AUTODESK. UNIVERSITY

Generative Design: Getting the Results

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About the speaker

Robert Savage

Robert Savage is a Senior Education Specialist at IMAGINiT Technologies. He is a 30-year design veteran who has designed everything from molds and molded parts to robots. At Remotec, a division of Northrop Grumman Corporation, he spent 5 years as a lead designer in the research and development group, as well as CAD and Vault Administrator. He is an Autodesk Certified Instructor and a Certified Inventor Professional. He has used Inventor software since its inception, as well as being well-versed in a variety of other design software. He has 20 years of experience teaching 3D design software, including AutoCAD Electrical, Product Design Suite Ultimate software, Factory Design Suite Ultimate software, Simulation Moldflow software, Fusion 360, Nastran In-CAD and Vault Professional software.

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Generative Design: Getting the Results

For the last couple of years, I have taught Generative Design classes at Autodesk University. The first years, we did an Introduction to Generative Design Lecture, last year we did a lab showing the process and setup for applying a Generative Design to a part. This year we want to look at the results that you get from running the part and talk about how to interpret the information that you it gives you back. We also want to look at how to download the desired result as a solid model, modified the file for any needed cleanup, and used in an assembly. We are going to start by submitting a file to Generative Design then we want to look at the results that are returned for strength, weight and even cost. We will review sorting the results to get the best possible option for what we want then we will download the file and talk about what can be done with the file. I will finish up by talking about changes to Generative Design that have come out this year.

Generative Design: Getting the Results

REVIEW THE SETUP AND UPLOAD THE FILE WE WANT TO USE

I want to do a quick overview of the setup and upload process.

BREAKDOWN AND SORT THE RESULTS OF THE FILE

We will review the results we get.

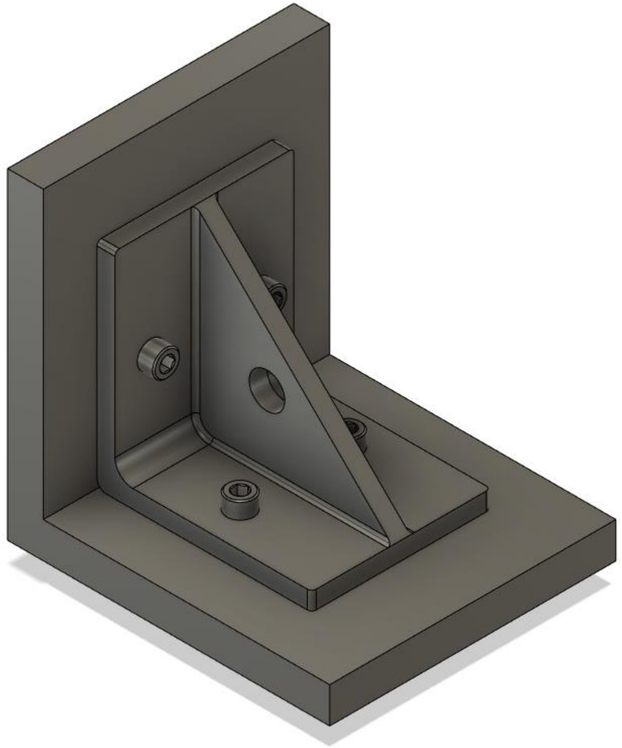
DOWNLOADING THE FILE, WE WANT TO USE

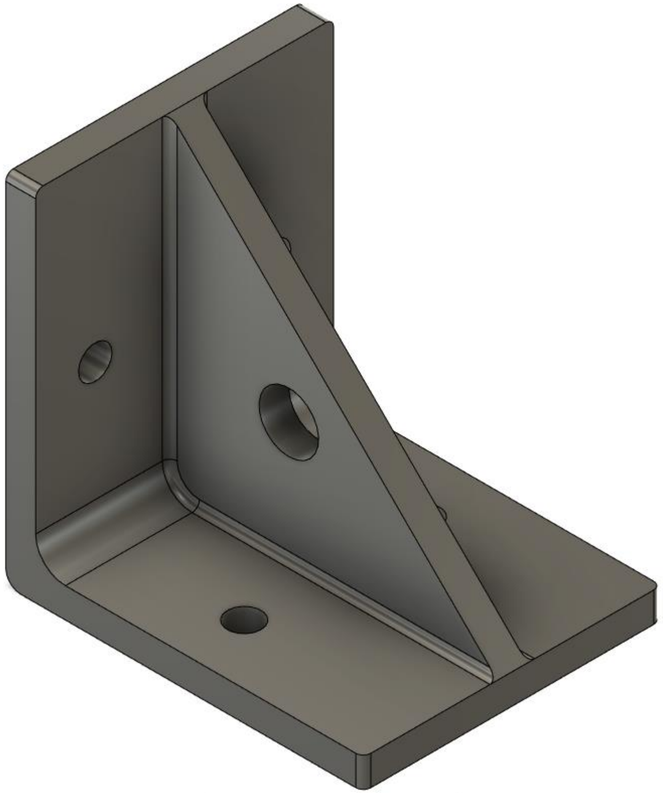
Download the results we select.

