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Automate Inventor by engineering with Generative Design

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Learning Objectives

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

Description

Generative Design is changing the way we design, engineer, and manufacture the products of tomorrow. By leveraging cloud technology - 100's or 1000's of higher performing design options can be generated based on objectives, allowing users to make tradeoffs for different materials, performance, and production options. The benefits of Generative Design are also not restricted to just the world of Additive Manufacturing, but can also be leveraged with Subtractive Manufacturing, and even as design inspiration for traditional techniques. What you might not be aware of, is that Generative Design technology is now available to any user of the Manufacturing collections. This allows you to seamlessly go from your CAD workflows within Inventor, to generating a design in Fusion 360, back to having the generated design into the context of your original assembly with Inventor. Join us to learn how to get started with Generative Design in Fusion 360 alongside Inventor.

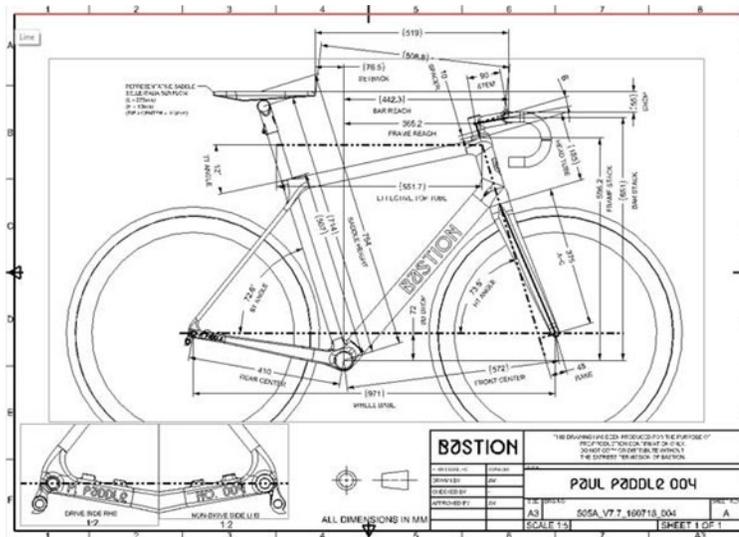
Speaker(s)

Alessandro Gasso is currently employed as Fusion 360 / Generative Design Adoption Specialist within the Customer Success Organization at Autodesk, Inc. Over the past 19 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 2019. 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).

Generative Design

To power this technology requires a step change in software to drive not a function of the system, but the entire process.

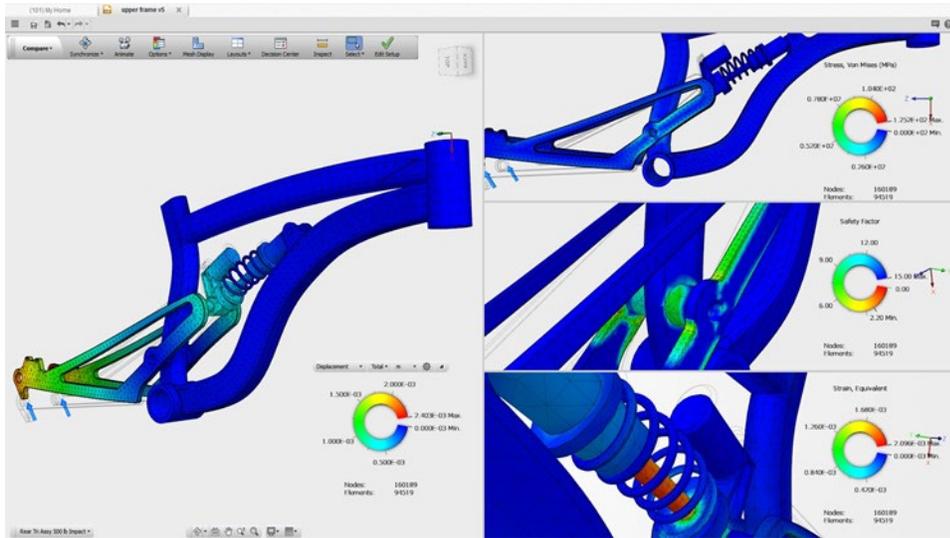
So far in the history of engineering software, we've seen 3 waves of disruption, but thanks to these new trends, we're about to witness a 4th.



In the first wave of disruption, we saw 2D CAD revolutionize design through the ability to reuse and edit content.



In the second wave of disruption we saw 3D parametrics deliver massive leaps in productivity through it's ability to control change.



In the 3rd wave of disruption, we saw model based design equip engineers with the technology necessary to simulate behavioral characteristics of designs in order to improve product performance and quality.

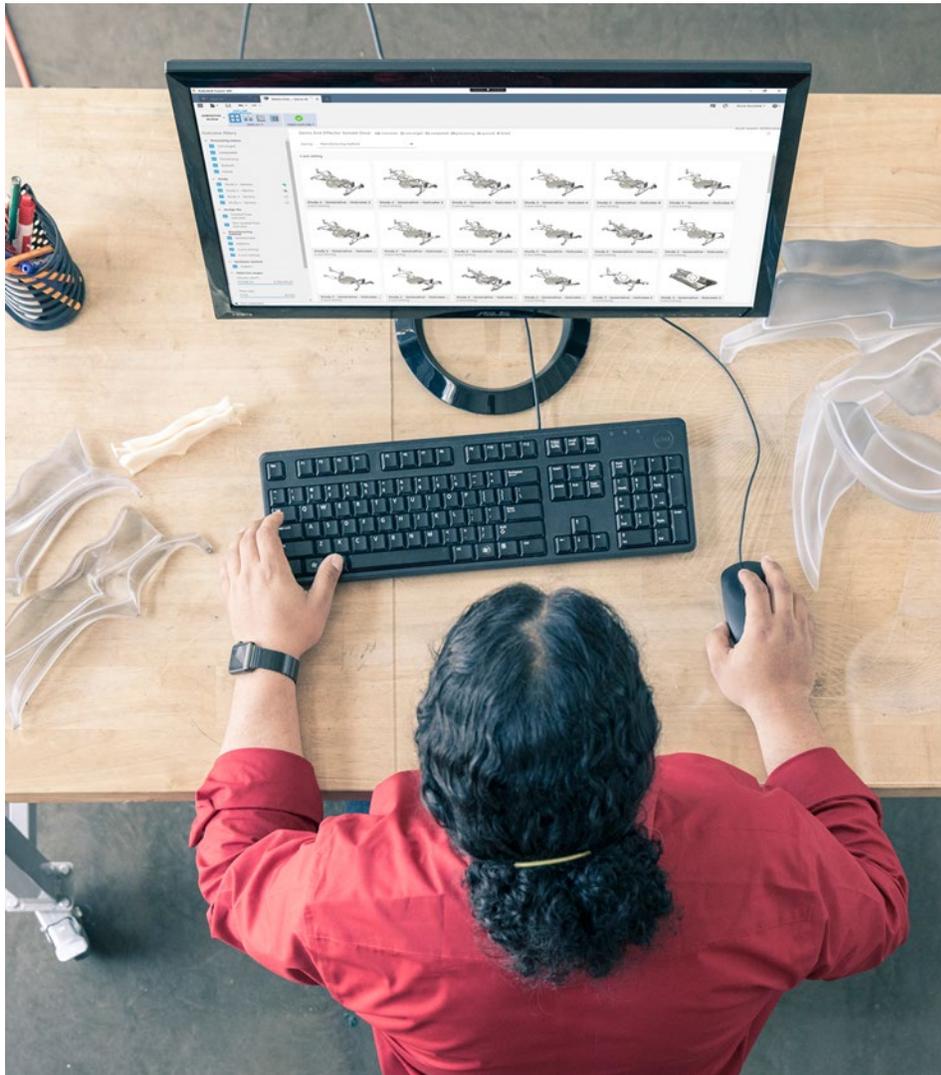


But in this next, 4th wave of disruption, we will witness the advent of a new technology that empowers engineers to automate the process of generating huge volumes of design and manufacturing instructions, optimized to the precise requirements of the customer and the manufacturing process being utilized, so that organizations can deliver not just one great product, but hundreds of thousands of uniquely optimized solutions, at scale, for an infinitely variable market demand.

