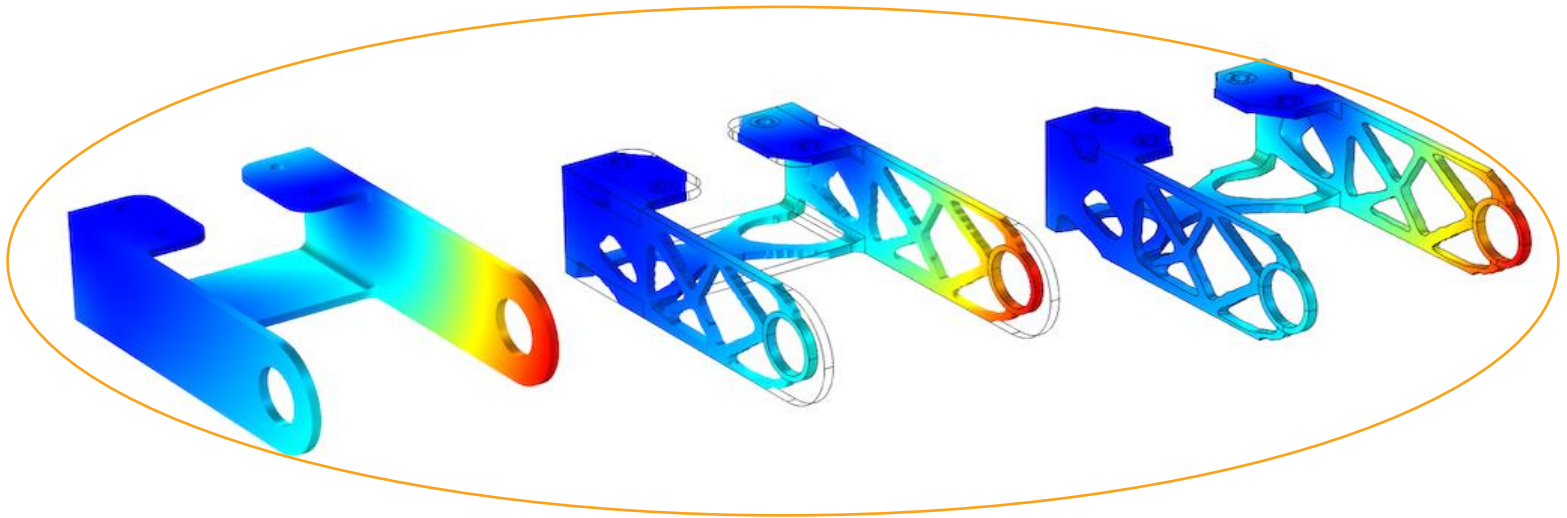
Dayananda Sagar University, Bengaluru

# **Case study selection**

# Introduction about the project

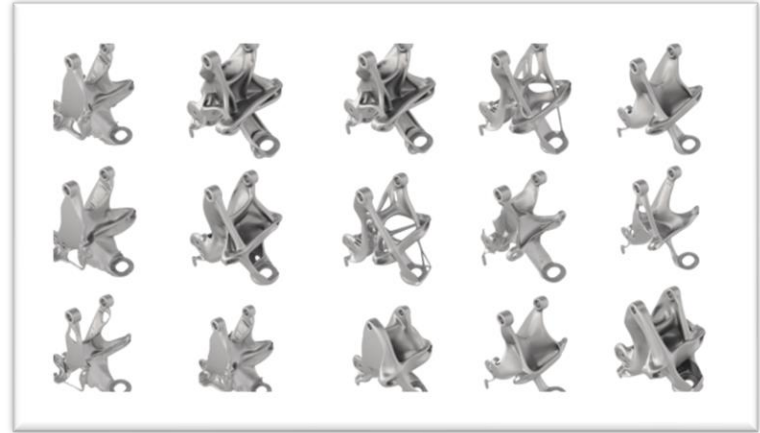
## Topology Optimization

Topology Optimization is a mathematical method that optimizes material layout within a given design space, for a given set of loads, boundary conditions and constraints with the goal of maximizing the performance of the system.