MODIFY AND USE THE FILE IN AN ASSEMBLY

Sue the part we download.

What we are starting with.

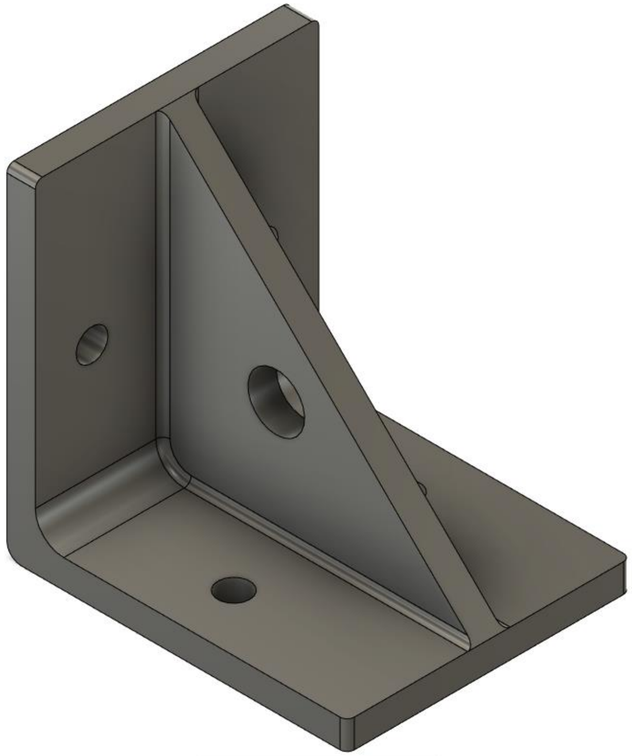




Review the Setup and Upload the file we want to use

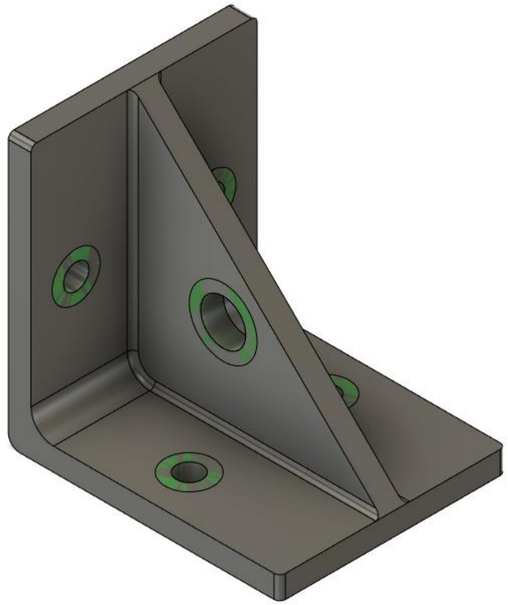
The setup process can be complicated depending on the part, but it breaks down in to 5 categories and they are:

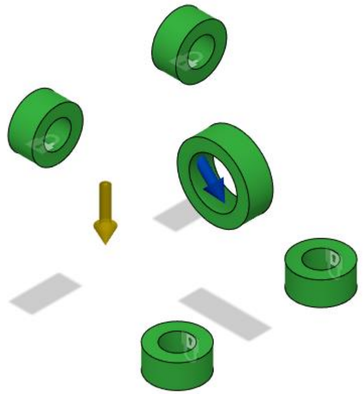
- Identify the problem domain and gather information
- Creating preserve geometry
- Creating obstacle geometry
- Setup your boundary conditions
- Run your studies