This is what we call generative design and manufacture.

What is Generative Design

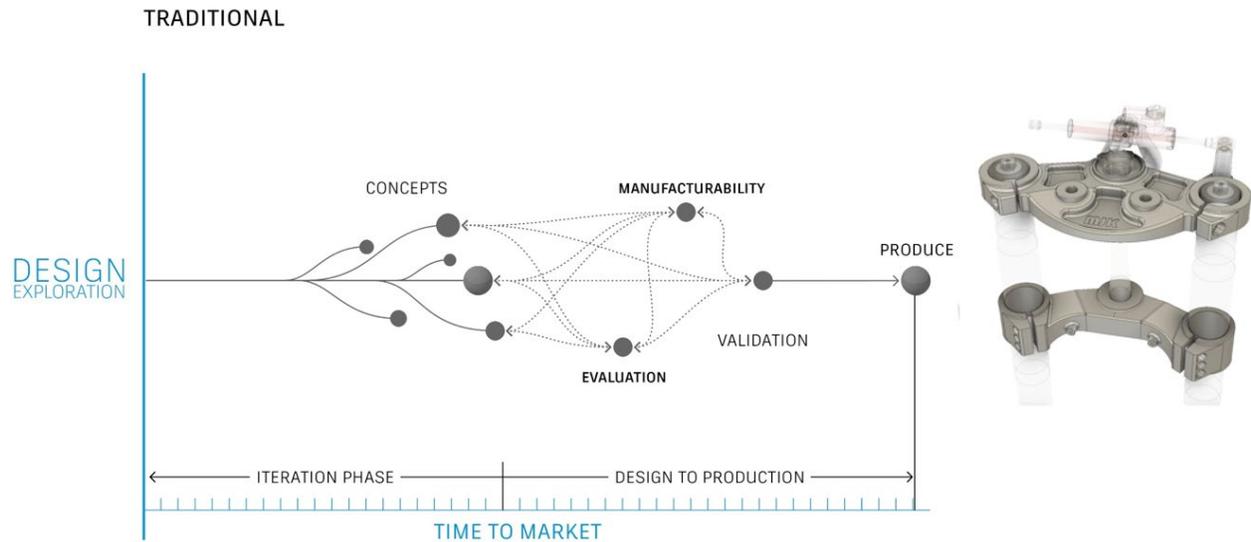
Generative Design is a design exploration technology. Simultaneously generate multiple CAD-ready solutions based on real-world manufacturing constraints and product performance requirements.



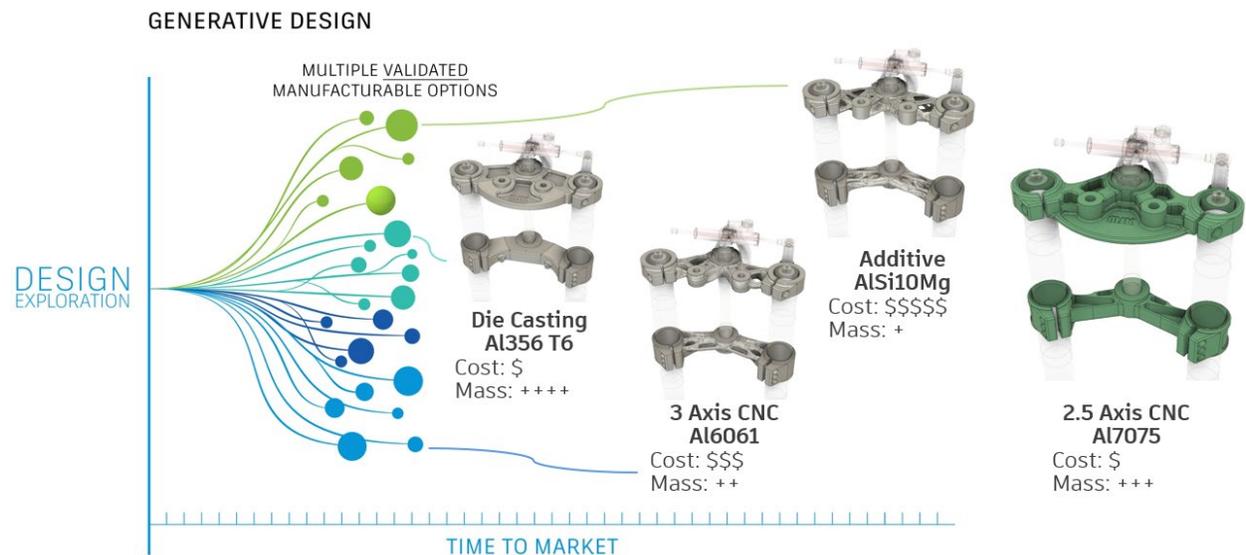
Designers or engineers input design parameters (such as materials, size, weight, strength, manufacturing methods, and cost constraints) into generative design software and the software explores all the possible combinations of a solution, quickly generating hundreds or even thousands of design options.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

How Generative Design helps 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.



This can lead to numerous iterations, feedback cycles and restarts, which elongates the time to manufacture.



Generative Design generates a wide range of designs 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 and amplifying ability to innovate.

Why Generative Design?

Today, the design teams has less time to come up with new ideas and to conceptualize and there are challenges with tribal knowledge where just one or two people have all the ideas in their heads.

Downstream manufacturing processes are not considered during the design fase and late-stage changes are costly.

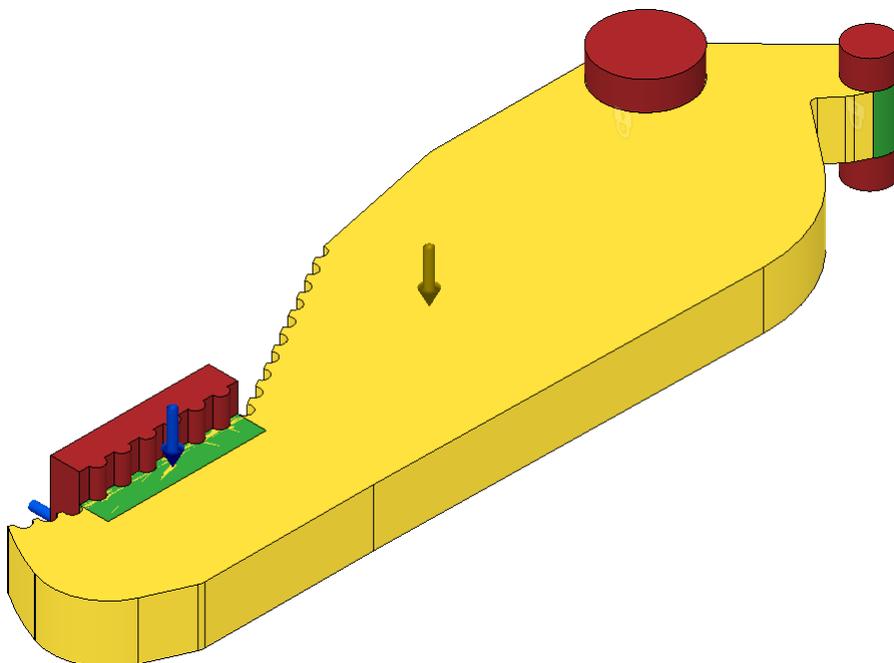
So Why Generative Design?