# Generative Design

- Recursive process
- Transformation approach
- Many organic design outcomes



# Nose landing gear types

- Nose wheel type retractable
- High nose wheel type retractable
- Nose wheel type fixed
- Tail wheel type fixed



# Chosen aircraft type

Cessna Grand Caravan



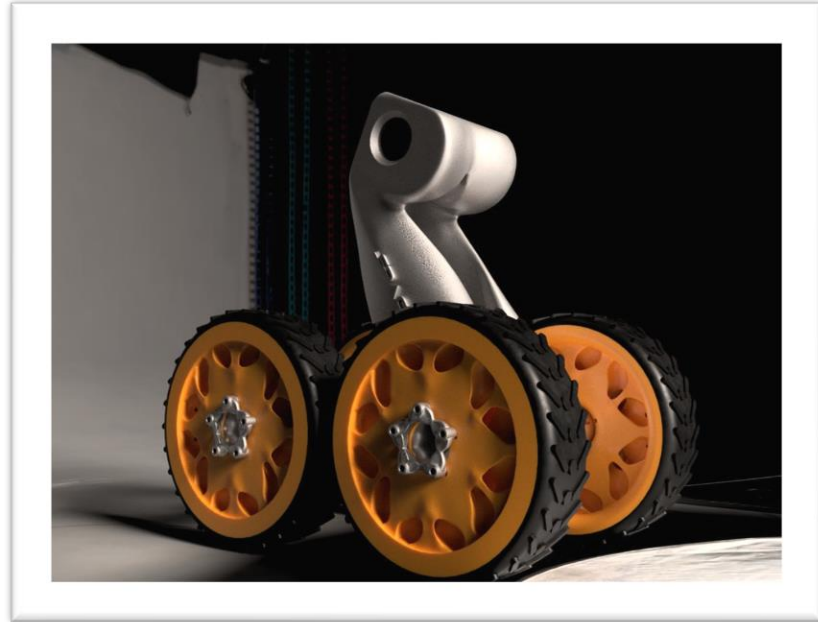


# **Applying Generative Design**

# Expected results by using Generative Design

Considering the objectives which can be accomplished by the Generative Design technique

- Reduced weight
- Improved efficiency
- Customized product development





# Generic design review

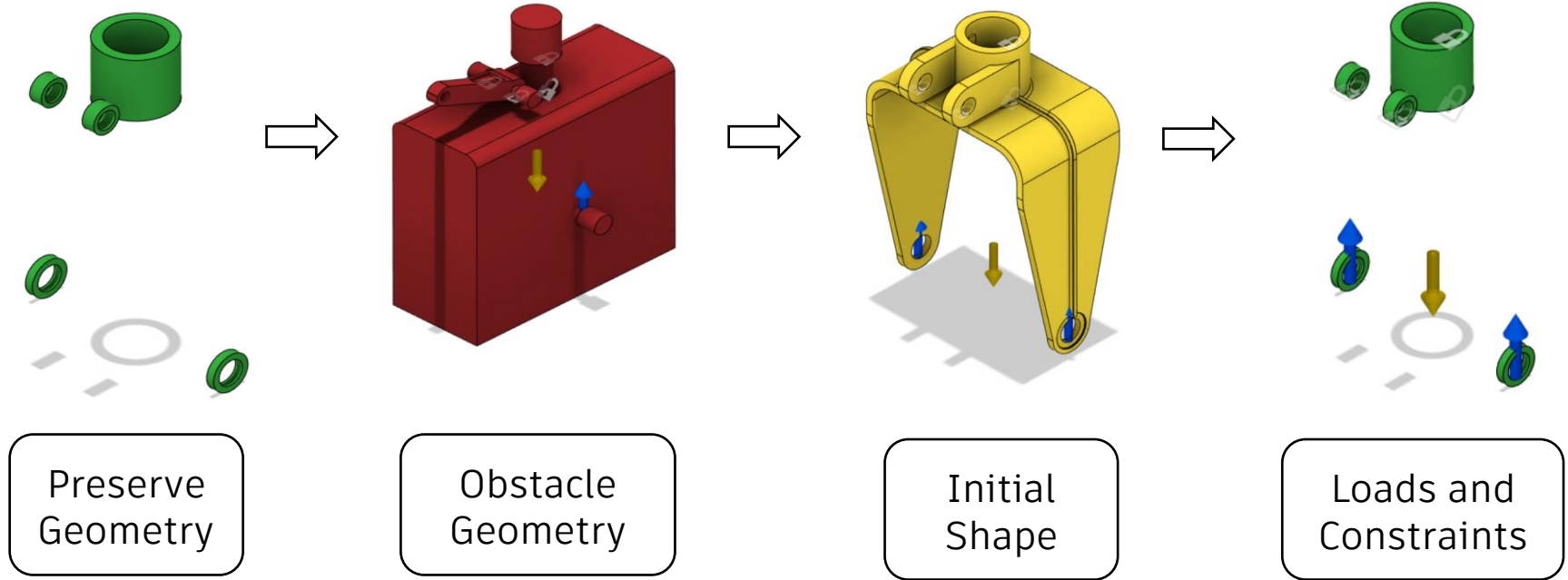
Standard engineering approach generic design

