Autodesk Generative Design Capabilities for Machinery Industries

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Autodesk

Learning Objectives

- Understand Autodesk Generative Design approach
- Understand the new design space tool
- Explore generative design outcomes
- Learn how to increase product performance on machinery components

Description

As part of Fusion 360 software, Autodesk Generative Design is the new design space tool for designers and engineers capitalizing on the power of cloud and artificial intelligence (AI). During this session, we are going to discover how to use it for expanding and increasing the innovation on machinery industries effecting products' performance and production costs. We will use real customer examples. One example will show the complete workflow for redesign a critical component of an automatic pallet stretch wrapping machine. The outcome is 75% lighter and allows to replace 50+ components in the original design, with one.

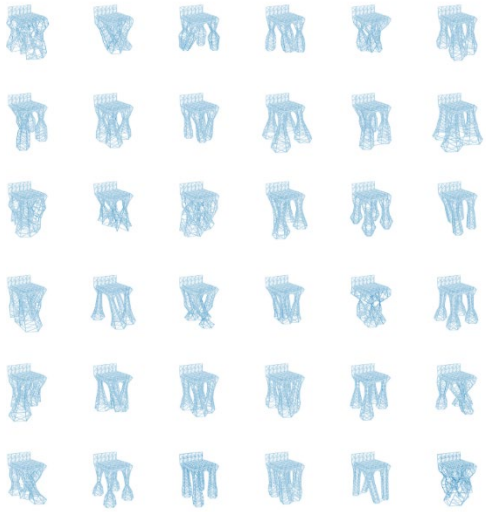
Speaker(s)

Alessandro Gasso is currently employed as Fusion 360 / Generative Design Adoption Specialist within the Customer Success Organization at Autodesk, Inc. Over the past 17 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 2018. 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).

Harv Saund Technical Specialist – Fusion 360, Autodesk UK - harv.saund@autodesk.com | @harv_saund
Joined Autodesk in 2016.Prior to Autodesk, 5 years as a Solidworks technical consultant, 2 years spent in Race Engine Development & a degree in Motorsport Engineering
Product focus is the Fusion 360 platform incl. CAM, Eagle, FEA, Generative Design & Library.IO

AUTODESK GENERATIVE DESIGN

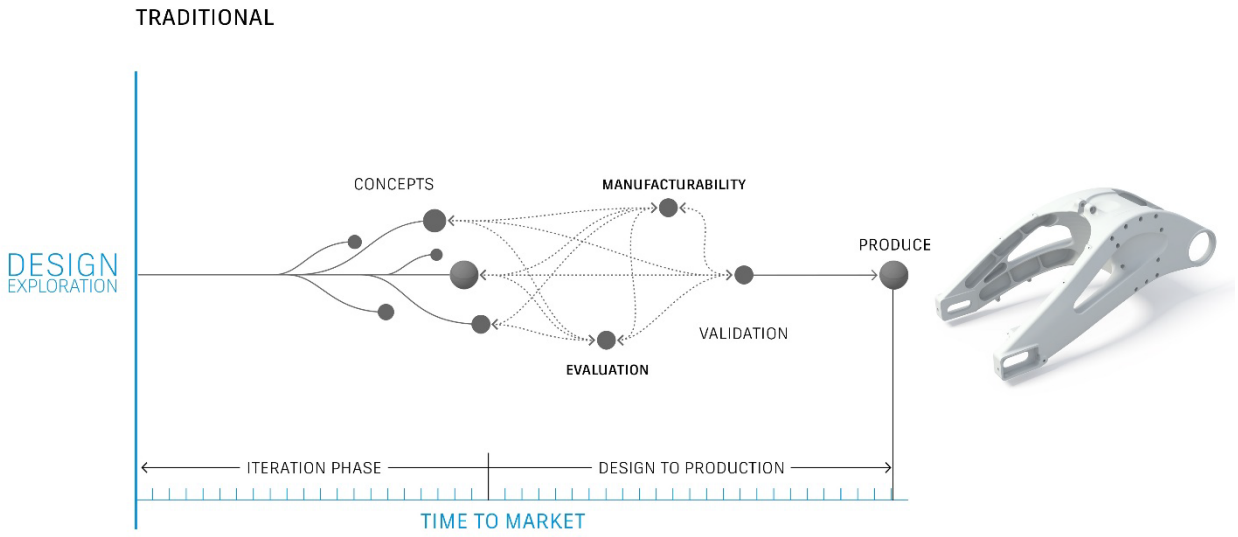
Autodesk Generative Design is a design exploration technology.
Simultaneously generate multiple CAD-ready solutions based on real-word manufacturing constraints and product performance requirements.