For the first time, the computers are helping us, instead of us having to feed it every sketch, extrusion and stay on top on what can actually be manufactured.

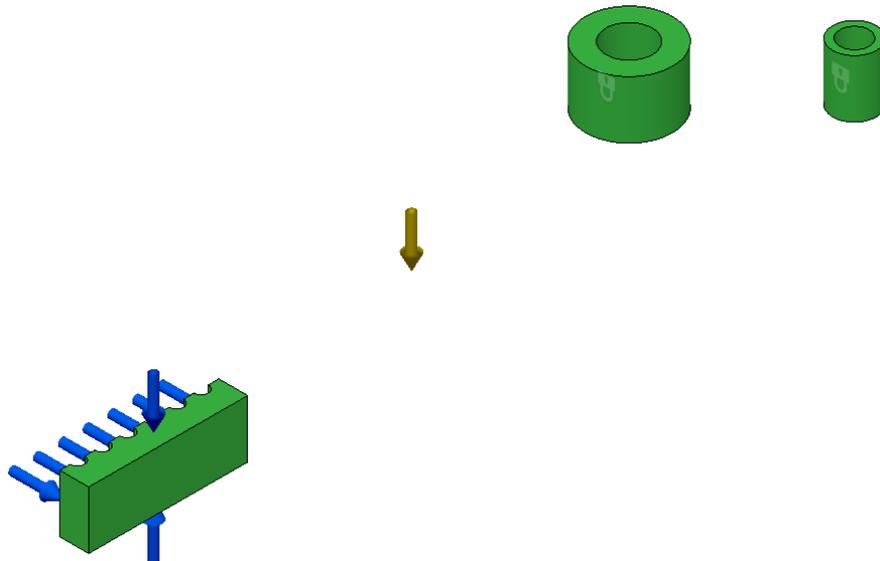
Generative Design provides cost and manufacturing options in the beginning, not in the end when 100's of hours has been spent in the design process.

Generative Design offers more options to choose from. So the design engineers can do what they are good at, what is problem solving and using their skills to pick the best design for the task.

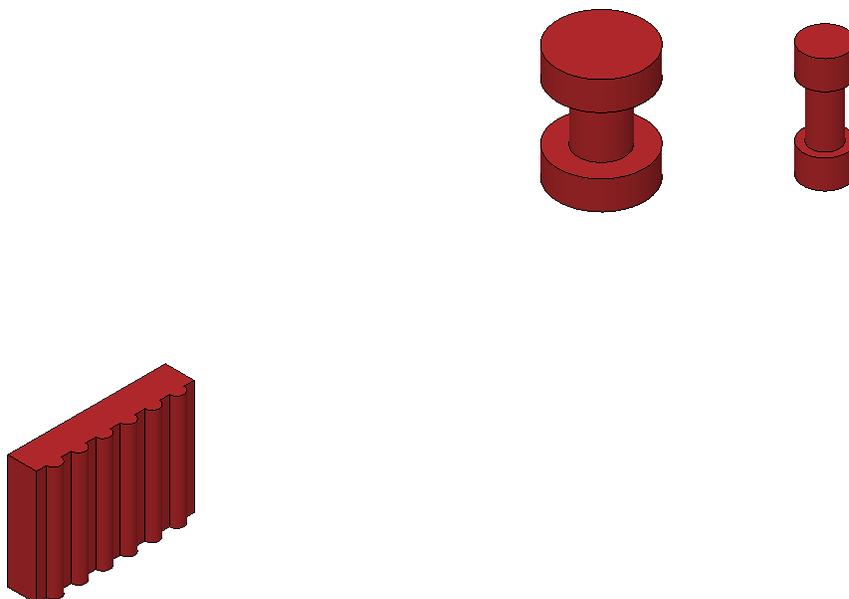
How Generative Design works



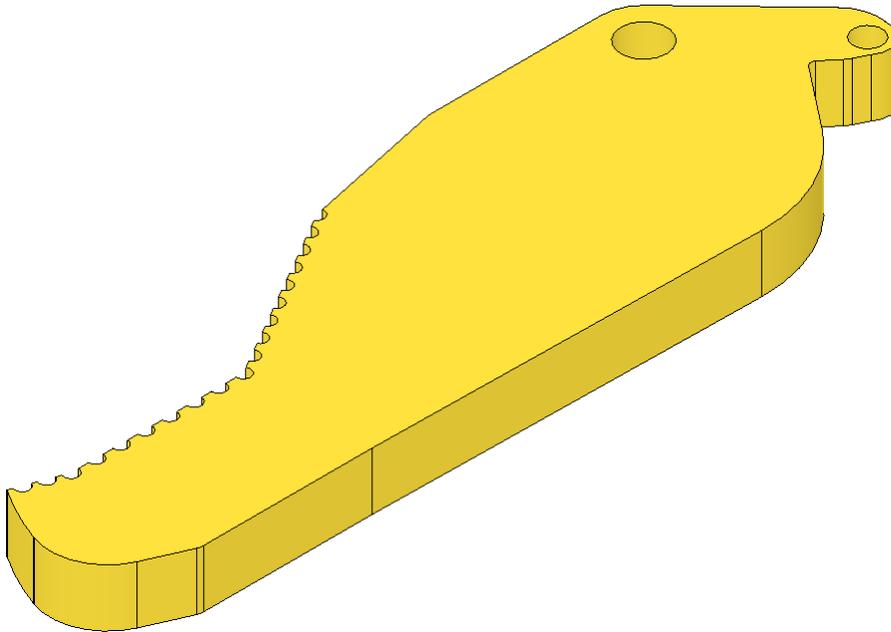
The first step for setting up a Generative Design study consists in creating the geometries of the Design Space. That is, the preserve geometry, the obstacle geometry and the starting shape (optional)



