IM225780

Autodesk Generative Design Capabilities for Machinery Industries

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Learning Objectives

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

Description

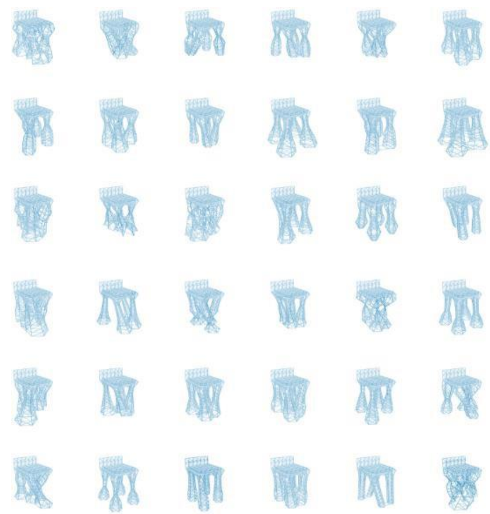
As part of Fusion 360 Ultimate software, Autodesk Generative Design is the new design space tool for designers and engineers capitalizing on the power of cloud and artificial intelligence (AI). During this class, we are going to discover how to use it for expanding and increasing the innovation on machinery industries effecting products' performance and production costs. We will use real customer examples.

Speaker(s)

Matteo Crocetti. With 17-year experience on CAD\CAM\PLM products as Application Engineer in several companies, Matteo Crocetti joined Autodesk in 2013 as a Technical Sales EMEA focused on Autodesk Design and Manufacturing Products and Data Management. He is really passionate for disruptive technologies and in general, everything that can help to find a new way to make anything.

Alessandro Gasso is currently employed as Manufacturing Cloud 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 in 2012, 2013, 2014, 2015, 2016, and 2017. 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).

AUTODESK GENERATIVE DESIGN

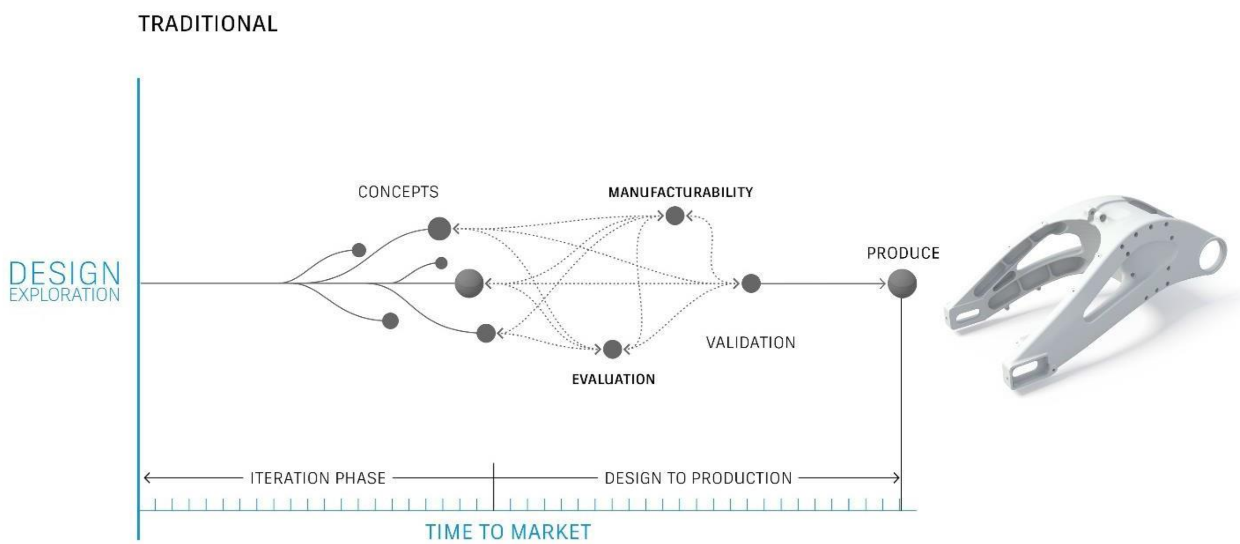


Autodesk Generative Design is a design exploration technology.
Simultaneously generate multiple CAD-ready solutions based on real-word manufacturing constraints and product performance requirements.

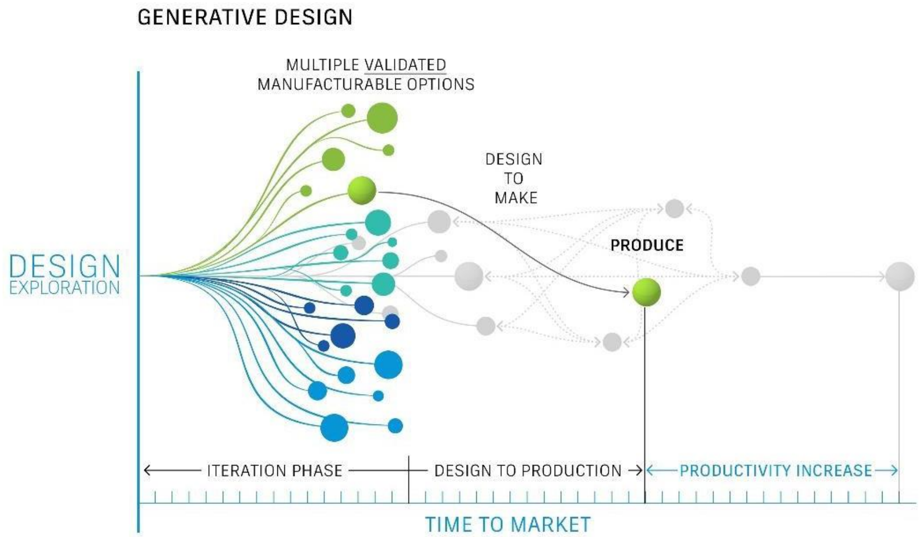
Designers or engineers input design parameters (such as materials, size, weight, strength, manufacturing methods, and cost constraints) into generative design software and the software explores all the possible combinations of a solution, quickly generating hundreds or even thousands of design options. 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

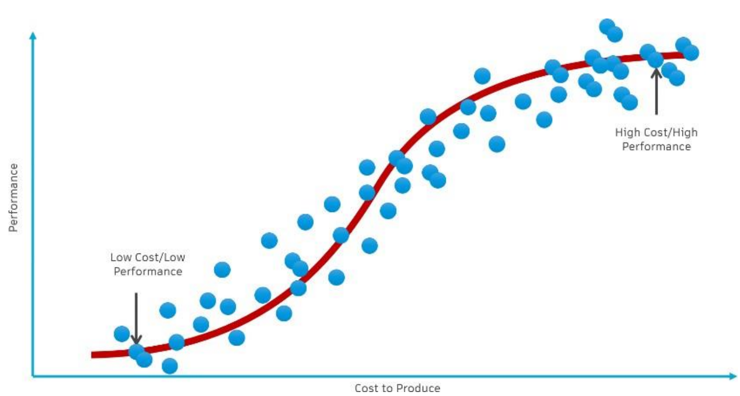


In the traditional approach, we must evaluate and validate the manufacturability of few concepts before sending one of them to production.

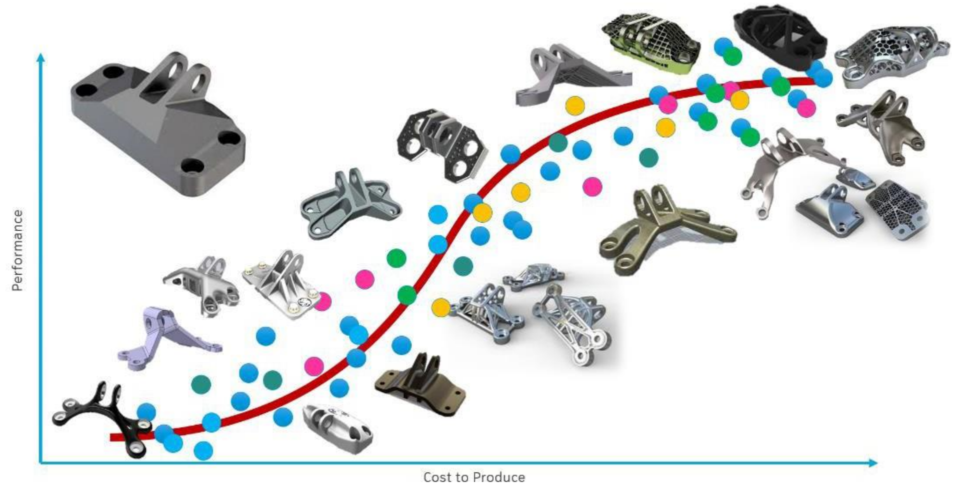


Generative Design generates a wide range of designs, from thousands to tens of thousands, that meet the requirements.
The result is complex, high-performance structures that human designers would never have conceived.
Unlike topological optimization, the software explores all possible permutations of 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.