## Characteristics

- Material - Aluminum 6061
- Weight - 963.27 grams
- Manufacturing Method - Die Casting



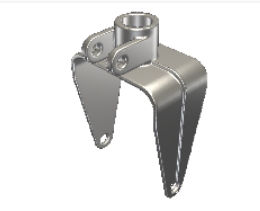


# Generative Design process



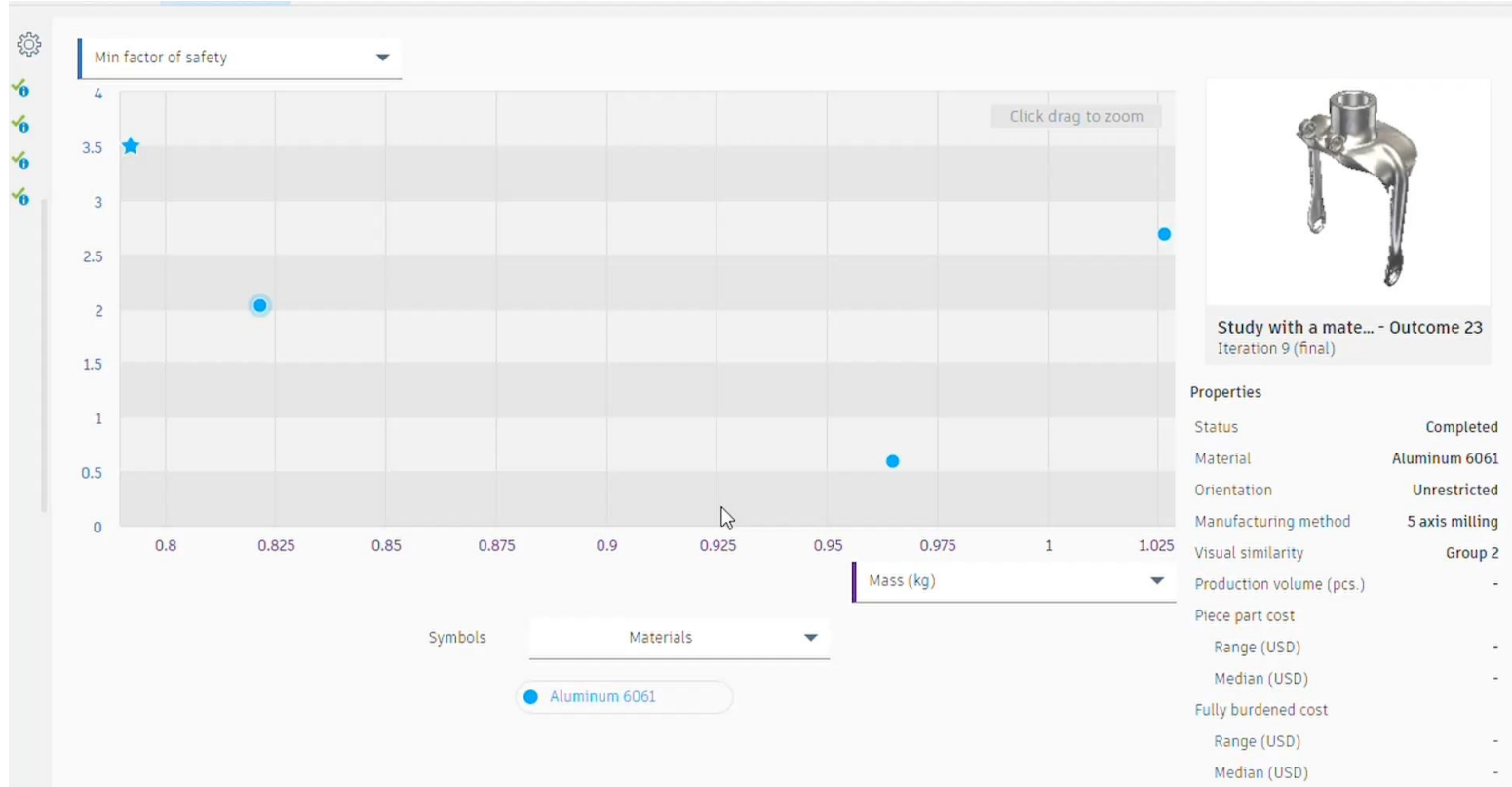
## Few other inputs:

- Objective - To minimize mass with a minimum safety factor of 2.
- Manufacturing methods, materials

# Selection of best design

							
Study with a mate... - Outcome 20 Completed		Study with a mater...- Outcome 21 Completed		Study with a mate... - Outcome 22 Completed		Study with a mate... - Outcome 23 Completed	
<b>Properties</b>		<b>Properties</b>		<b>Properties</b>		<b>Properties</b>	
Status	Completed	Status	Completed	Status	Completed	Status	Completed
Material	Aluminum 6061	Material	Aluminum 6061	Material	Aluminum 6061	Material	Aluminum 6061
Orientation	-	Orientation	Z+	Orientation	X+, Y+, Z-	Orientation	Unrestricted
Manufacturing method	Unrestricted	Manufacturing method	Additive	Manufacturing method	3 axis milling	Manufacturing method	5 axis milling
Visual similarity	Group 5	Visual similarity	Group 3	Visual similarity	Group 7	Visual similarity	Group 2
Production volume (pcs.)	-	Production volume (pcs.)	-	Production volume (pcs.)	-	Production volume (pcs.)	-
Piece part cost	-	Piece part cost	-	Piece part cost	-	Piece part cost	-
Range (USD)	-	Range (USD)	-	Range (USD)	-	Range (USD)	-
Median (USD)	-	Median (USD)	-	Median (USD)	-	Median (USD)	-
Fully burdened cost	-	Fully burdened cost	-	Fully burdened cost	-	Fully burdened cost	-
Range (USD)	-	Range (USD)	-	Range (USD)	-	Range (USD)	-
Median (USD)	-	Median (USD)	-	Median (USD)	-	Median (USD)	-
Volume (mm <sup>3</sup> )	357,333.68	Volume (mm <sup>3</sup> )	293,373.49	Volume (mm <sup>3</sup> )	380,131.02	Volume (mm <sup>3</sup> )	304,261.22
Mass (kg)	0.965	Mass (kg)	0.792	Mass (kg)	1.026	Mass (kg)	0.822
Max von Mises stress (MPa)	465	Max von Mises stress (MPa)	78.6	Max von Mises stress (MPa)	102.6	Max von Mises stress (MPa)	135.7
Factor of safety limit	2	Factor of safety limit	2	Factor of safety limit	2	Factor of safety limit	2
Min factor of safety	0.59	Min factor of safety	3.5	Min factor of safety	2.68	Min factor of safety	2.03
Max displacement global (mm)	5.76	Max displacement global (mm)	0.52	Max displacement global (mm)	1.06	Max displacement global (mm)	0.95