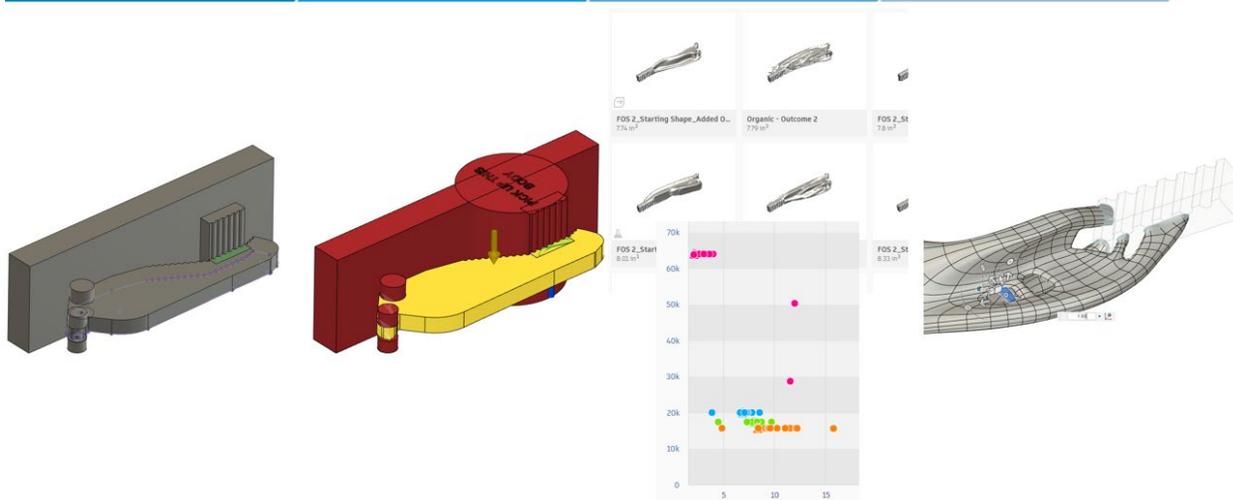
The preserve geometry typically includes the connection points to attach the design to other objects or interact with them, such as handles. This is the geometry where you apply the loads and constraints for the study. This geometry is incorporated into the final design.



The obstacle geometry represents areas we want to avoid, because we need clearances for things like fastener and tool access, other components of the assembly, possibly the motion of some of them, etc. The solver does not add any material to these spaces.



The starting shape is the initial shape from which the solver generates the outcome. The starting shape is optional.



For completing the set up, the Design Conditions (Loads and Constraints), the Design Criteria (Optimization objectives and Manufacturing constraints) and the materials must be defined.

Based on that, Generative Design generates the outcomes, from where it is possible to select the one(s) to be produced.

The model to be produced can be exported as a “CAD-ready” solid model, that can be still edited and validate in Fusion 360, Inventor or any other CAD software, for be prepared for the production.

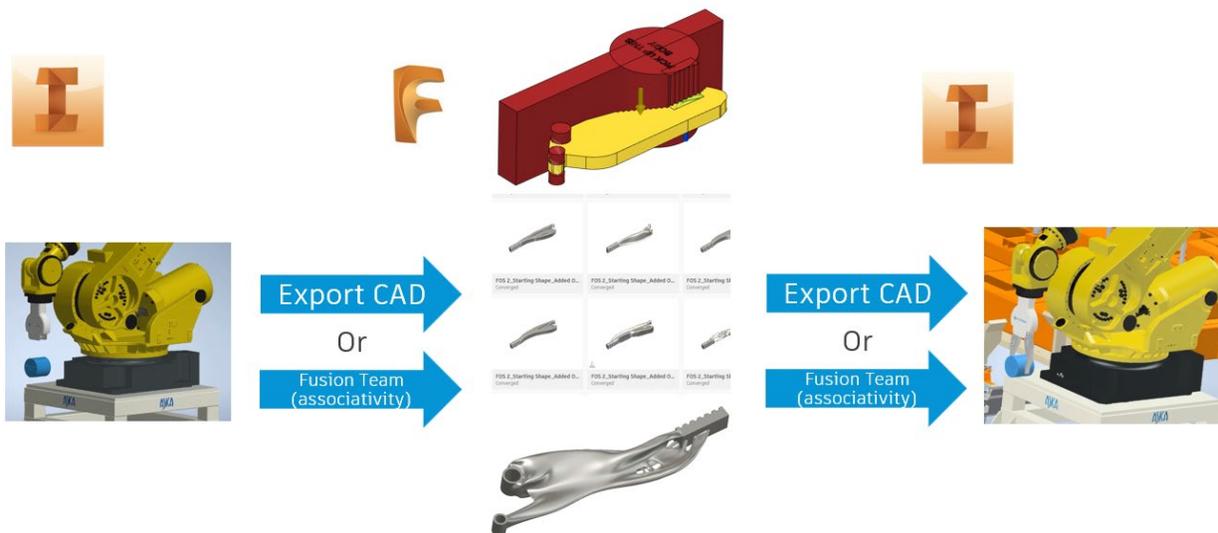
Inventor and Generative Design

In this presentation we create the geometries for the Design Space in Inventor and we can open the resulting Inventor file that contains them associatively in Fusion 360, where we will complete the setup and the workflow for generating and exporting the outcomes in the Generative Design environment.

Inventor and Fusion 360 / Generative Design are part of the Product Design & Manufacturing Collection. More info [here](#)



PRODUCT DESIGN & MANUFACTURING COLLECTION



Setup - Generate - Explore - Validate

We can do that taking advantage of the AnyCAD capabilities.

AnyCAD

AnyCAD allows you to take models from Inventor (and other CAD software) in their original format and use them directly in your Fusion 360 designs.

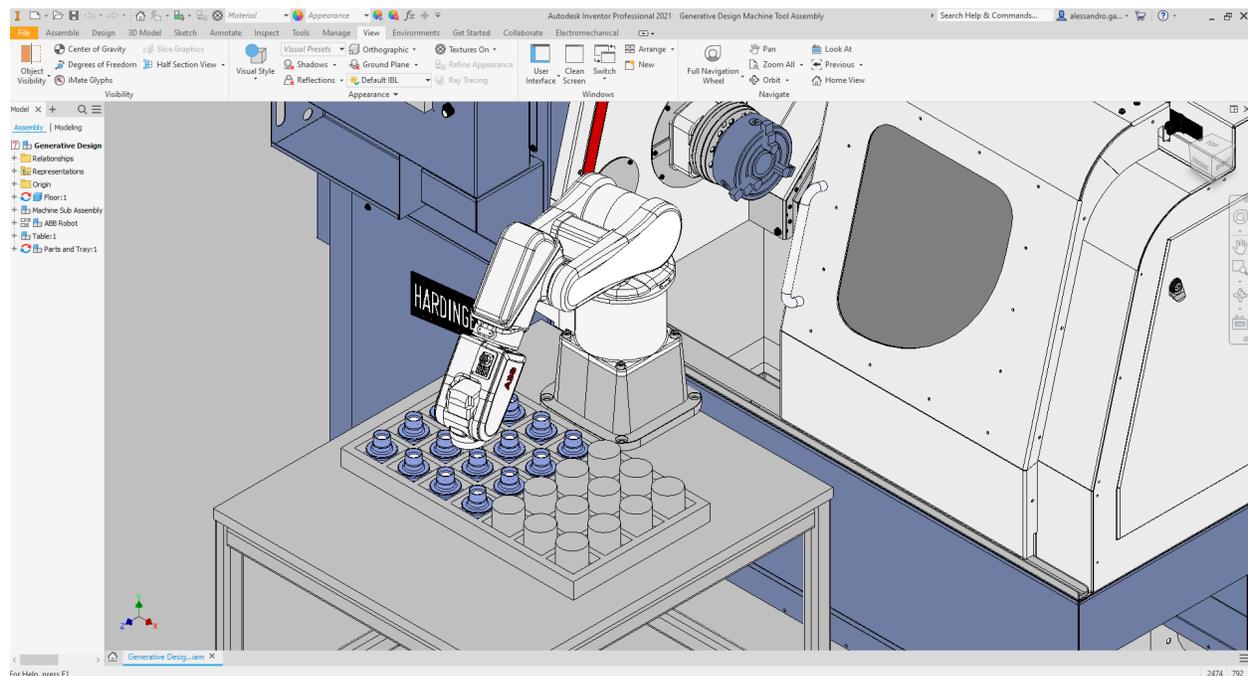
AnyCAD preserves your CAD data associations, so changes made to the original designs in their native applications are automatically shown in Fusion 360.