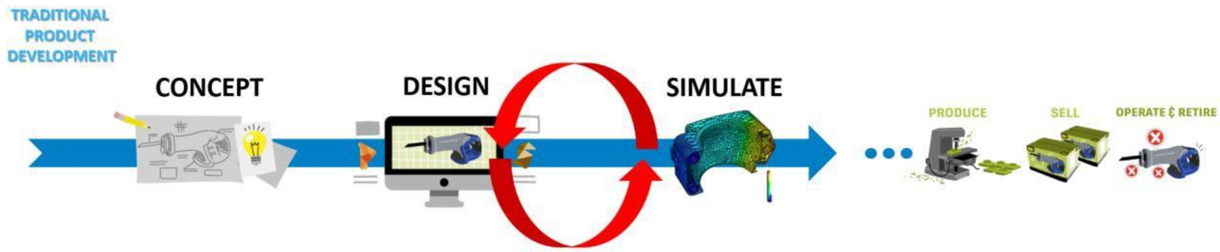
AUTODESK GENERATIVE WORKFLOW

The primary intent of Generative Design is to change the paradigm of engineering where the CAD software is playing a role mainly related to create 3d content based on human experience. After 40 years, engineers and designers are still using 3d and 2d applications for developing ideas based on their experience of the real world.

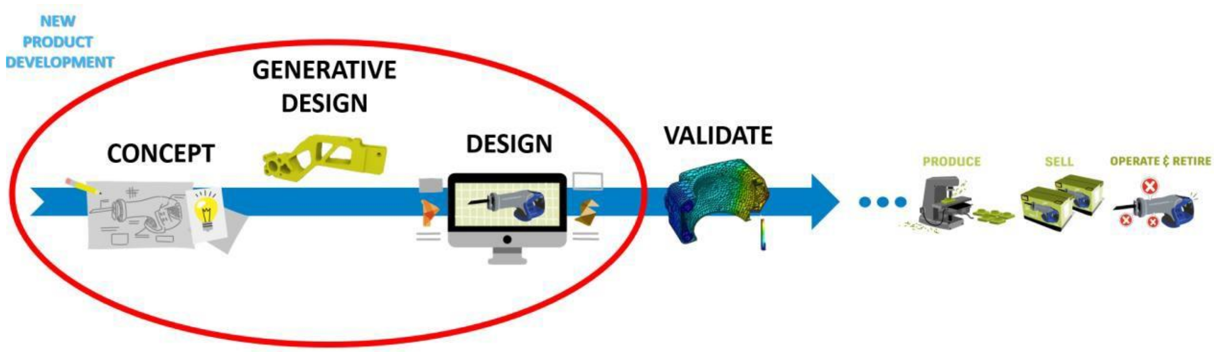
Those experiences are still the best way for creating digital models but are limited due to human being capabilities. Personal experience, school, geographic location, family, food, life style…etc, everything has an impact on the product development.

Generative Design is a tool that helps to augment engineering capabilities during the creation phase of a project.

If we take a tour on the traditional product development, it's easy to see that the Design and Simulation processes could be iterated multiple times for fine-tuning a previous concept phase.



With Autodesk Generative Design, engineers and designers are able to obtain a design space of hypothetical solution based on stating inputs and needs and add those synthetic suggestion to their experience for creating new shape, already optimized and ready for final VALIDATION and FEM analysis.



MOVE THE REAL ENGINEERS VALUE

Introducing Generative Design on concept workflow means primarily to free time on modeling routine and move the real value of engineers in setting project needs and boundary conditions.
This new workflow can be a real collaboration between software and humans.

At the moment, generative design is a partnership between the design package and the engineer. The engineer pulls the strings and the computer does the rest.

Software such as Autodesk Generative Design is highly functional, allowing the design engineer to input a wide array of design parameters and objectives, such as the type of material, desired performance and mechanical properties, cost considerations, and fabrication technique.

The software then runs through a huge number of generated designs towards solutions that satisfy the engineer's requirements. The resulting options are presented to the designer with a full set of data which includes the mechanical properties of the object. The engineer evaluates the various results and then has the option to return to the design parameters and adjust them if necessary.

Generative design ties into another piece of Autodesk software called Netfabb, which fabricates designs using additive manufacturing (also known as 3D printing). This means that a prototype of the product can be made very quickly once a design is chosen in the Autodesk generative design system. This highly integrated approach to design and manufacturing is making the process more streamlined and efficient than ever before.

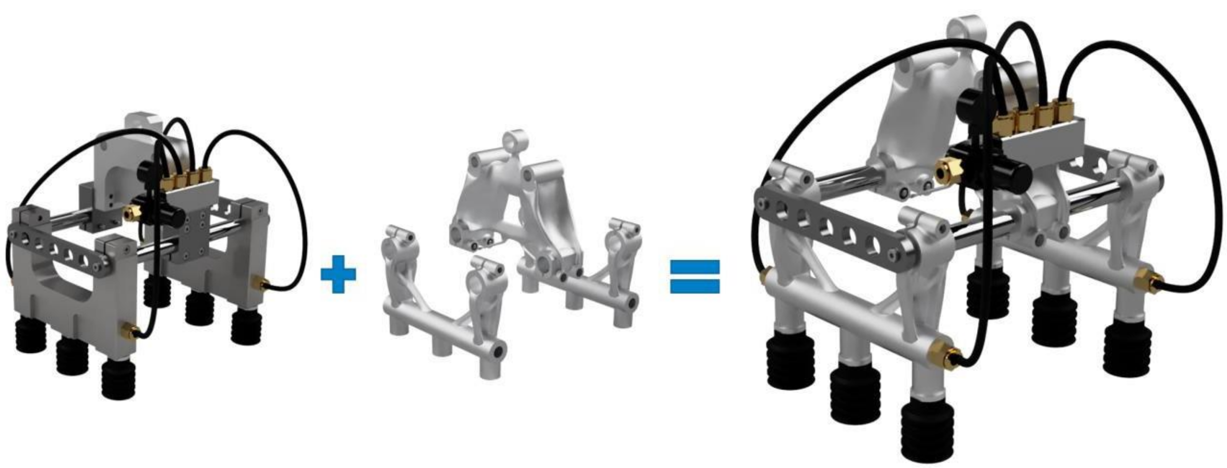
WHAT THE FUTURE CALL

Generative design is already making its mark on the world we live in. New Balance has developed customizable running shoes that are generatively designed to exactly fit the feet and running posture of athletes, before being additively manufactured.

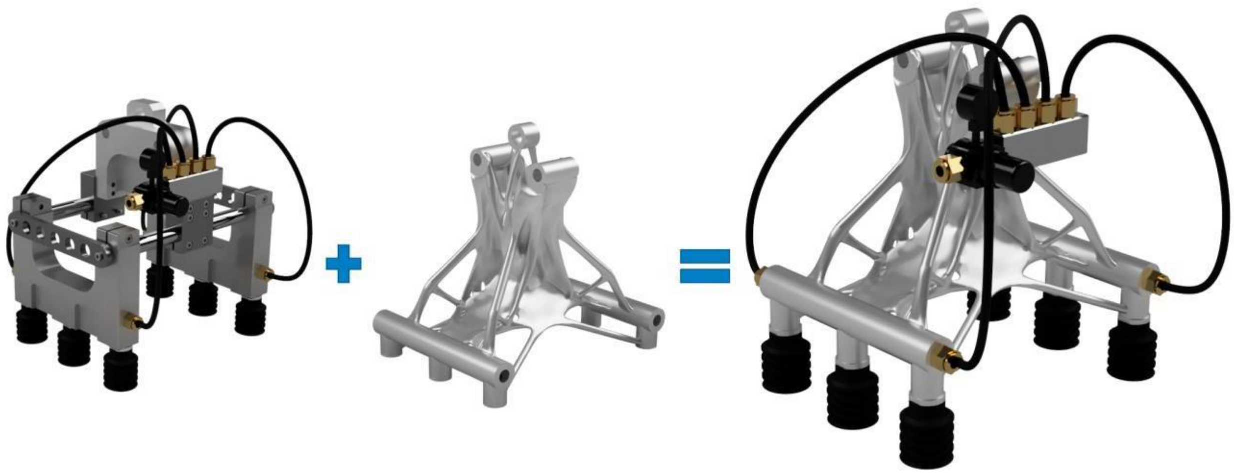
In the near future, it will be commonplace to see unusual-looking products and structures that have been generatively designed for optimal functionality.