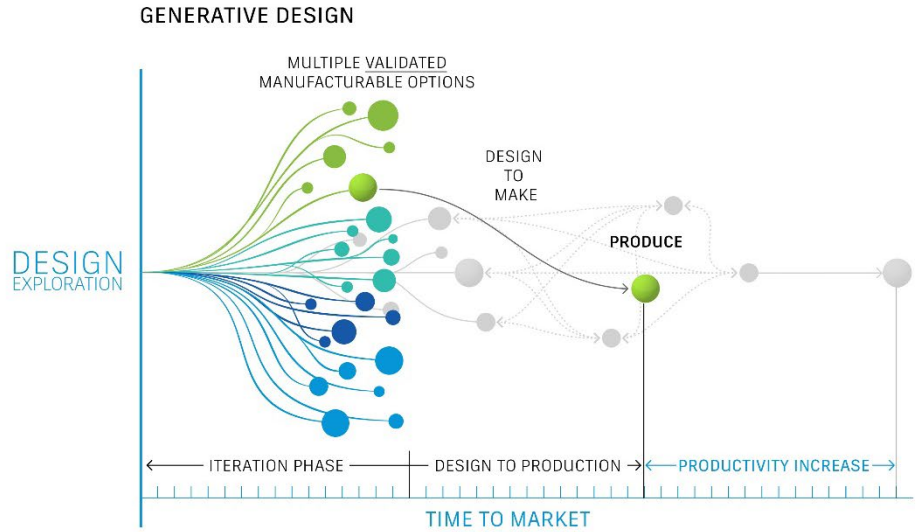
Designers or engineers input design parameters (such as materials, size, weight, strength, manufacturing methods, and cost constraints) into generative design software and the software explores all the possible combinations of a solution, quickly generating hundreds or even thousands of design options. From there, the designers or engineers can filter and select the outcomes to best meet their needs.

All the chairs in this picture meet the design requirements, respect the boundary conditions and can all be produced with the manufacturing technologies available today.

HOW DOES AUTODESK GENERATIVE DESIGN HELP THE PRODUCT DEVELOPMENT PROCESS

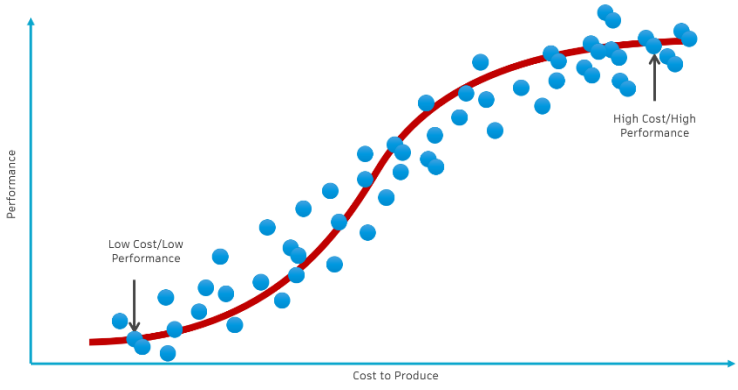


In the traditional approach, we must evaluate and validate the manufacturability of few concepts before sending one of them to production.

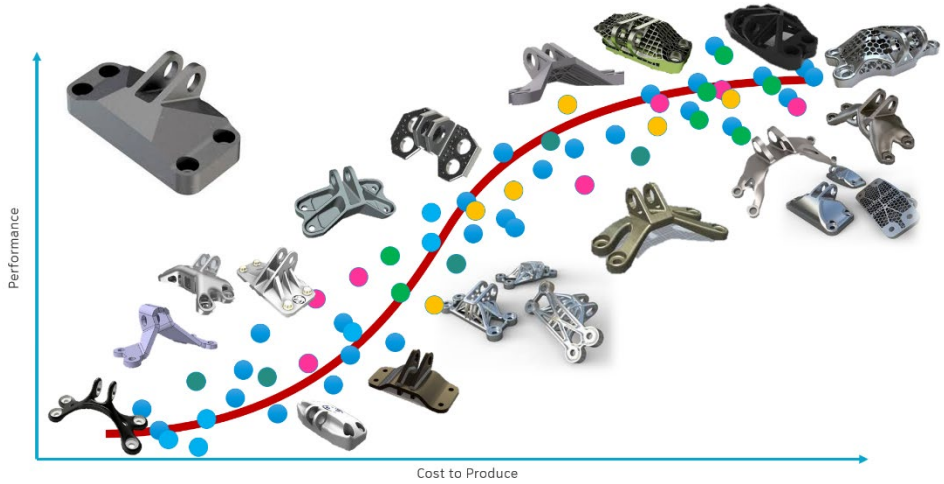


Generative Design generates a wide range of designs, from thousands to tens of thousands, that meet the requirements.
The result is complex, high-performance structures that human designers would never have conceived.
Unlike topological optimization, the software explores all possible permutations of a solution, considering even today's production capabilities and technologies, quickly generating design alternatives.
What makes the design exploration unique is its ability to analyze all the possible variants of a solution and present the list of possible choices to the designer, who will be able to make an educated decision on tradeoffs for a given design challenge and produce it, reducing the time to go from the design to production and therefore, increasing the productivity.

Another often benefit of Generative Design is the ability to consolidate parts. Because generative design can handle a level of complexity that is impossible for human engineers to conceive – and because additive manufacturing can enable the fabrication of the complex geometries that generative algorithms often produce – single parts can be created that replace assemblies of 2, 3, 5, 10, 20 or even more separate parts. Consolidating parts simplifies supply chains, maintenance and can reduce overall manufacturing costs.



The price performance curve is the way in which teams can make an educated decision on tradeoffs for a given design challenge. You can make different choices along this curve, which will each satisfy the requirements, with both a different cost as well as a different performance and experiment. You need to decide which one delivers the value that you need.