Important: In order to use AnyCAD functionality, you have to comply with several requirements:

- You have to be signed up for [Fusion Team](#).
- You have to be a part of a Team.
- [Desktop Connector](#) has been properly installed.

End-to-End workflow

We are going to use Generative Design for redesign grippers for material handling of a robot that has been designed in Autodesk Inventor.



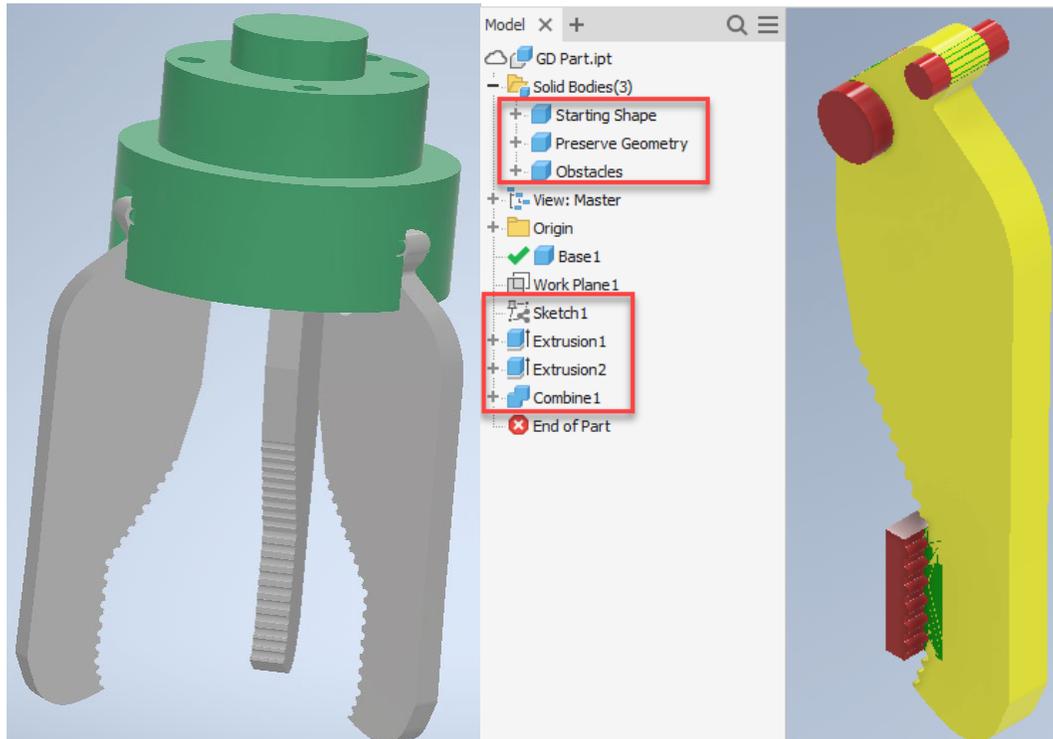
The objective is to redesign a lighter a better performing component exploring more innovative solutions that can be produced also with traditional manufacturing methods, like milling and 2-axis cutting.

Design Space

We create a standard Inventor file and we save it directly in the Fusion 360 project on the Fusion Team Hub, thanks to the AnyCAD capabilities.

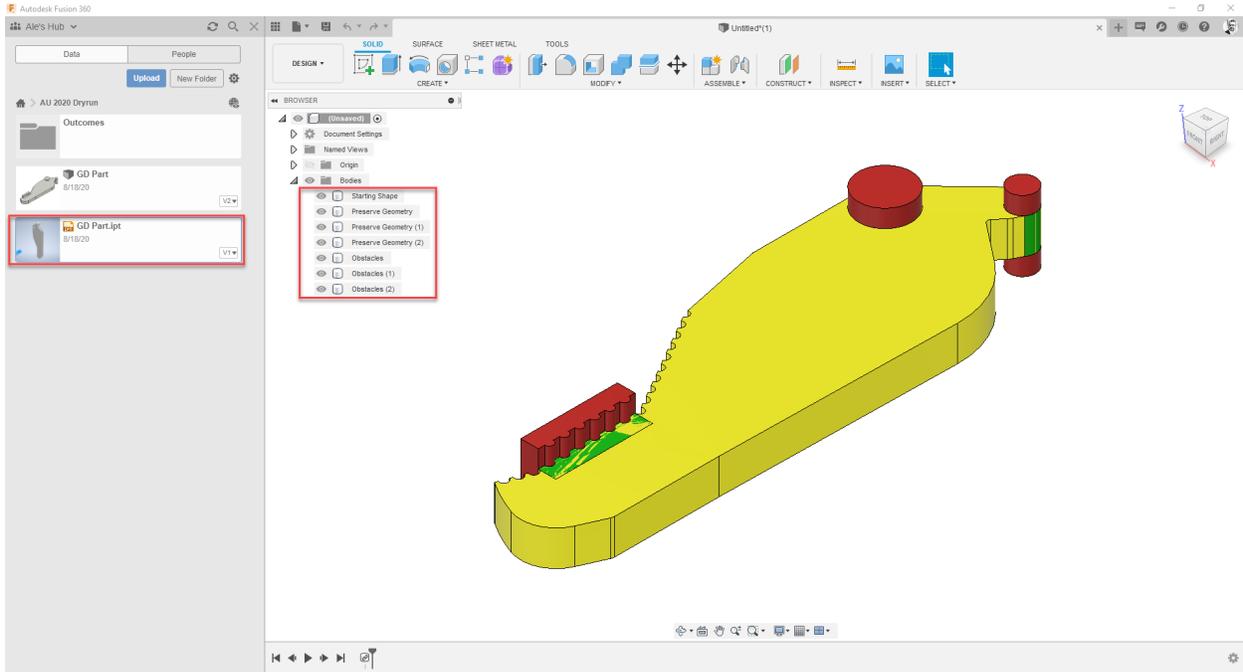
This file contains the three basic objects for creating the Generative outcomes.

We use a traditional gripper for the Starting shape.