The challenge for designers and product developers is to stay competitive in the marketplace. As more and more companies adopt generative design practices, it's likely that their offerings will become similar. The challenge then will be for design engineers to use their knowledge and skill to adjust the design requirements, thus allowing the computer to come up with original designs.

For example if we take this pick and place assembly based on moving things around using vacuums, engineers can convert that shape into something more performing increasing lightweight, changing manufacturing and overall reducing machine consumption at all. The way to do that are based on real needs.



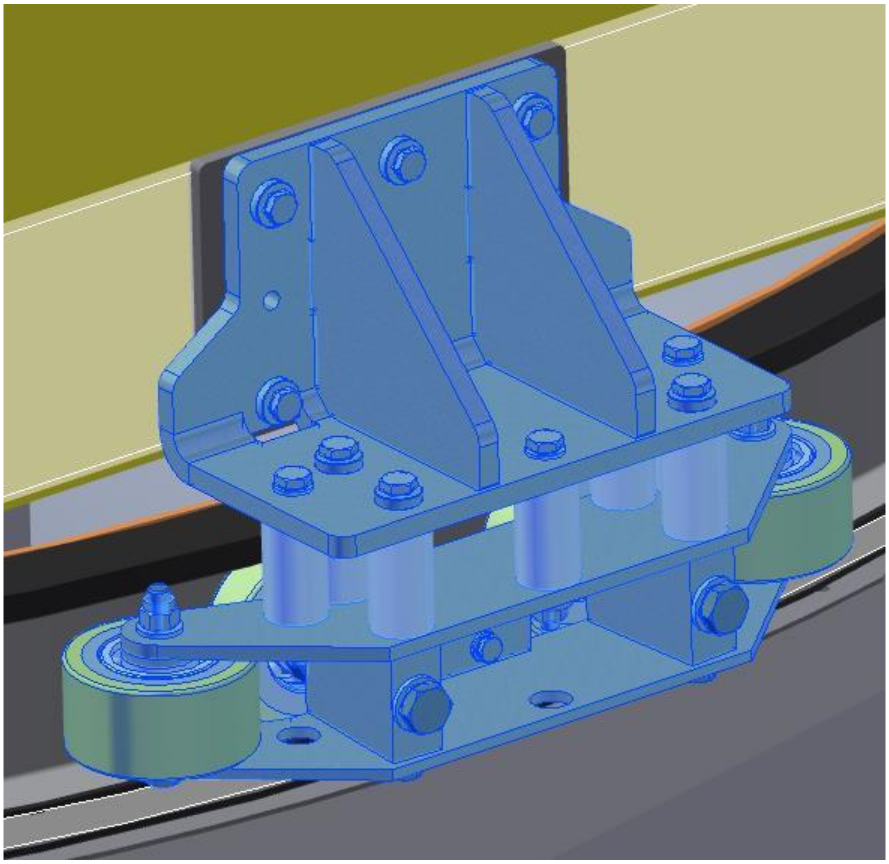
Engineers have to define manufacturing typology and set expectation of their machine in order to respect the prerequisite of working condition, materials manufacturability and everything can impact the products. Than they can decide to redesign existing parts, o substitute all the structure as a unique part as below.



They can also be inspired by the design space and create something similar to a Generative Design resu

Customer Example

We are going to use Generative Design for redesign a critical component of an automatic pallet stretch wrapping machine.



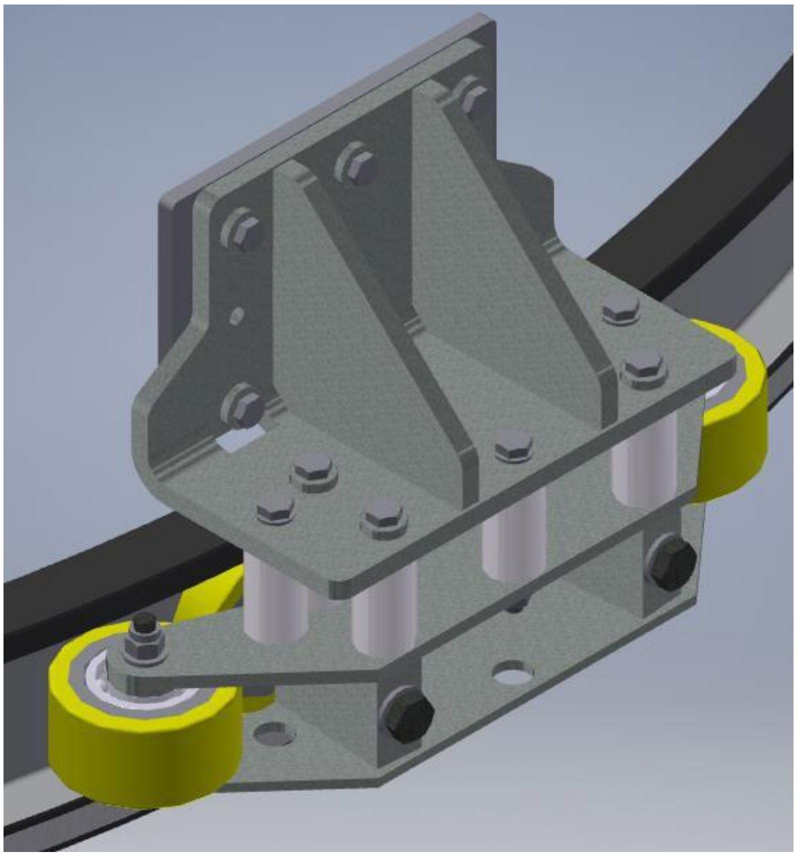
Objectives

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!!!

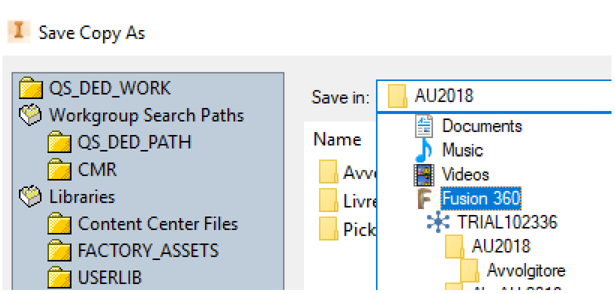
Workflow

The old design has been created in Autodesk Inventor.
So, the first step of this workflow is to create in Inventor a derived component from the main assembly.
We want to use this component as reference for defining the Preserve and Obstacle Geometries for the Generative Design workflow.

Therefore, the derived component will contain the component we want to redesign and few additional entities from the main assembly that will be useful for defining more precisely the Obstacle Geometry.