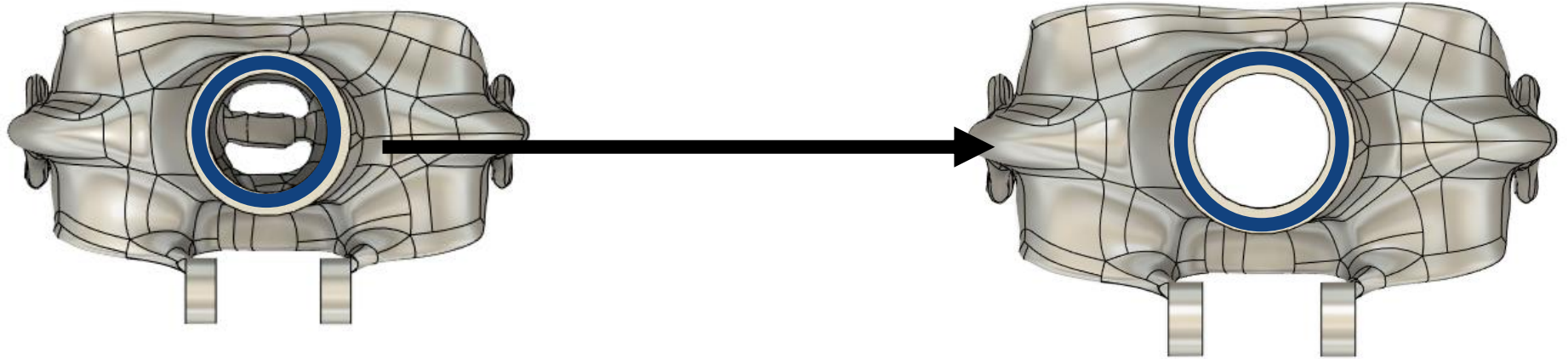
# Scatter plot results





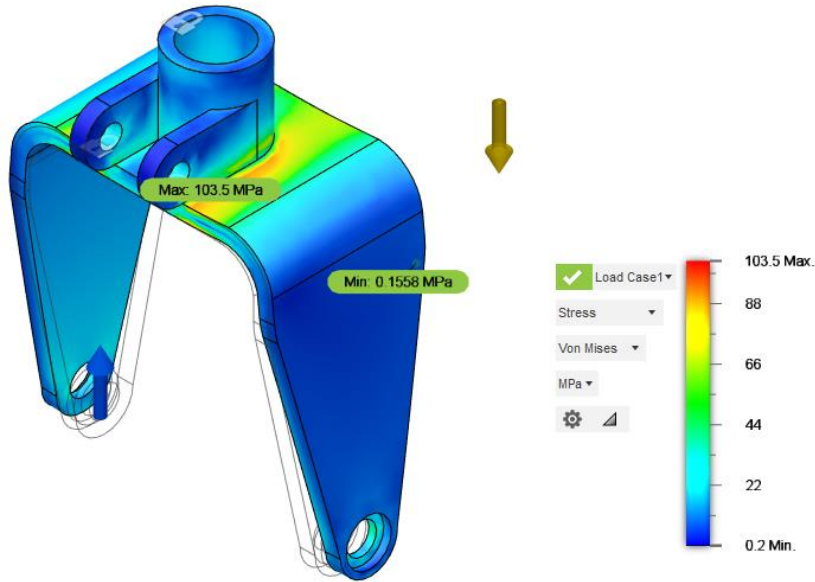
# **Post processing and simulation**

# Post processing



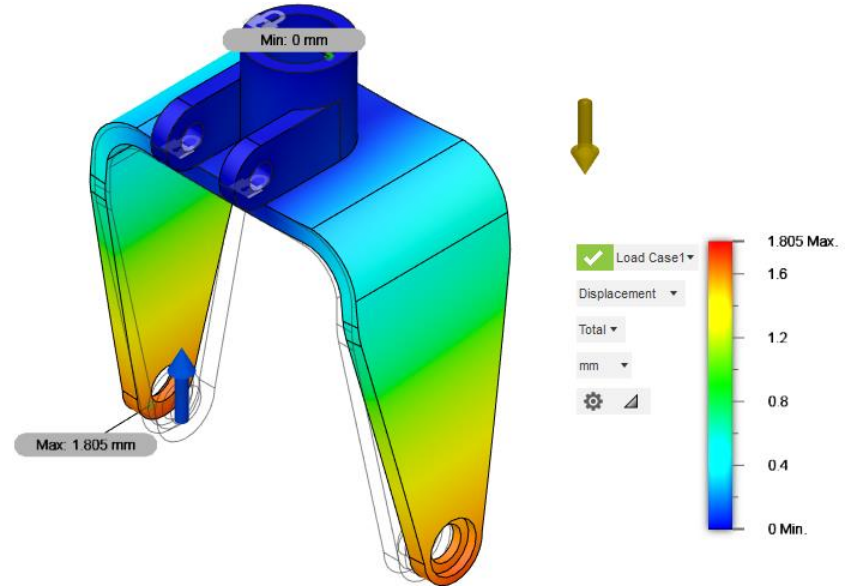
# Simulation study - standard engineering design