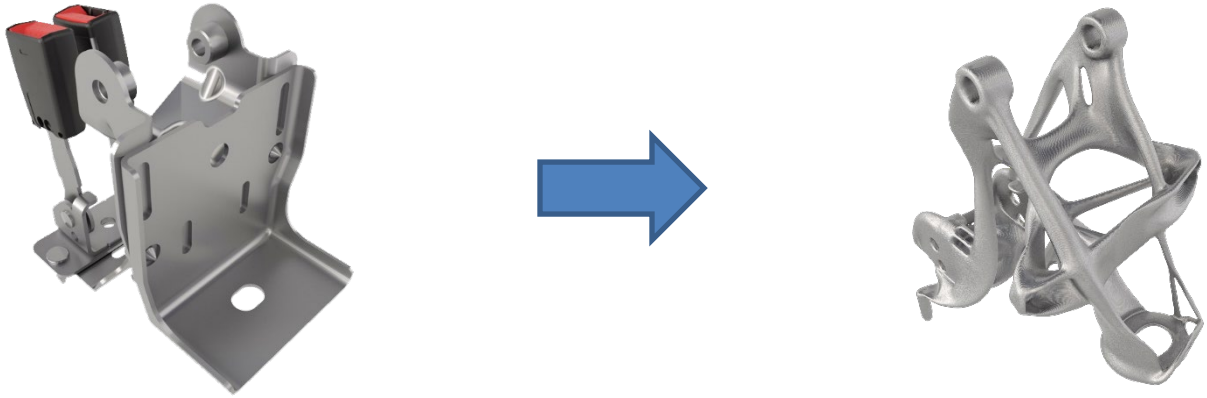


A popular open sourced design challenge was the GE Bracket challenge. The interesting thing from this challenge is that many hundreds of designs were created, all satisfying the requirements, but all with different costs to produce, based on materials, process, and other design parameters.
The challenge for any design team is how can you produce all these options, which culminate into multiple man years of engineering effort, with today's rapid decision-making environments.

The answer is to turn to Generative Design that with the help of cloud computing, can augment the ability of engineering teams to develop and explore the full design space for any problem that they may want to explore.

CUSTOMER EXAMPLES

GENERAL MOTORS - Automotive Manufacturer



At General Motors, they think generative design paired with additive manufacturing can be completely disruptive to our industry.
They have some very unique design challenges in some of their upcoming vehicle programs. One of those was a seat bracket. That seat bracket is very important from a functional safety perspective and they needed to fully functionally optimize this design for mass.
They chose to use generative design as their design tool to come up with different options for the seat bracket.
Normally, when they face a design challenge like that, they may come up with two or three different design options; but with generative design they could come up with over **150**, some solutions that they just couldn't have thought of with any other existing design tools.
They run it through their normal set of test procedures that are required for this part. This part is **40% lighter** and **20% stronger** and they could **consolidate 8 components into 1**.
GM has many different parts and pieces on their vehicles; over 30,000 on average. Now, the real challenge is to find all those different applications where they can apply the same principles of generative design to really optimize their vehicles further.
More details here.

CLAUDIUS PETERS - Industrial Equipment Manufacturer

Claudius Peters is widely recognized as one of the premiere manufacturers of cement plant equipment. This 112-year old company sustains its competitive advantage through a continuous journey of innovation -- investing in new technologies and new ways of doing things.

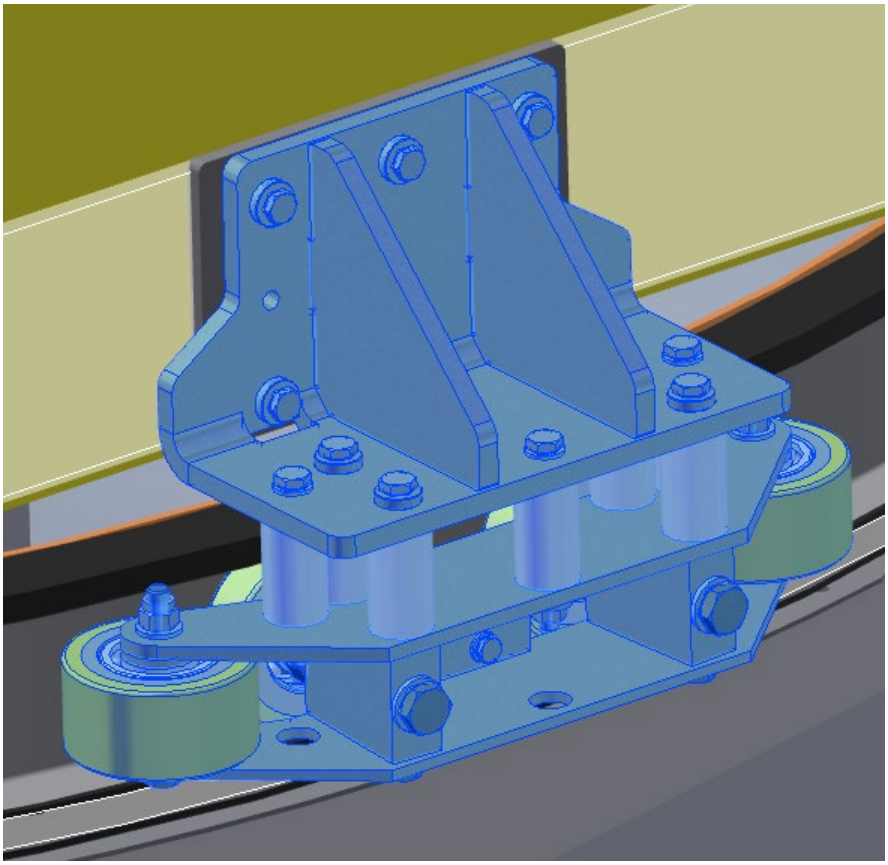
This year, their digital team began experimenting with generative design. The Clinker Cooler, an essential piece of concrete cooling equipment, was the first application. Saving material is an important cost factor in this heavy, cast part.