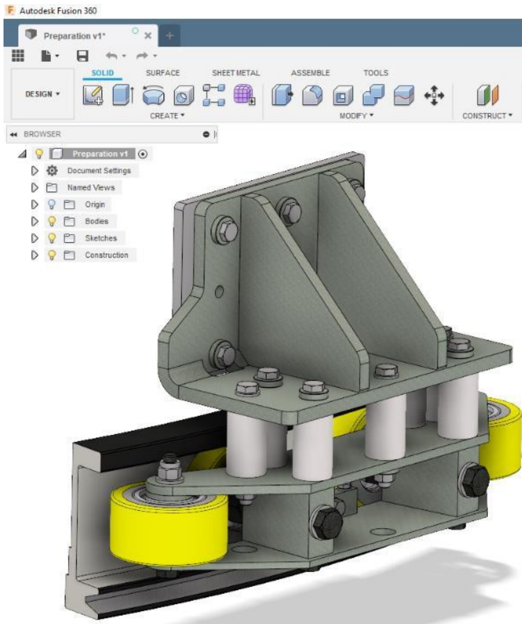


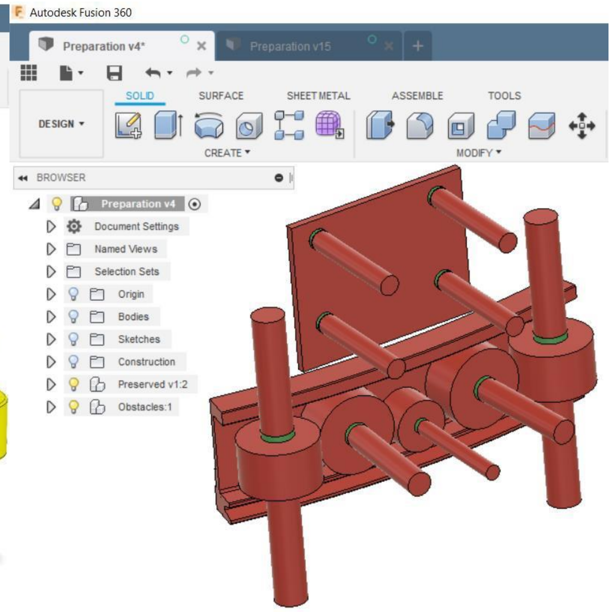
From Inventor we save the derived component to the Fusion 360 project in Fusion Team using the Autodesk Desktop Connector capabilities.



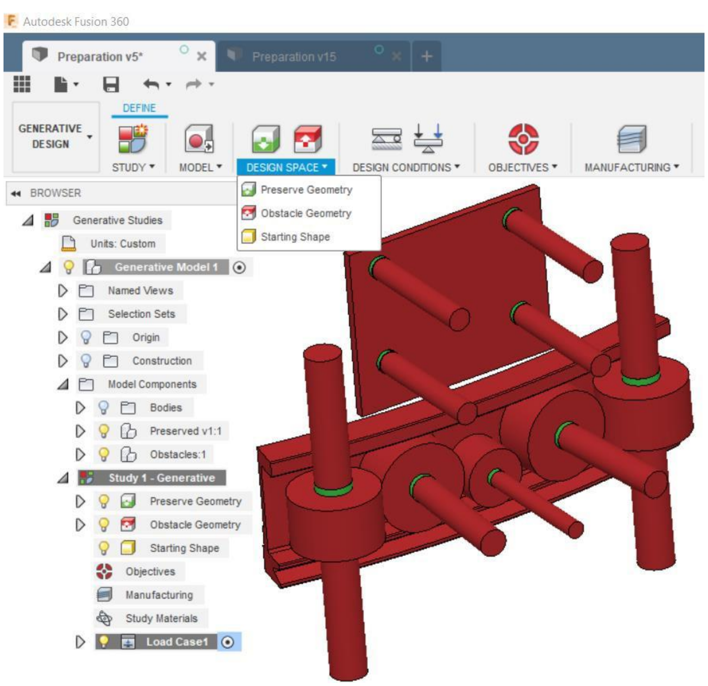
I open the Inventor file in Fusion 360, and using it as reference, I start creating the Preserve and Obstacle Geometries.

From the picture below, 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.

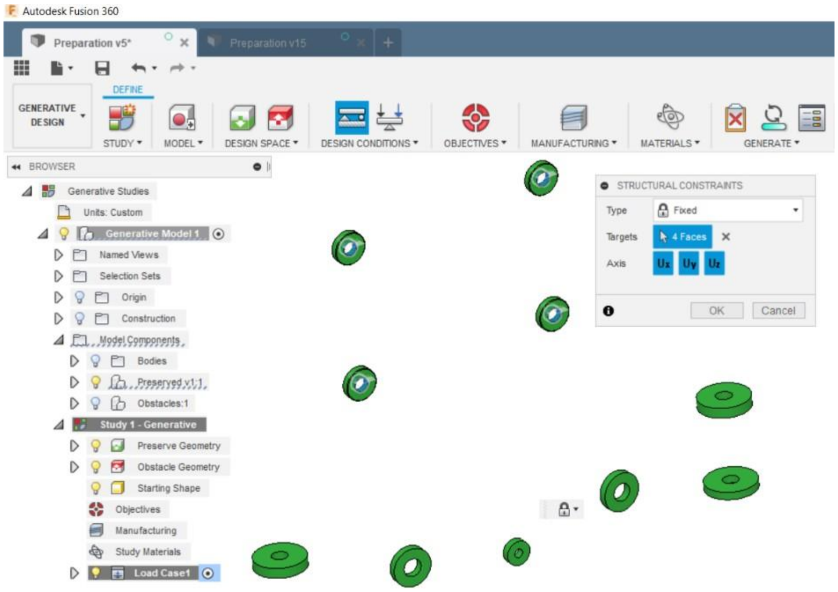




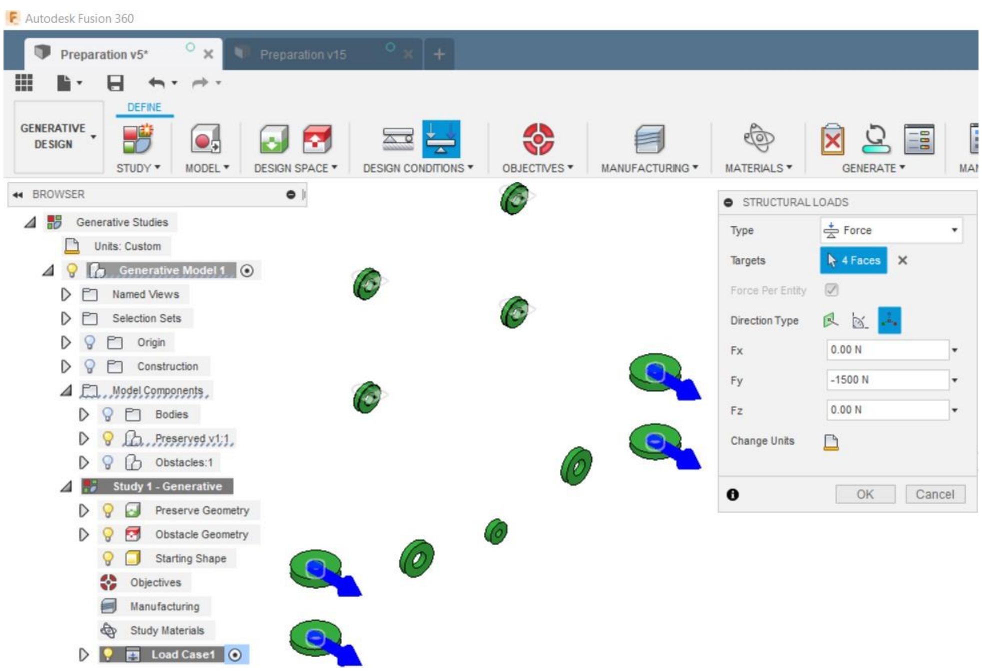
Then, in the Generative Design environment in Fusion 360, we define the Preserve and Obstacle Geometries.



After that, we can hide the Obstacles, so I can apply the design conditions to the Preserve Geometry, starting from the fixed constraints we apply to the four fixings.