## Stress distribution



Maximum von Mises stress = 103.5 MPa

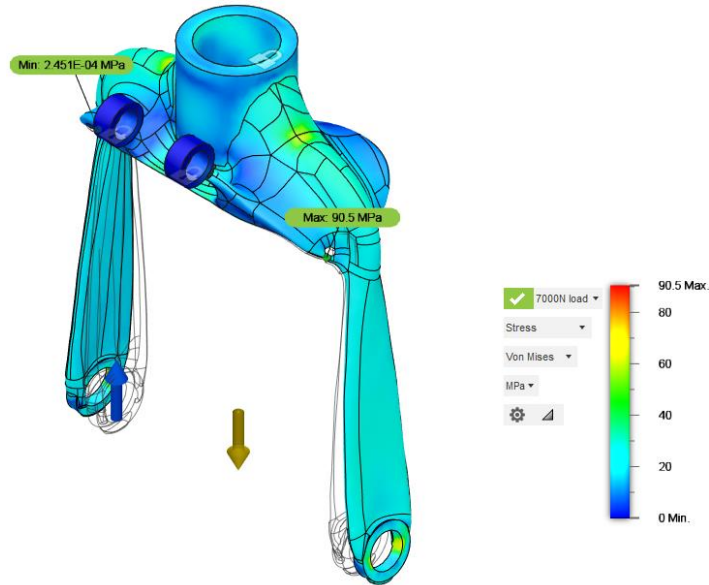
## Displacement plot



Maximum displacement global = 1.805 mm

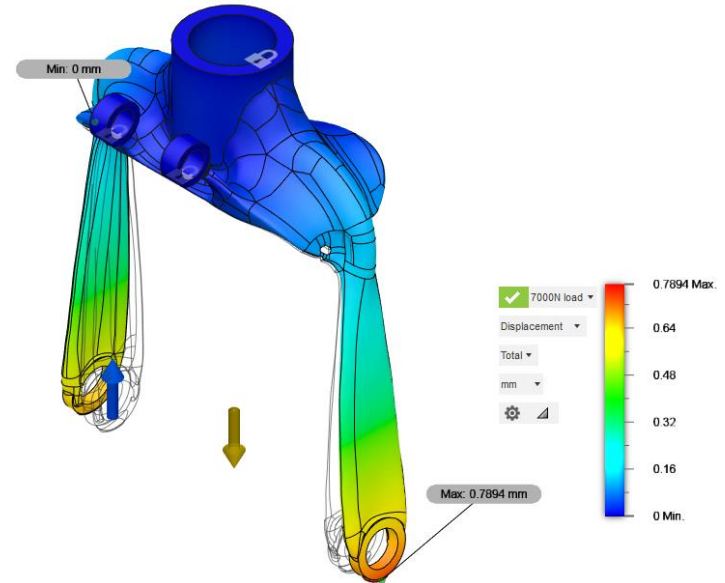
# Simulation study - Generative Design

## Stress distribution



Maximum von mises stress = 90.5 MPa

## Displacement plot



Maximum displacement global = 0.7894 mm

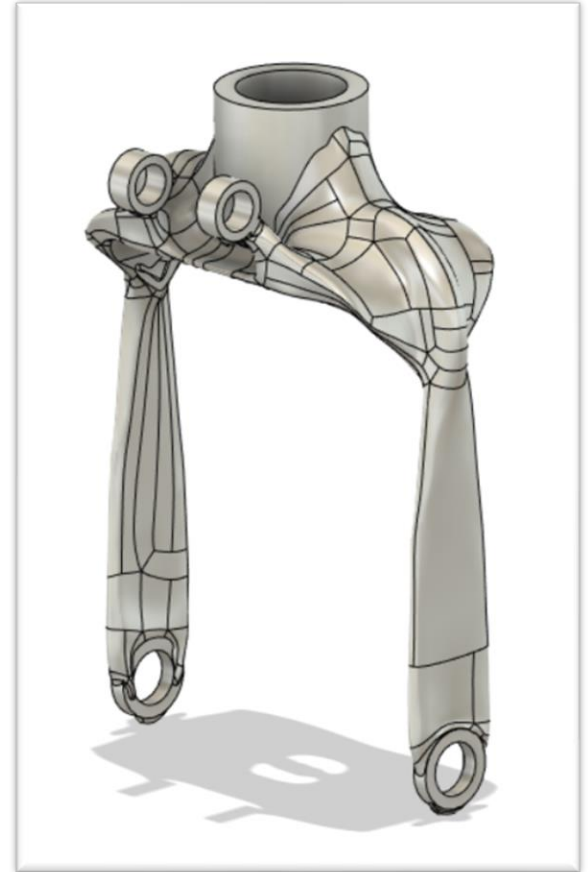