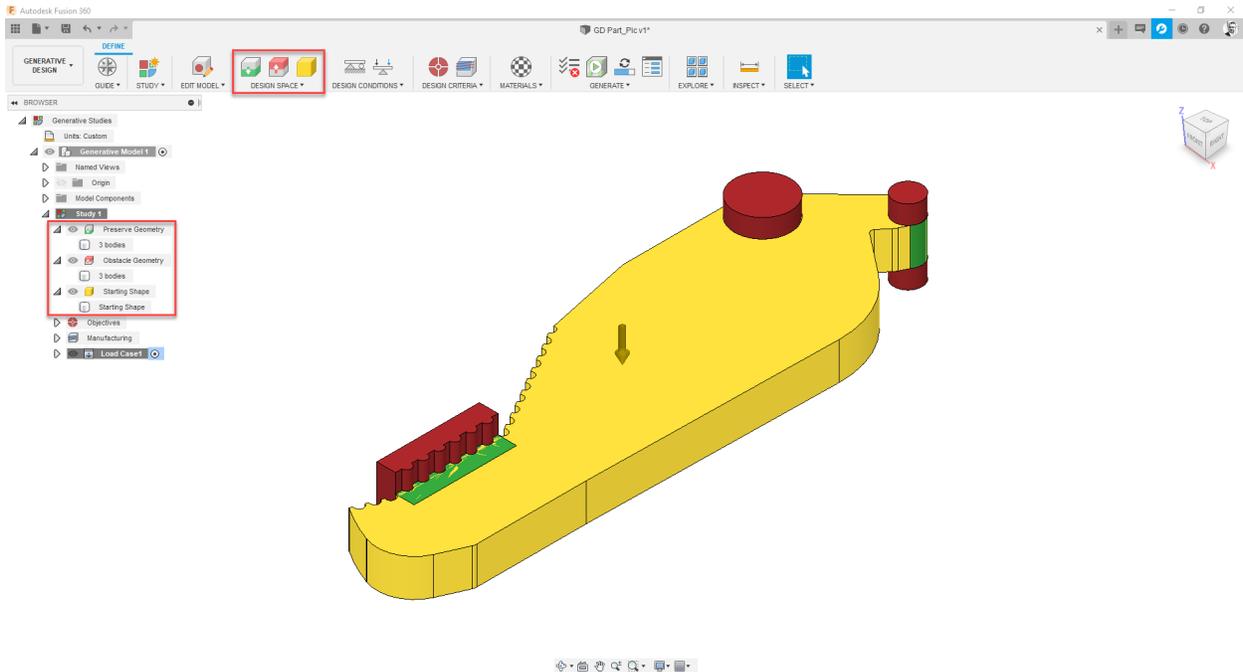
The Preserve regions, what in this case will be the areas the grippers mounts to the robot and the area needed for holding the product. The Obstacle regions, this is a defined area where we don't allow the material to be built by Generative Design. This Includes the area for the product, and also space for screws, counter boards and any tooling that needs access.

The modeling within Inventor is done with four simple commands. Sketch, project, combine and extrude.



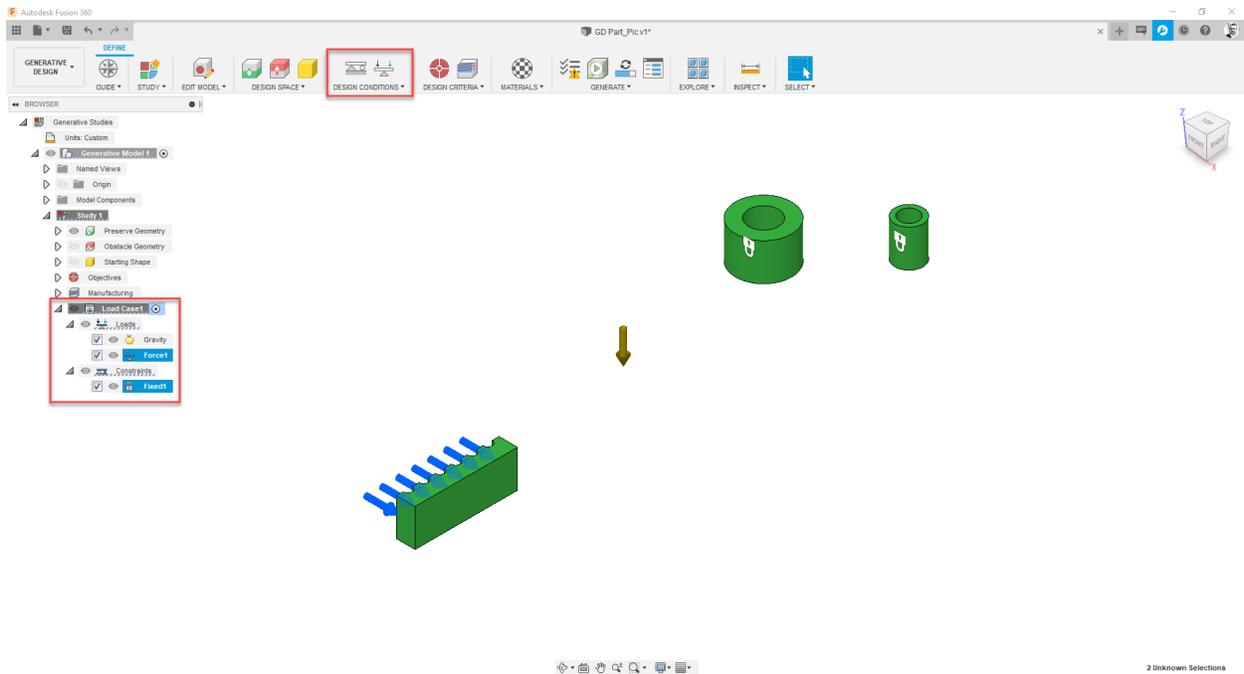
Opening the final Inventor file in Fusion 360, we get the same folder structure.

Generative Design Setup



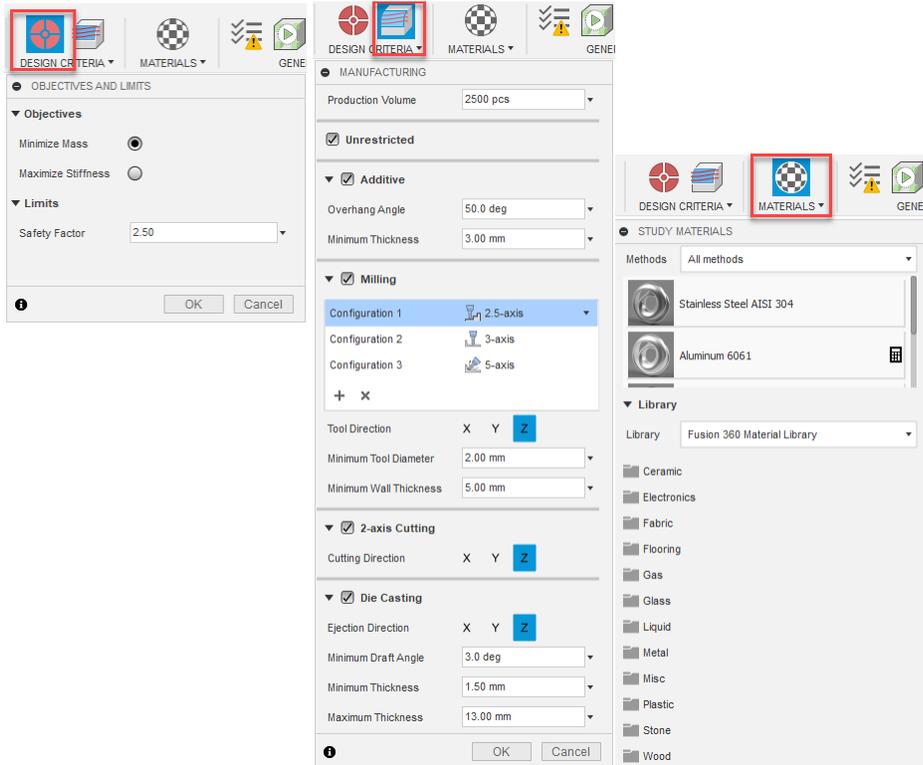
In Fusion 360, Generative Design workspace, we specify the starting

shape, and then the preserve and the obstacle regions.