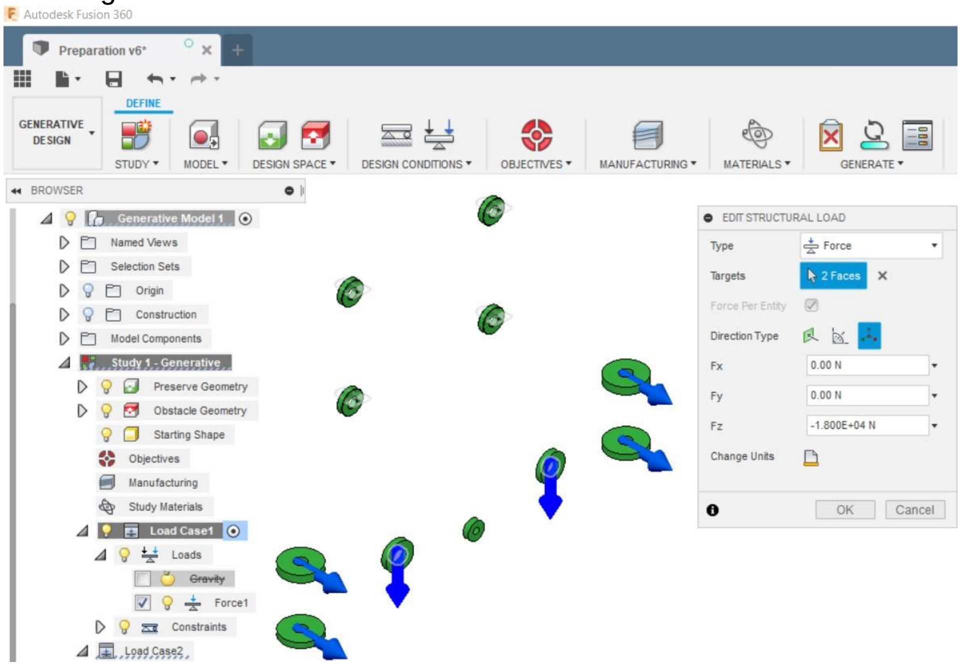


Then, we apply a load of 1500 N in the negative Y direction to the four faces in the image below.

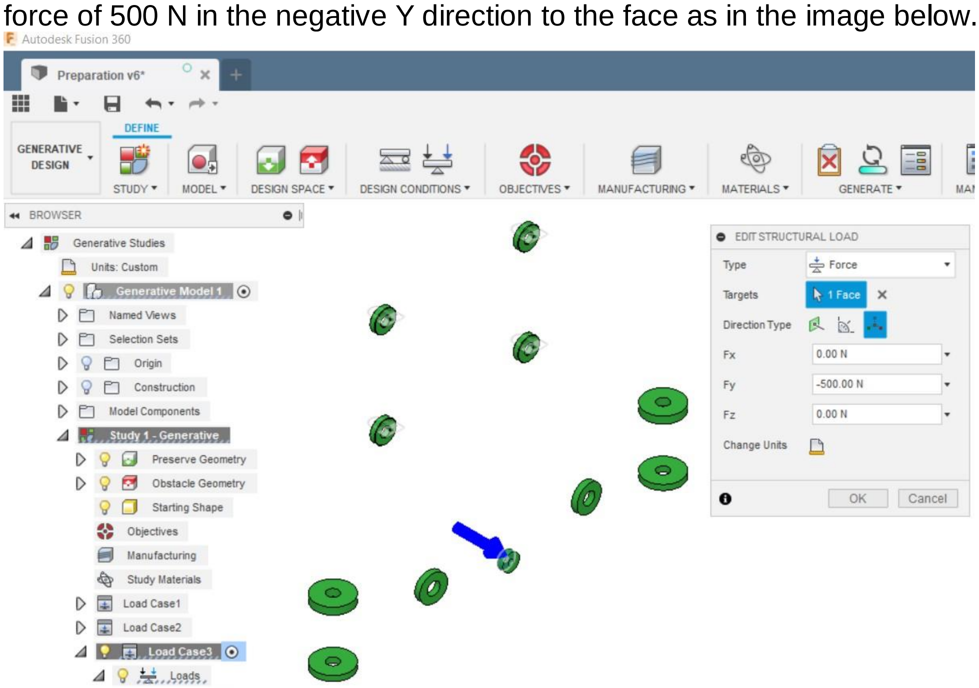


After that, we clone the Load Case 1, so I don't need to reapply the fixed constraints to the fixings.

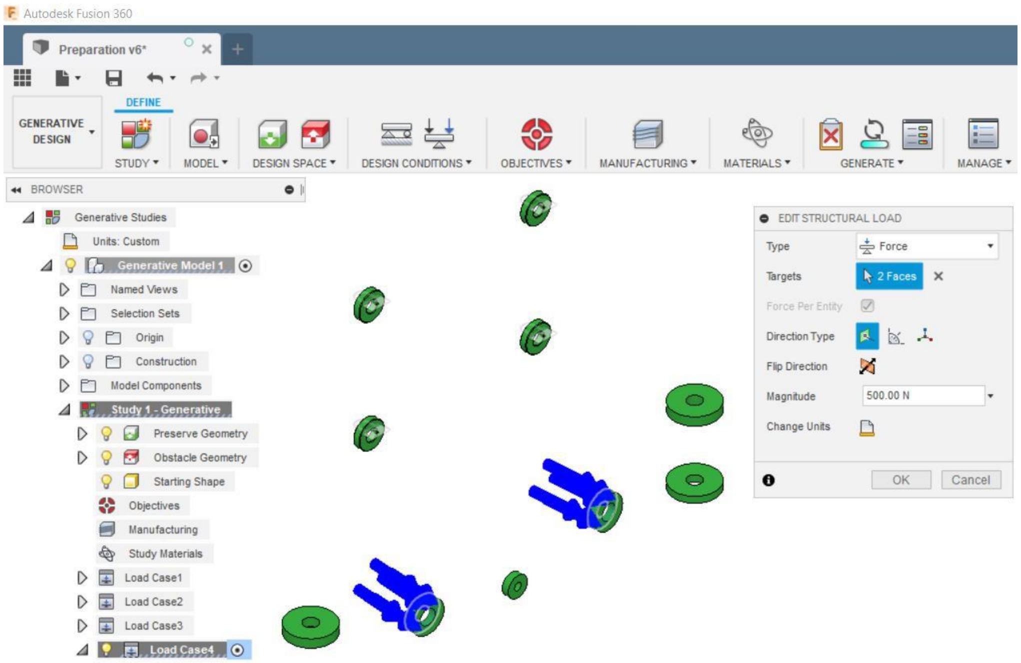
We just need to edit the Force and apply 1800 N in the negative Z direction to the faces as in the image below.



We repeat the step above, cloning the previous load case, editing the Force and applying a force of 500 N in the negative Y direction to the face as in the image below.

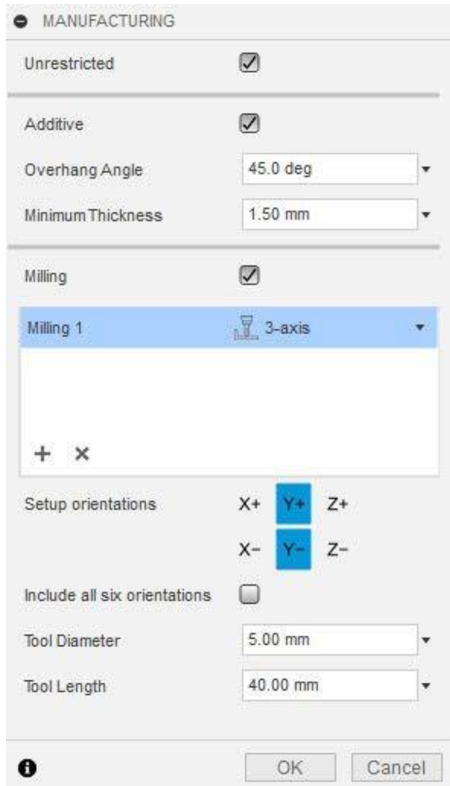


Finally, repeating the same steps, we apply the last force of 500 N perpendicularly to the two faces as in the image below.

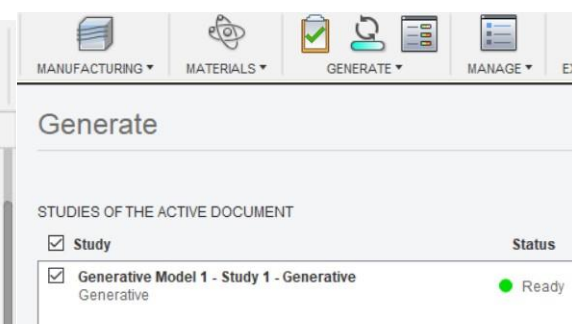


After having defined the Load Cases, we specify the objectives for our results, that, as I wrote above, is mainly to reduce the mass of the existing design, using a Safety Factor of 5.

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



Finally, we specify the materials we select the materials we want the software explores for our results and we are ready to generate them.