# Generative Design review

Generative Design approach initial design

## Characteristics:

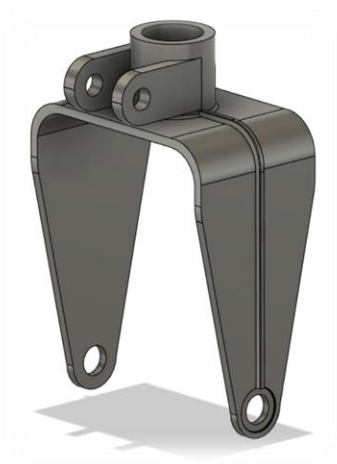
- Material: Aluminum 6061
- Weight: 741.45 grams
- Max Von Mises Stress: 90.5 MPa
- Max. displacement: 0.7894 mm



# Comparison

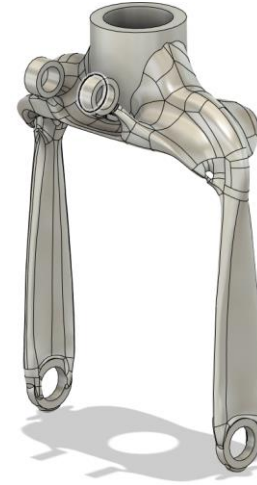
Comparison between generic design and Generative Design part

## Generic design review



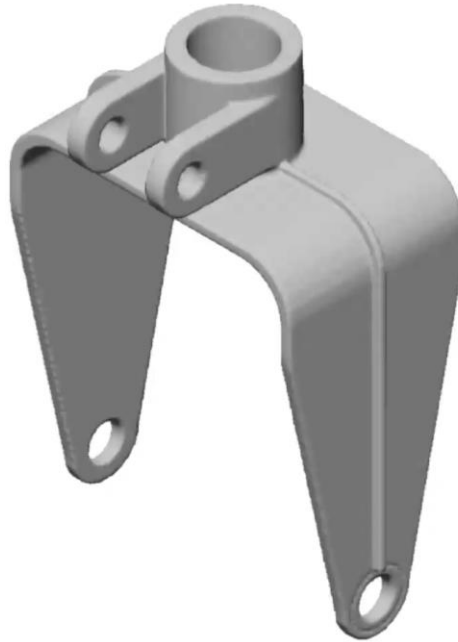
- Weight - 963.27 grams
- Displacement - 1.805 mm