The team setup the project in Fusion 360, applying goals and constraints. Excited and surprised by the result, they began to explore their options. Additive manufacturing was out of the question given the scale, but the team took the result, reverse engineered it back into Inventor using the simulation capabilities to validate the design and created a final part that could be cast.
This approach has not only **reduced materials by 25%**, potentially **saving 2000kg in materials per cooler**, but also it **improved the structural integrity of the cooler** and inspired the team to explore where they can go next.
More details here.

AUTODESK GENERATIVE WORKFLOW

Redesign a machine critical component

I'm going to use Generative Design for redesign a critical component of an automatic pallet stretch wrapping machine.



Objectives

We want to reduce the mass of this support (wheels and ball bearings excluded) consisting mainly of steel components with a total mass of about 15 kilograms and consolidate it, moving from the 50 parts that the old design is consisting of, to just 1!!!

Workflow

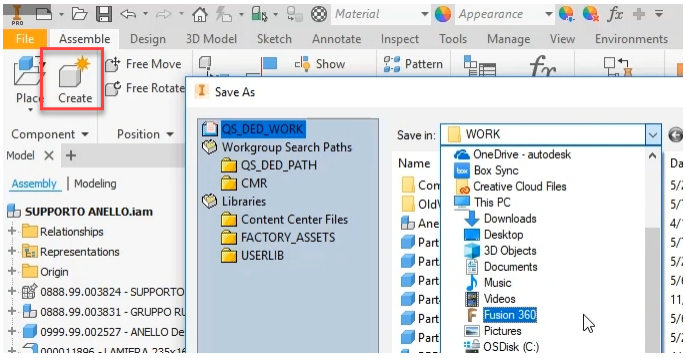
The old design has been created in Autodesk Inventor.

Create the Design Space

The first step of the workflow consists in creating the Design Space. That is, create the Preserve Geometry, that need to be in the final outcomes, and the Obstacle Geometry, that is, where I cannot have material in the final outcomes.
I can create the Design Space both in Inventor and in Fusion 360, depending in what application I'm more proficient in modeling.

Create the Design Space in Inventor

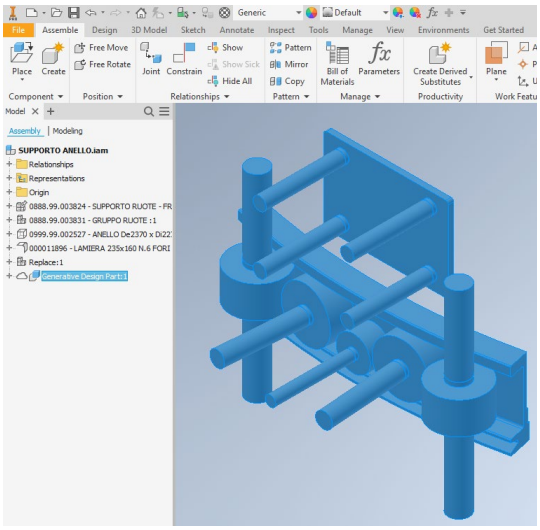
For creating the Design Space in Inventor, in the subassembly that contains the components to be replaced with the new design, I create a new part and save it directly in the project I've created on the Fusion Team hub, for the Generative Design study, using the Autodesk Desktop Connector capabilities.

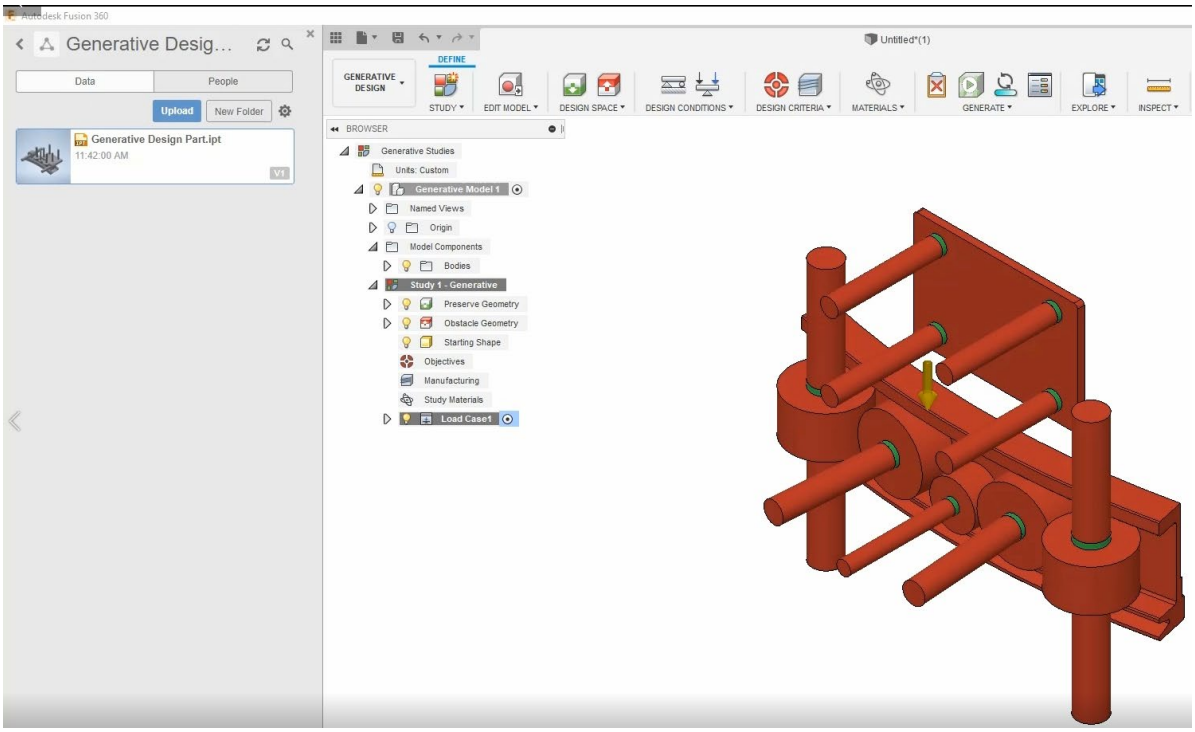


From the picture, you can notice I only provide four fixings, instead of six, as in the original design. The study will confirm the accuracy of this decision.