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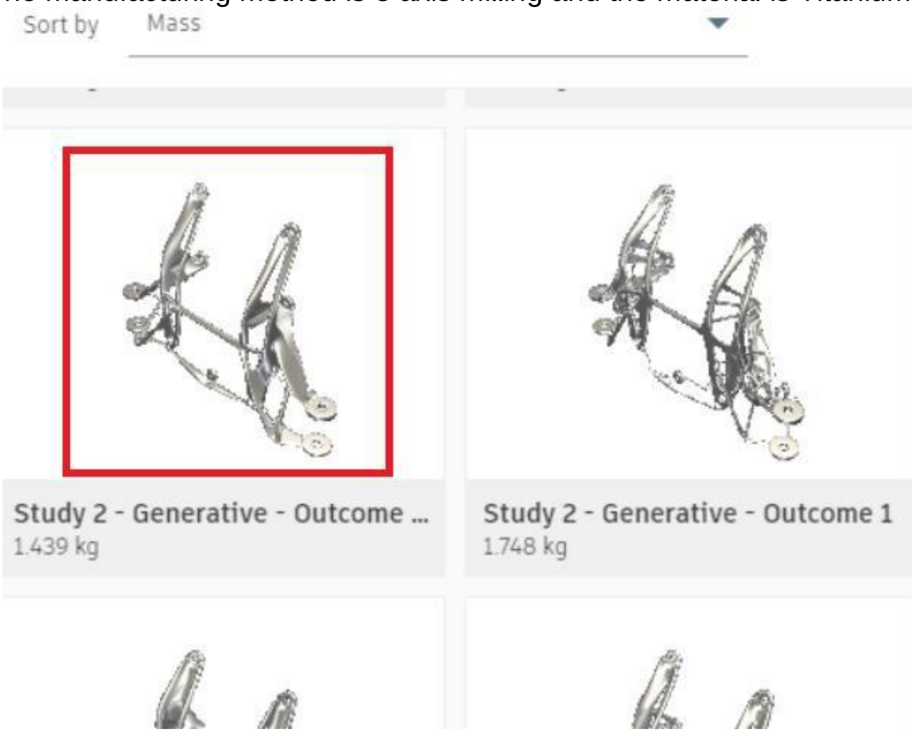
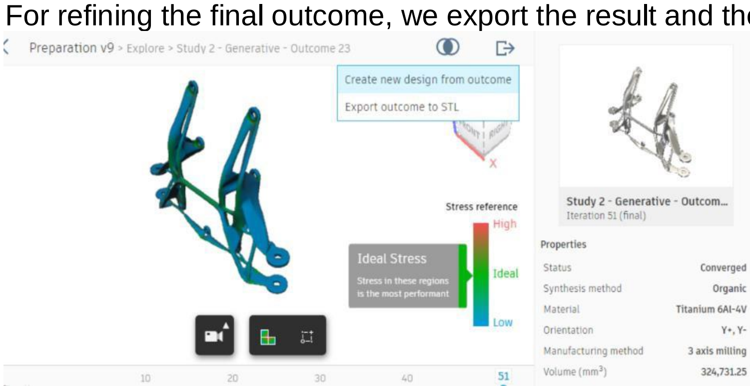
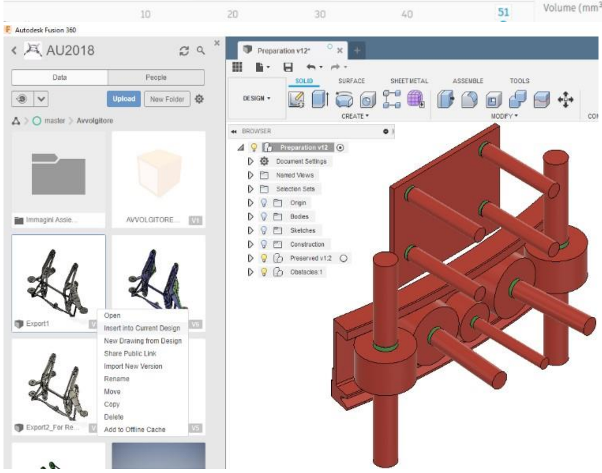
From the final outcomes we select the one that converged and offers a relevant mass reduction compared to the original design.
The manufacturing method is 3 axis milling and the material is Titanium

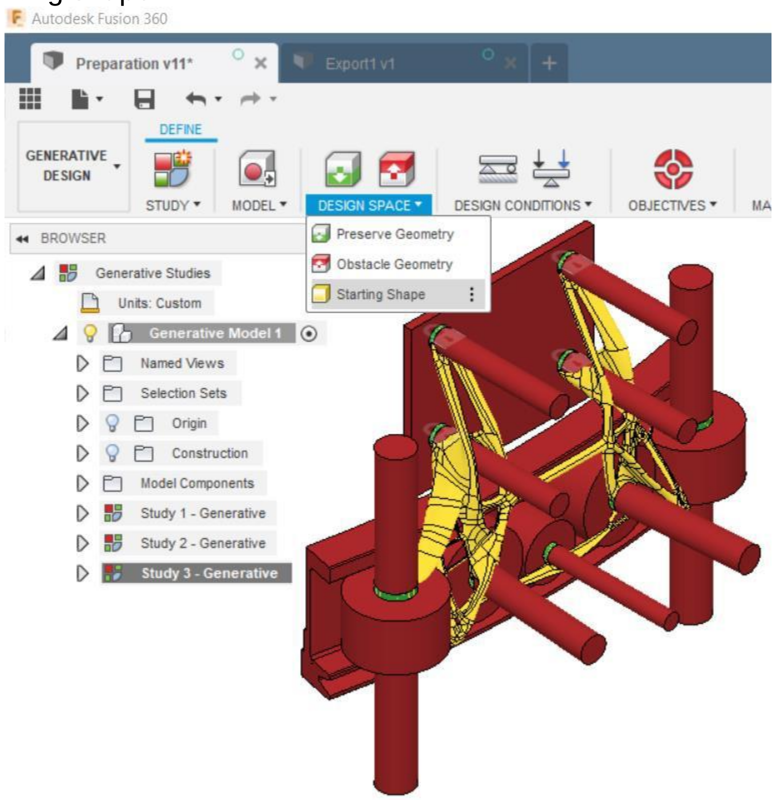


For refining the final outcome, we export the result and then insert it in the existing design.

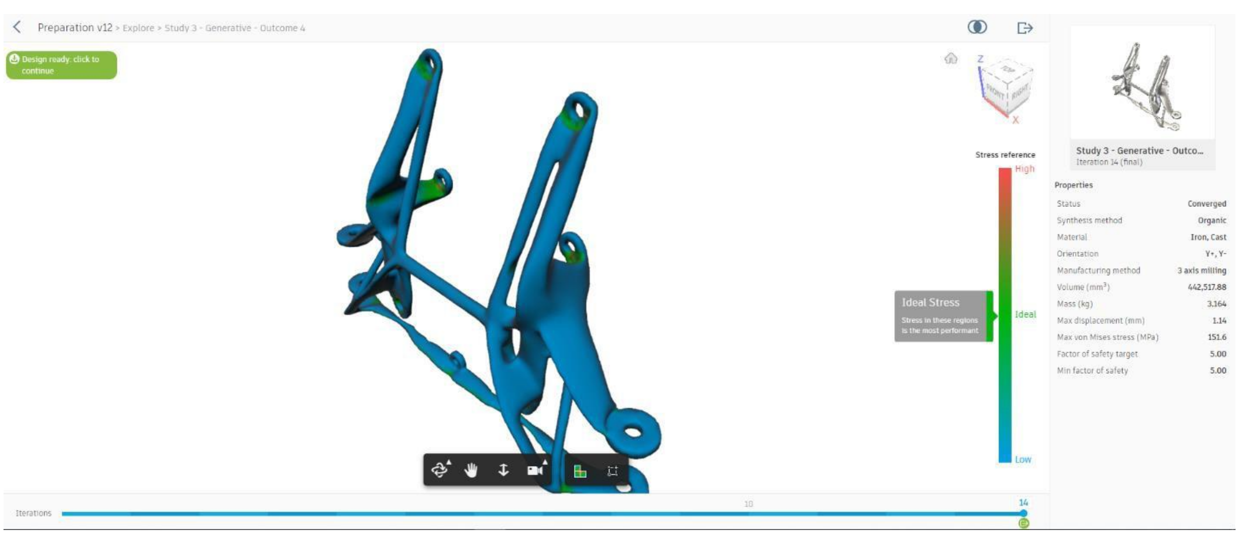




In the Generative Design environment, we clone the previous study and select the model inserted as starting shape.