## Generative Design review



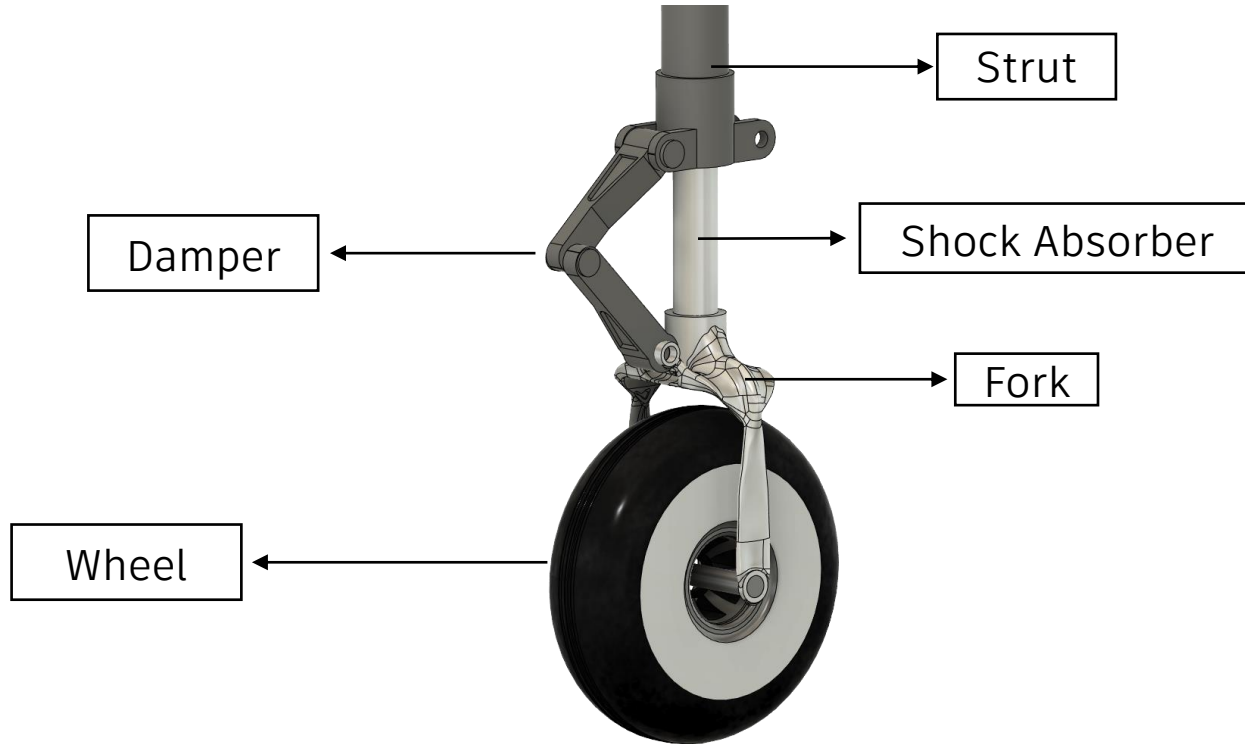
- Weight - 741.45 grams (23% lighter)
- Displacement - 0.7894mm (56% reduction)

# Generative Design model evolution



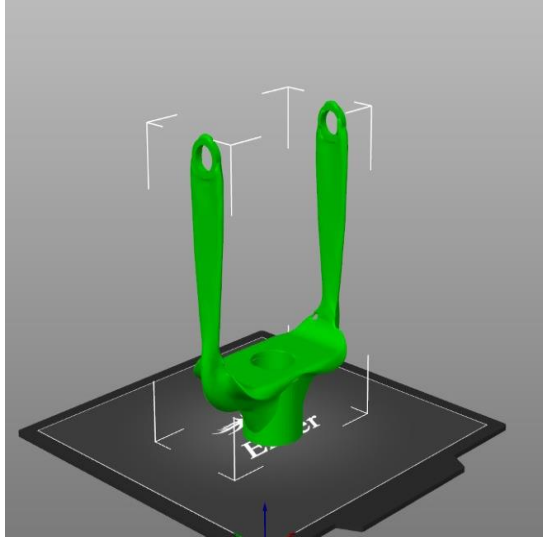
# Generative Design model review

Full assembly of the landing gear with Generative Design part



# 3D printed fork

3D Printed using PLA Material



# References for case study

- “Generative Design: What it is? How is it Being Used? Why it’s a Game Changer!”  
<https://www.carbodydesign.com/2018/05/gm-uses-generative-design-for-vehicle-lightweighting/> Matthew McKnight, (2017).
- Research, design and fabrication of quadcopter chassis by Generative Design and 3D printing.
- Design Space Exploration with Autodesk Generative Design by Kenny Cornett and Michael Musiol.

The background of the slide features four abstract, dark gray, three-dimensional geometric shapes positioned in the corners. These shapes resemble stylized, faceted crystals or architectural elements, each with sharp edges and reflective surfaces that catch the light, creating bright highlights and deep shadows. They are arranged symmetrically, framing the central text.

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