When the Design Space is complete, I save the part in Inventor.
In Fusion 360, I open the Inventor part and in the Generative Design environment, I assign the Preserve and Obstacle Geometries to the bodies created in Inventor.

In the new part, using the other components of the subassembly as reference, I create the Preserve and Obstacle geometries.

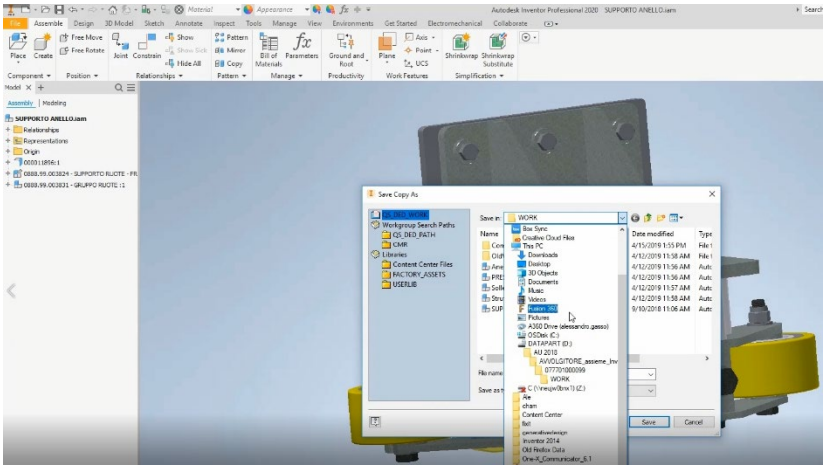




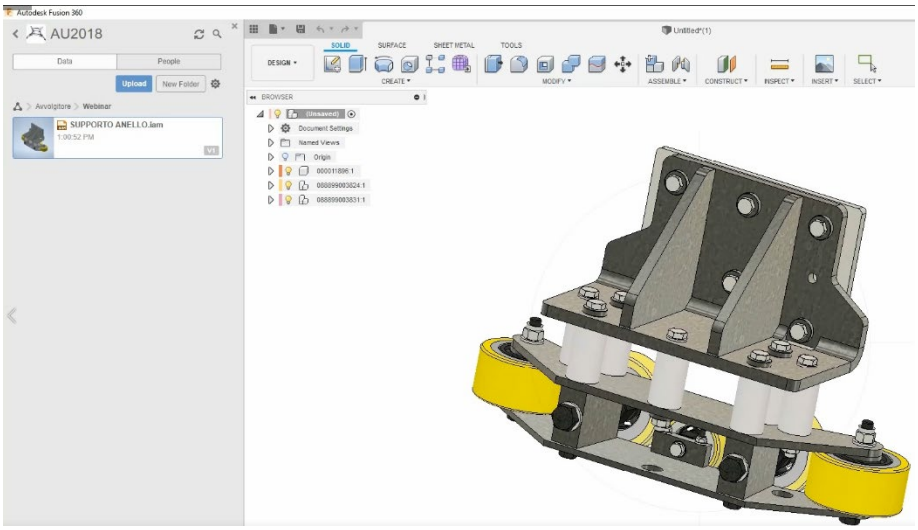
Find the detailed steps in [this video](#).

Create the Design Space in Fusion 360

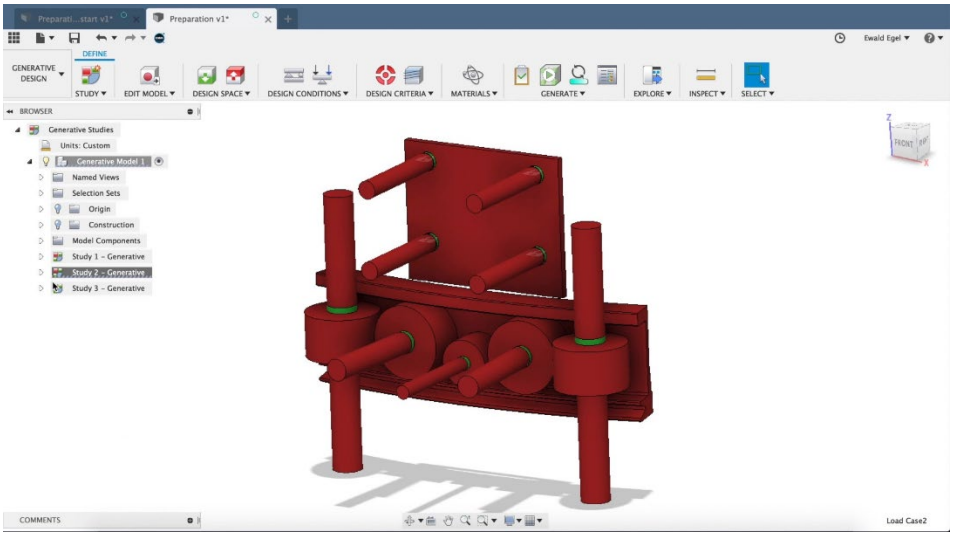
Alternatively, I can create the Design Space in Fusion 360.
For doing that, I save the subassembly that contains the components to be replaced in the project I've created on the Fusion Team hub, for the Generative Design study, using the Autodesk Desktop Connector capabilities.