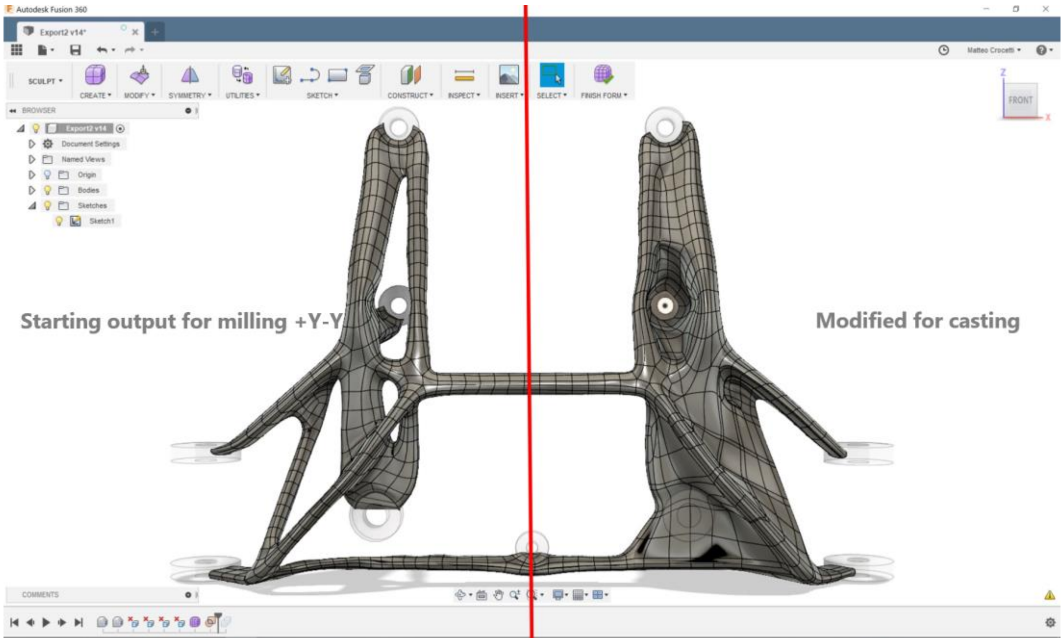


We edit the manufacturing option unchecking the unrestricted box.
We leave the other settings as in the previous study and generate the result.
Export the final outcome 79% lighter and that allows to replace 50+ component in the original design, with one.
We have selected a model to be manufactured with 3 axis Milling in Cast Iron.

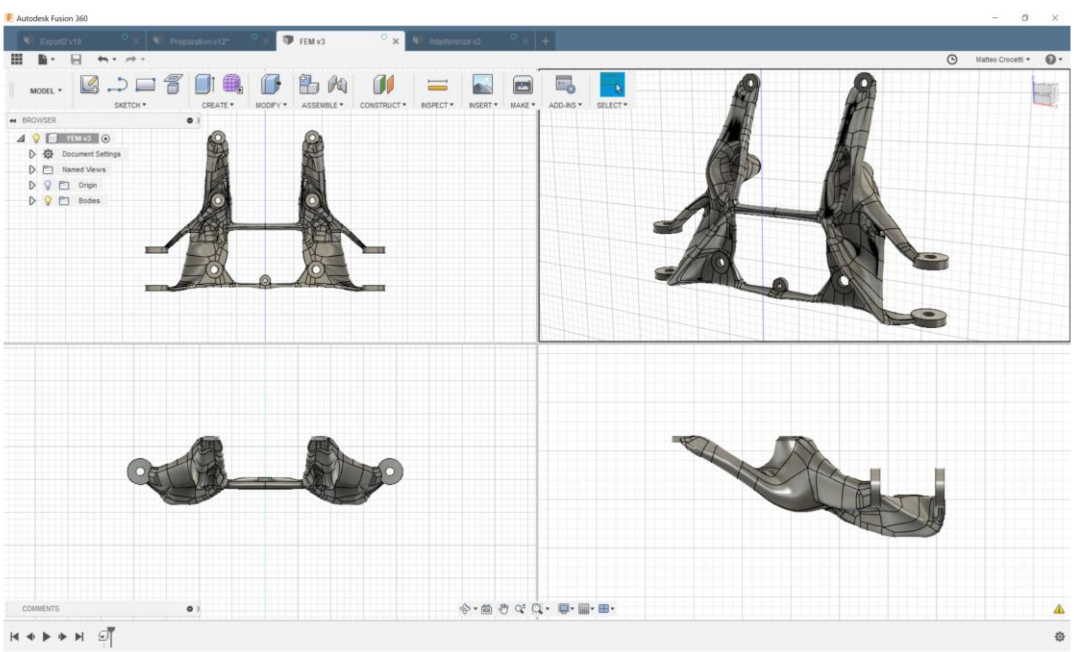


Starting from this shape user can move on and elaborate the real 3d model that has to be manufactured. According to the needs of number of parts, performance and everything that can impact the production costs, engineer will decide to go for milling from stock or casting.

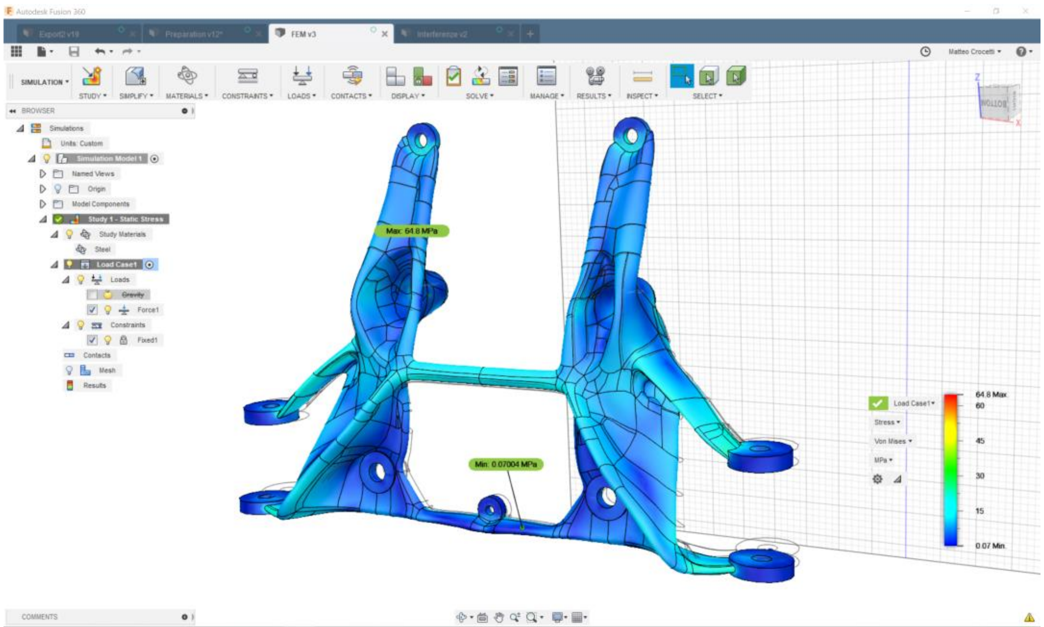
Let's go for casting. Using the T-spline environment we can modify the output and adapt the shape for making the mold.