Next we apply a constraint to where the grippers pivots the rotation for opening and closing and then apply the loads to the section where the grippers grab the product and to simulate gravity and movement.

We then define the Objectives of the study, select the Manufacturing process and select the materials. We can select up to seven materials in a single study



Generate

After that, we are ready to generate the outcomes.

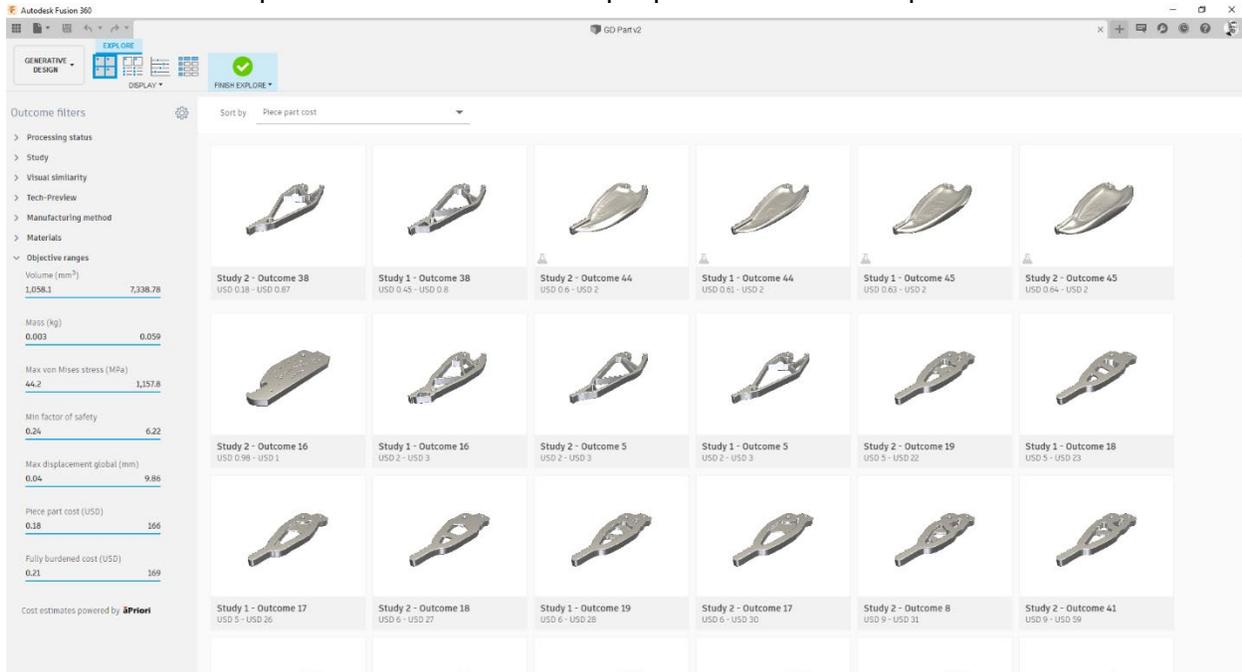


The Generative Design solver explores and provide results for un-restricted, the additive process, standard milling up to 5 Axis and for metal casting, for each material selected.

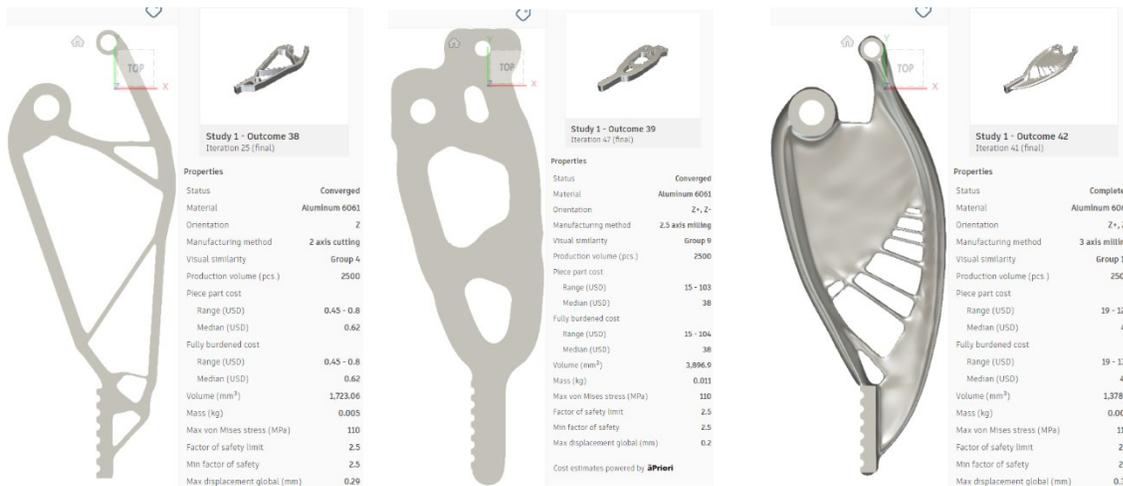
Explore

Within the explorer window, we can filter and validate different results and compare them against a min and max cost estimate based on material, production volume,

manufacturing methods and shape complexity. The results are saved in the cloud, and we can pick and choose from multiple pre-validated concept models.



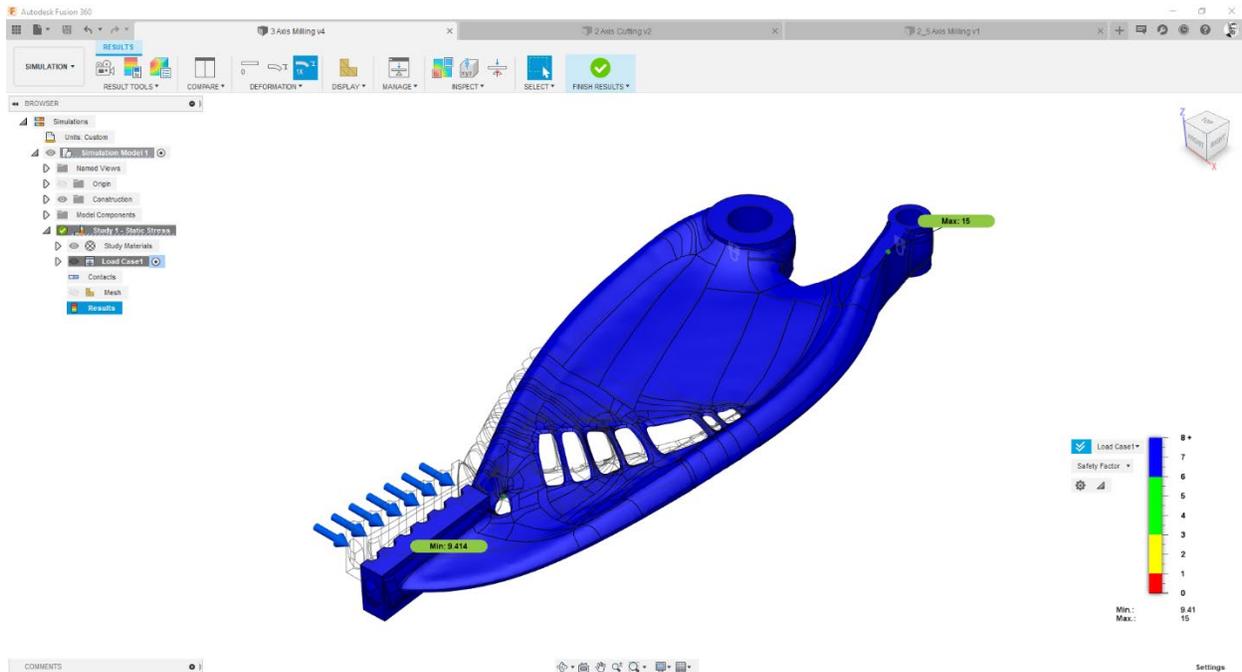
In this case we have download three possible design alternatives. 2 Axis, 2.5 and 3 Axis Milling.