I open the Inventor assembly in Fusion 360 and create the Preserve and Obstacle geometries using the other components of the subassembly as reference.



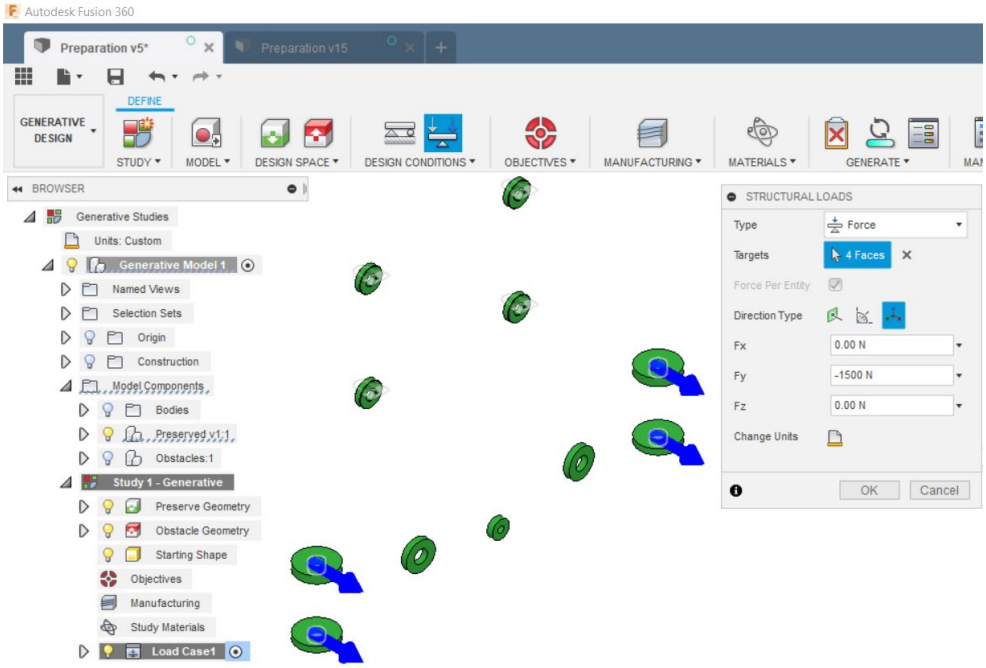
In the Generative Design environment, I assign the Preserve and Obstacle Geometries to the bodies created.



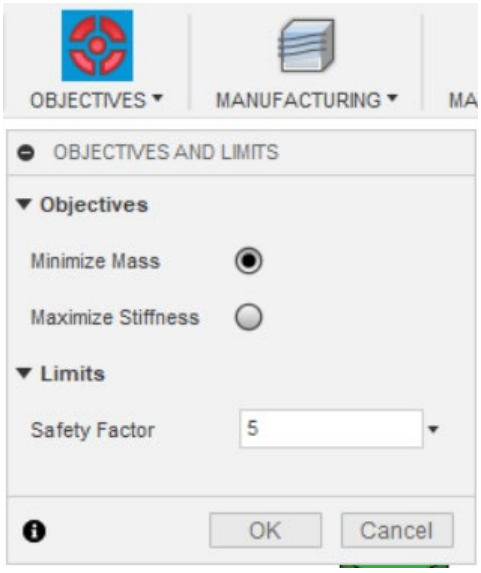
Find the detailed steps in [this video]

Define Design Conditions, Design Criteria and Materials

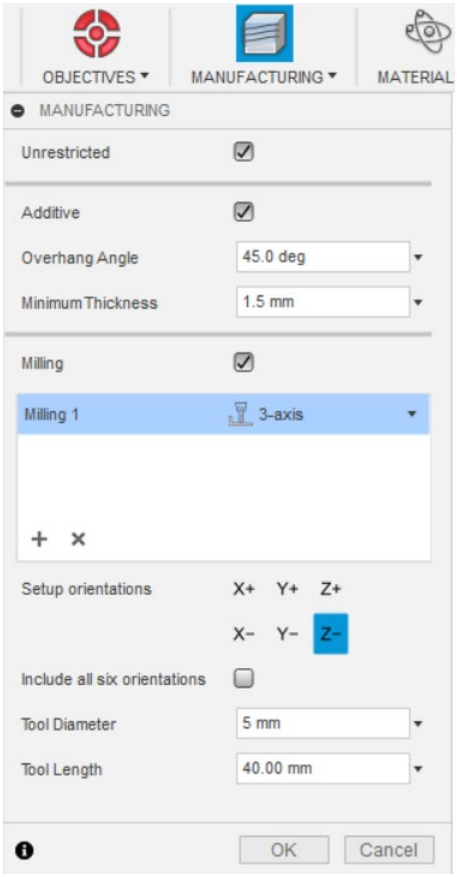
For defining the Design Conditions, I hide the Obstacles, so that it is easier to apply the loads and the constraints to the Preserve Geometry.



After having defined the Load Cases, I specify the objectives for our results, that, as I wrote above, is mainly to reduce the mass of the existing design and I set a Safety Factor of 5.



Then, I specify the manufacturing methods I would like to use, so that I can get the results for each of them.