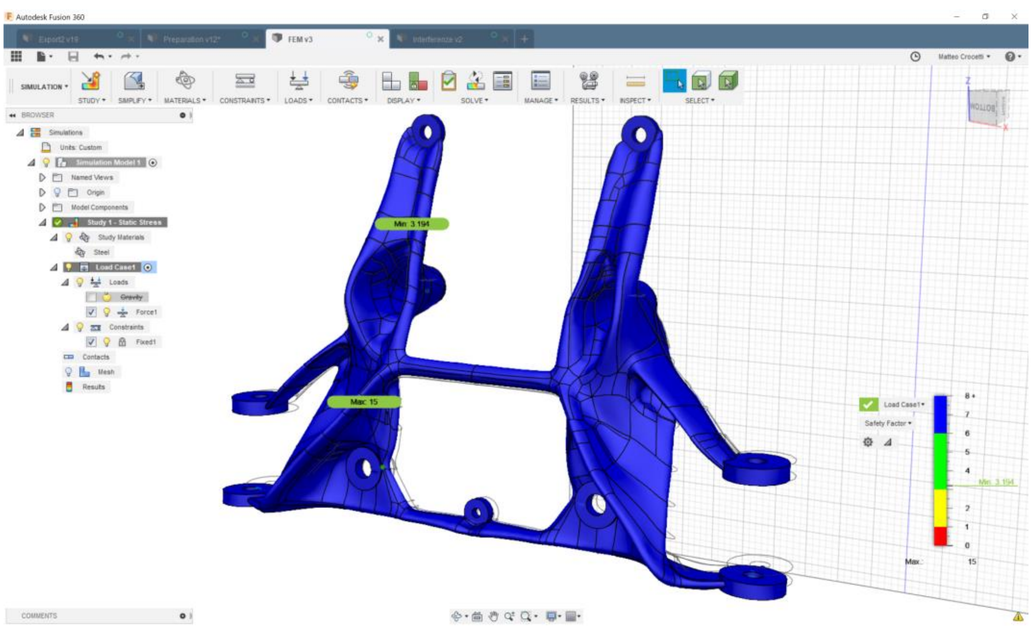
The final model looks like:



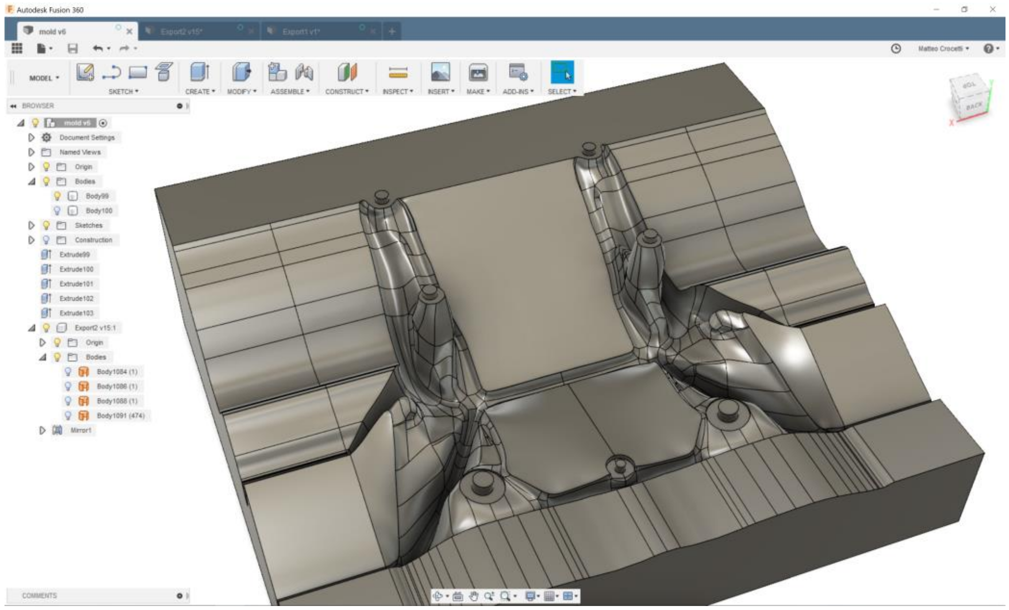
As a validation point, we run a stress analysis simulation in Fusion 360 using the same loads and constraints used for the Generative Design Study, for verifying the component doesn't break.



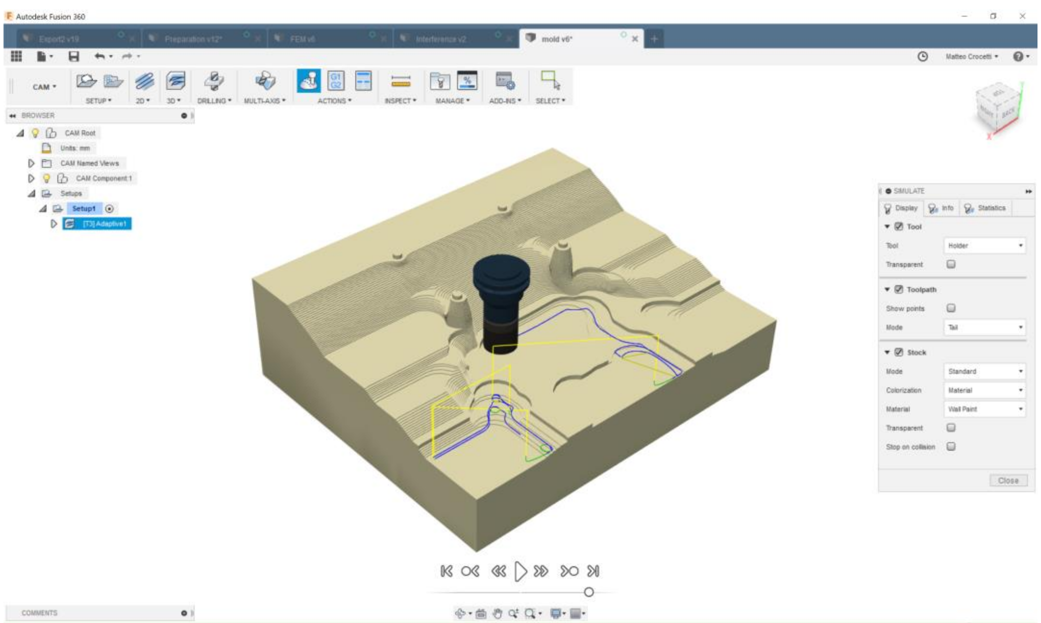
Also factor of safety respect the rules of Gereative Design setting:



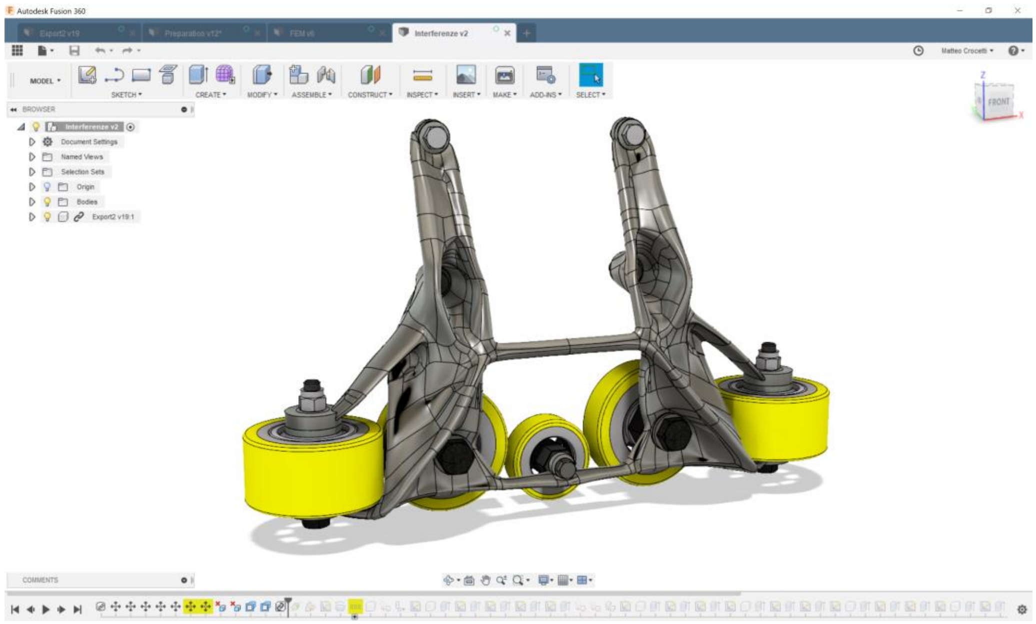
Cheded the model on Fusion360 Simulation, we can go for moulding the part using surface modeling and solid boolea like this.



The mold is ready also for machining in the manufacturing environment:



After that, in Fusion 360, we insert the model in the Inventor file we've created as derived component and saved to Fusion 360 project in Fusion Team and we remove the components from the original design that are meant to be replaced with the new design.



Finally, in Inventor, we replace the original design with the file created in the step above.