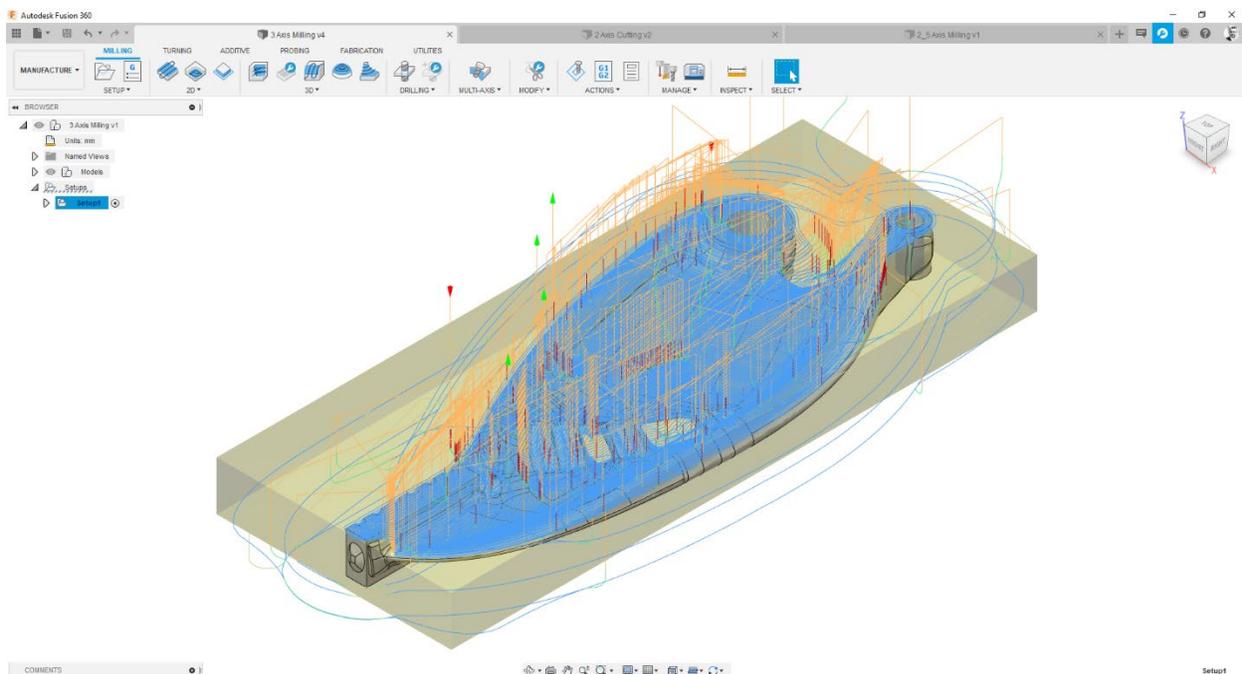
Validate

The outcomes from Generative Design are fully editable.

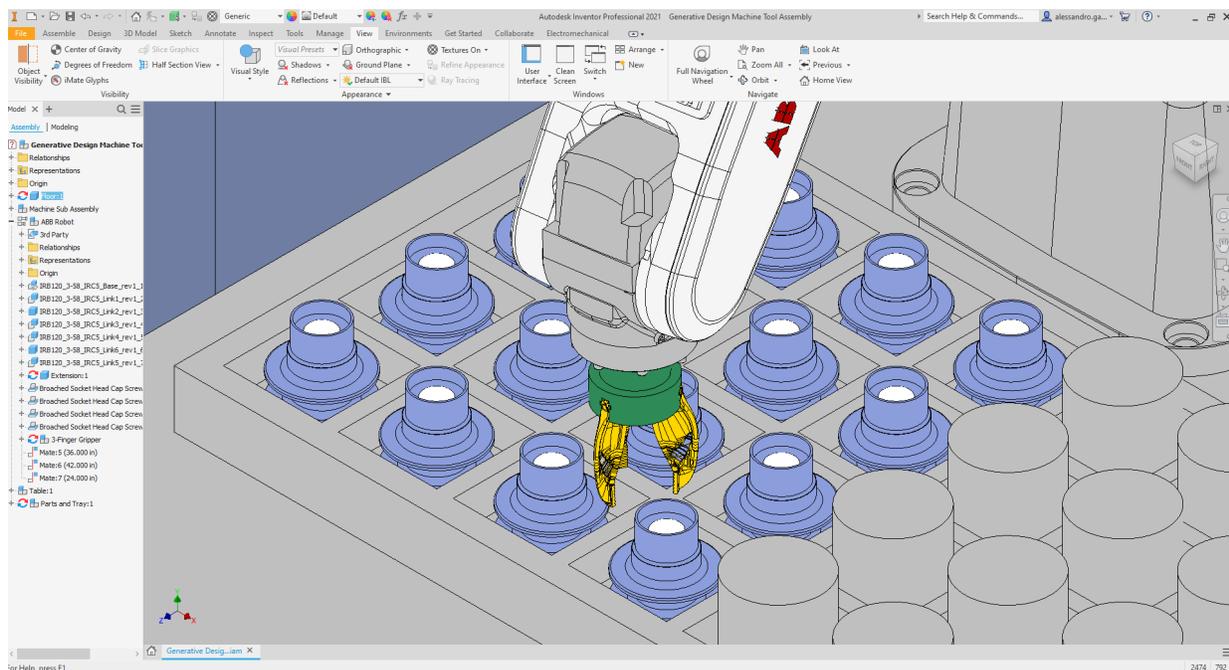
We can modify the end results and make the tweaks we would like. As a validation point, we run a stress analysis simulation in Fusion 360 using the same loads and constraints inherited from the Generative Design Study, for verifying the component doesn't break and also that the factor of safety respects the rules of Generative Design setting.



Then we machine the model in the manufacturing environment.



Finally, we go back into Inventor, and just as before, thanks to the AnyCAD functionality, we navigate to the Fusion team folder and insert their innovative version of the robot grippers to their master model in Inventor



Conclusions

In this example, we have redesigned the grippers for material handling of a robot. The original design was created in Inventor and we have done all the modeling needed for setting up the Generative Design study, in Inventor. Then, in the Generative Design workspace in Fusion 360 starting from what we have created in Inventor, we could explore more design options, with a better fit to each manufacturing process, spending less time getting a more competitive solution.

Tutorials

Inventor Tutorial

[Generative Design Study](#)

Fusion 360 Adoption Portal

[Front Loader - work in generative design with an Inventor file](#)