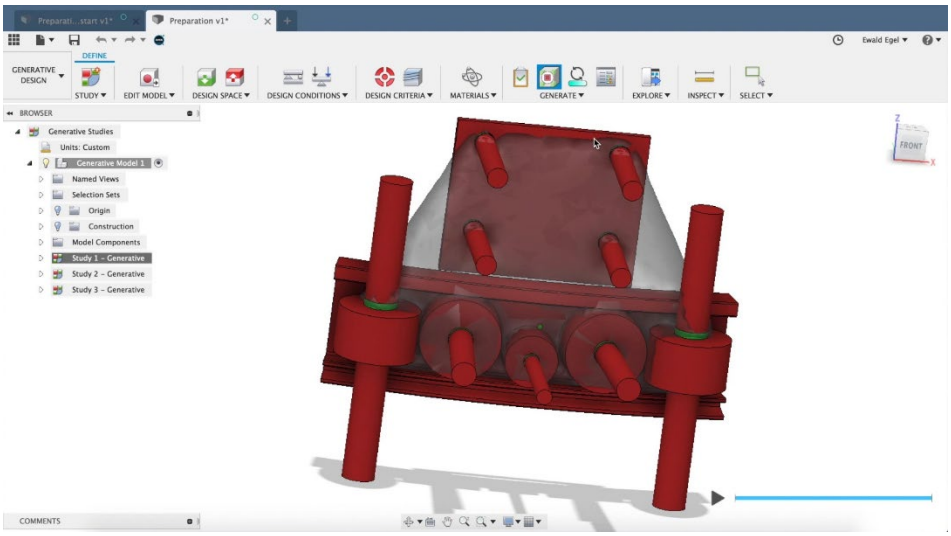


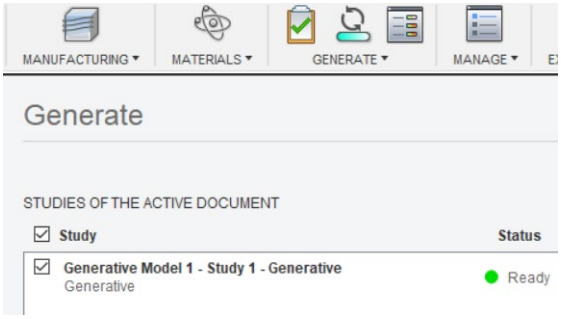
Finally, I select the materials I want the software explores for our results and I am ready to generate them.

Find the detailed steps in [this video]

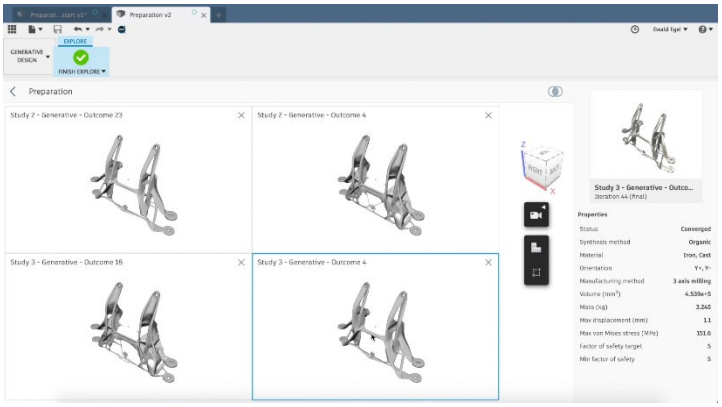
Generate, Explore and Export Outcomes

Before to start generating the outcome, I generate a preview of the outcome. This provide a rough visualization of the outcomes, but it helps detecting possible errors in the setup, like, for instance a missing obstacle.





Then, I start the generation of the outcomes and when the process is finished, I can filter and comparing the different results generated based on the different materials and manufacturing methods from the setup.

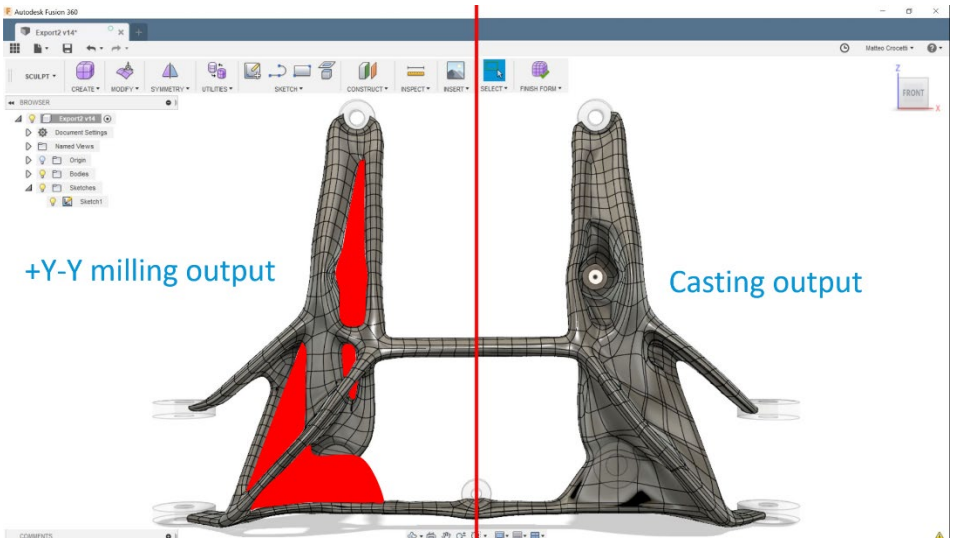


From the final outcomes I export the one that converged and offers a relevant mass reduction compared to the original design.
The manufacturing method is 3-axis milling in +Y-Y directions and the material is Cast Iron.