Identify the problem domain and gather information

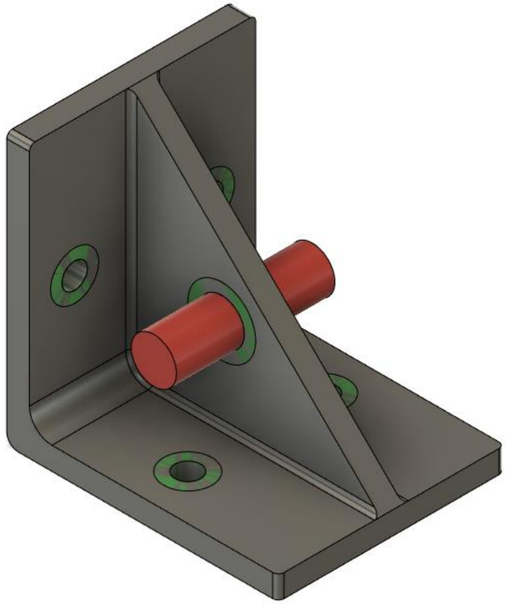
Spend some time thinking about the problem and the greater context that it fits in. How does the new part(s) interact with the greater assembly? What kind of manufacturing, assembly, or other practical considerations are present?

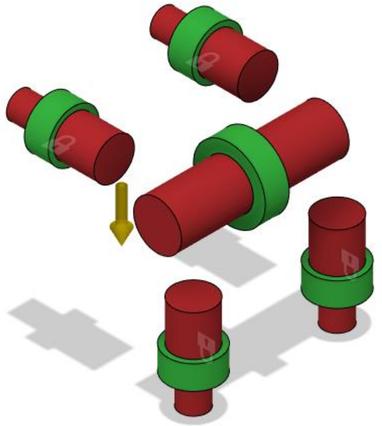




Creating preserve geometry

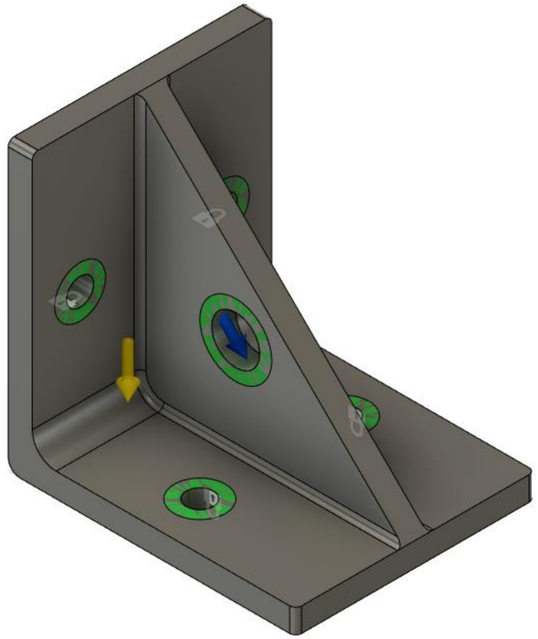
Start with the existing base model, be it a single part or an assembly. Create the interface geometry (e.g. bolt bosses, flanges, etc.) as new bodies to be used by the generative process. Be sure to include any needed extra grind/machine stock, fluid containment walls, or other "oddball" preserves.





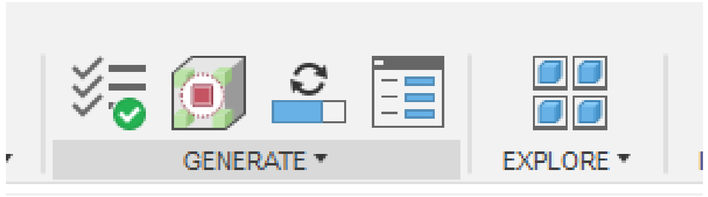
Creating obstacle geometry

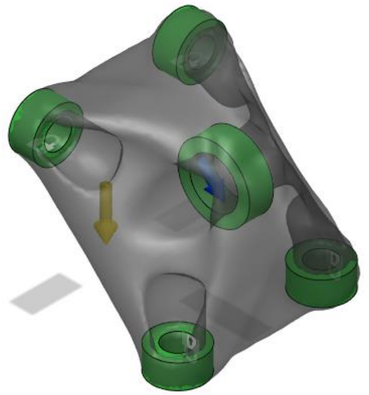
Again, working with the base model, create any obstacle geometry needed. This might include fasteners (nuts, bolts, screws, pins, etc.). It also might include more complicated geometry like swept solids (e.g. the path a toggle clamp makes as it swings into position).



Setup your boundary conditions

Specify the constraints, loads, manufacturing details, and materials into the system. Be sure to build your load cases based on any dynamic motions that may be involved (for example, a part of a car suspension may experience braking, acceleration, turning, or stasis).

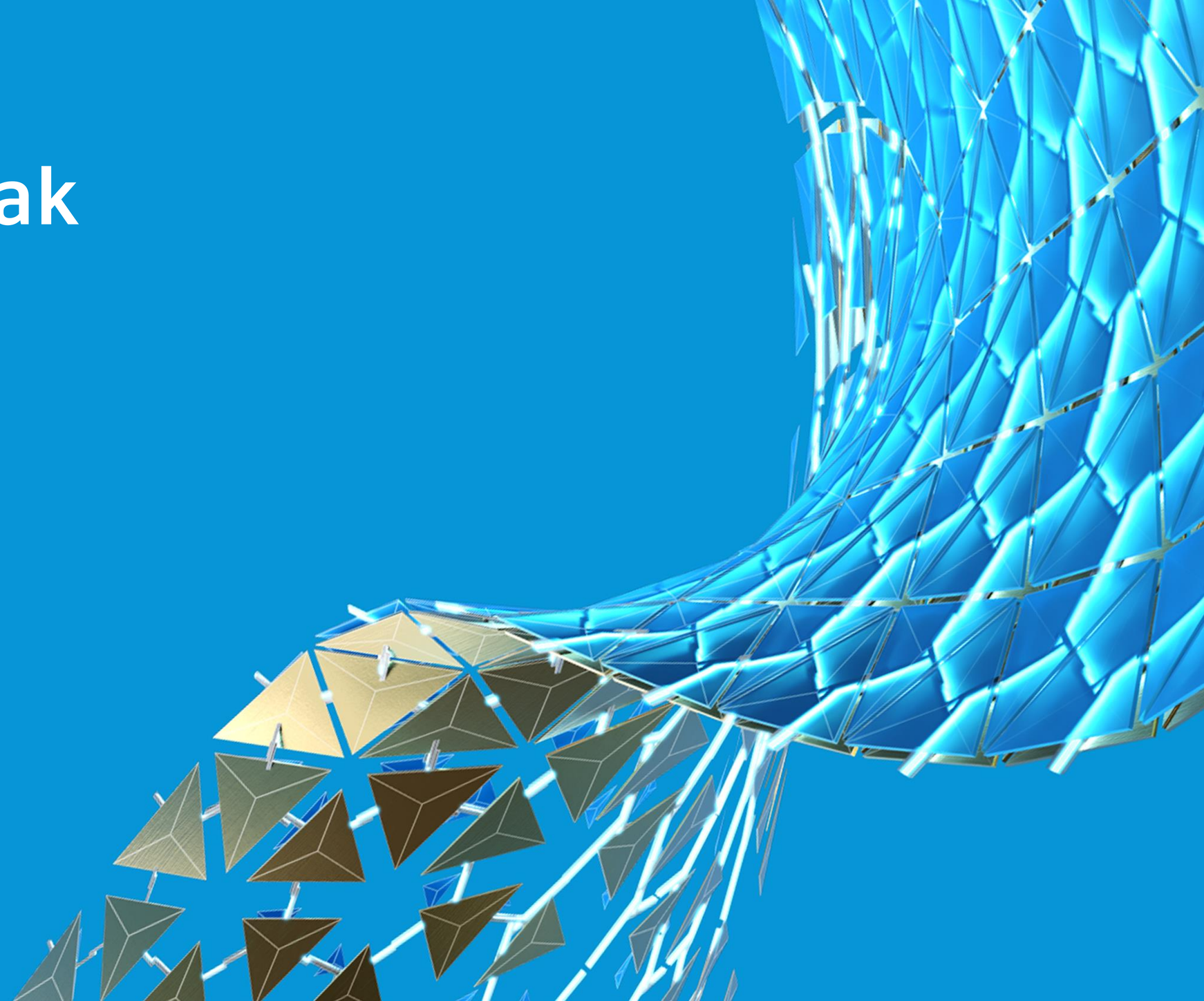




Run your studies

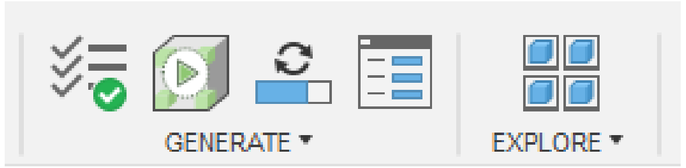
At this point, run your various studies. Pay attention to early results to ensure that you're getting expected kinds of results. You'll notice fairly early on if an obstacle is too short or you forgot some specific detail.