Find the detailed steps in this video

Edit the exported model

Since I want to produce this part with a casting approach, I have modified the exported model that was supposed to be for 3-axis milling production using the T-spline technology and the analysis tools inside Fusion 360.

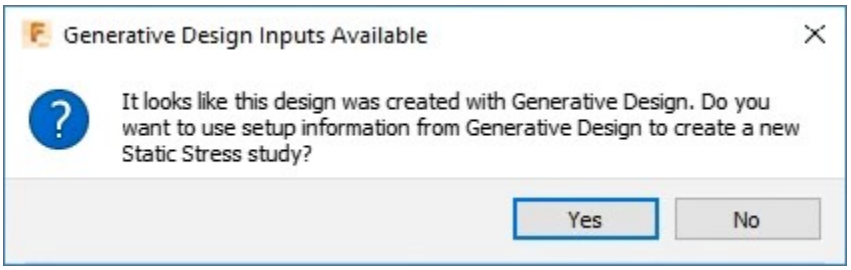


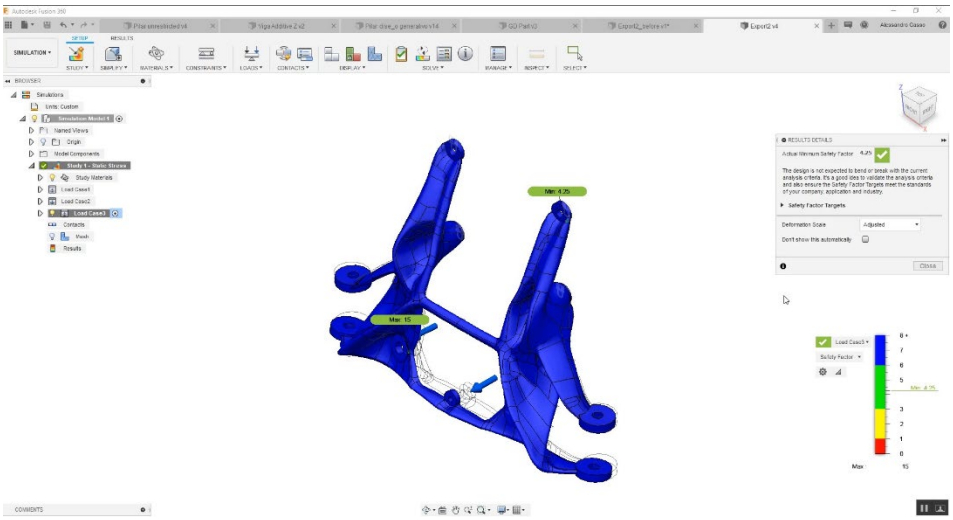
I can define as well the parting plane for the mold and removing the undercuts.
Find the detailed steps in [this video]

Validate the changes

After modifying the outcome, I want to verify that the final model can still resist under the Design Conditions defined for the Generative Design study with the Safety Factor set in the Objectives.

For doing that, I just need to switch to the Simulation workspace and accept to use the Design Conditions defined for the Generative Design study for creating the Static Stress study, that will validate the modifications

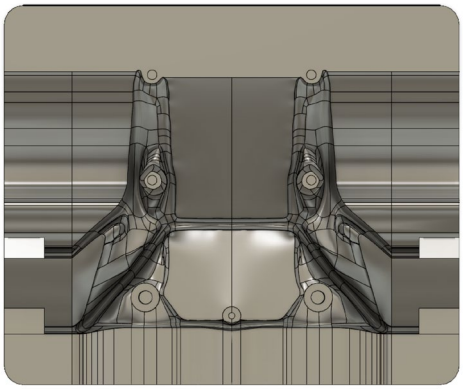




Find the detailed steps in this video

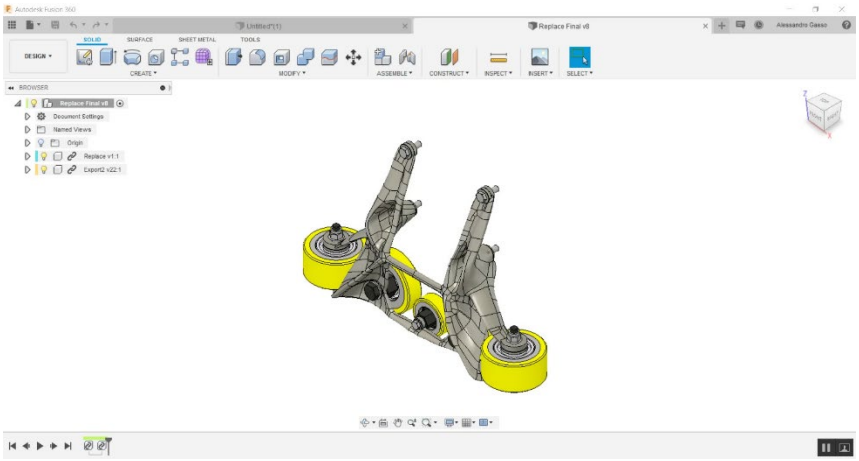
Mold concept and milling

Using the final shape, I create the mold using the standard Fusion 360 functionalities and in the Manufacture workspace generate and simulate the CNC toolpaths as you can see in tis video.



Replacing old with new design

In Fusion 360, I remove the components from the original design that are meant to be replaced with the new design.
Finally, in Inventor, I replace the original design with the Fusion 360 file created in the step above, as you can see in this video.



The final result is 75% lighter of the original one and has replaced 50 components.