Section Break



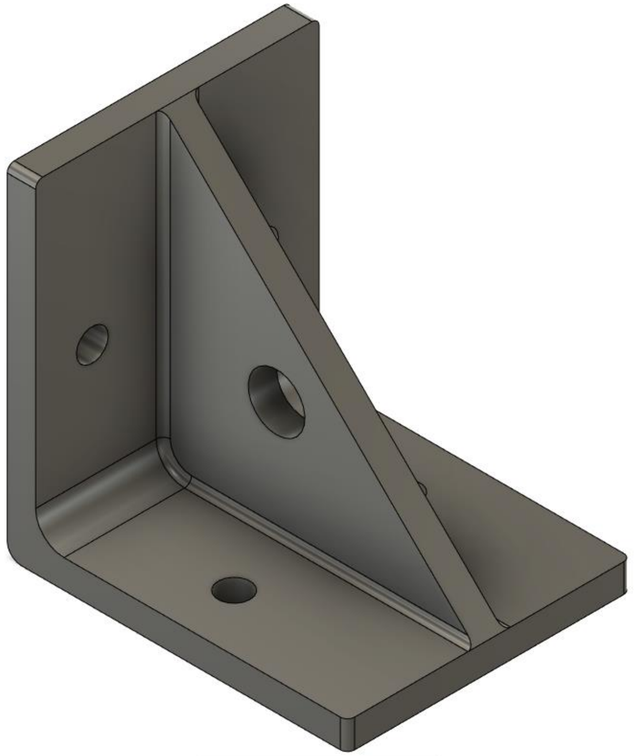
Breakdown and Sort the results of the file

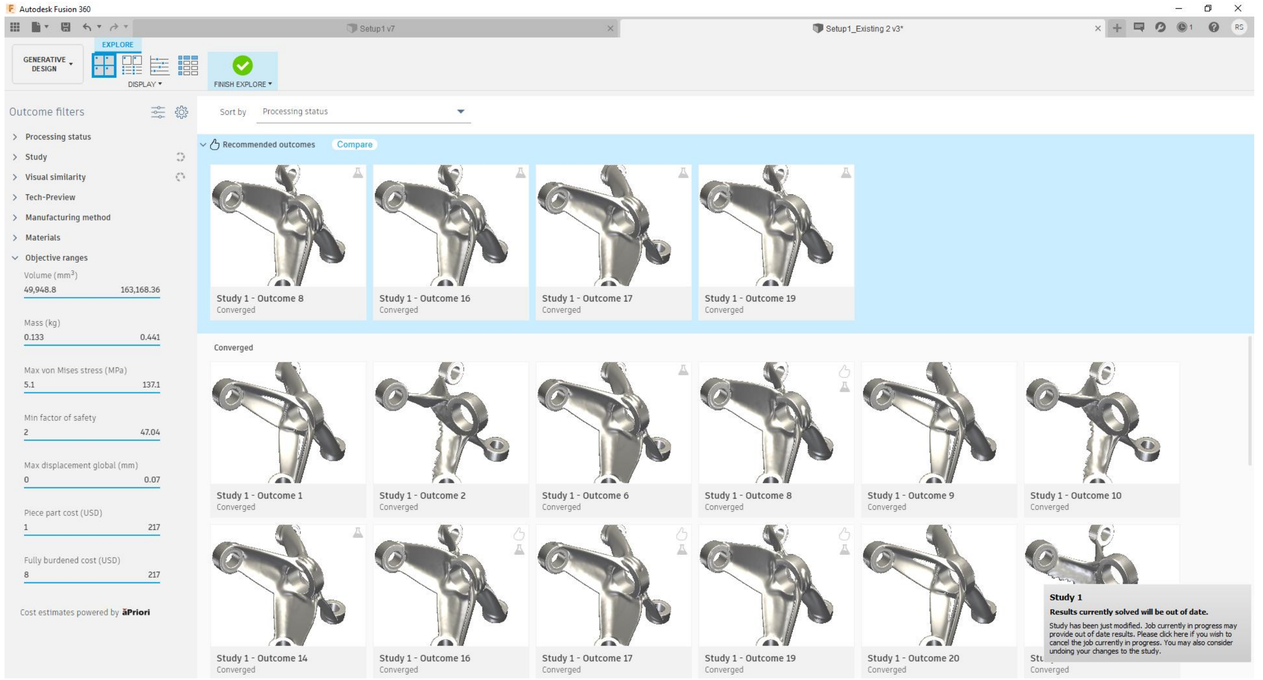
The results are based on several points including Material, Safety Factor, Mass...



Examine your results

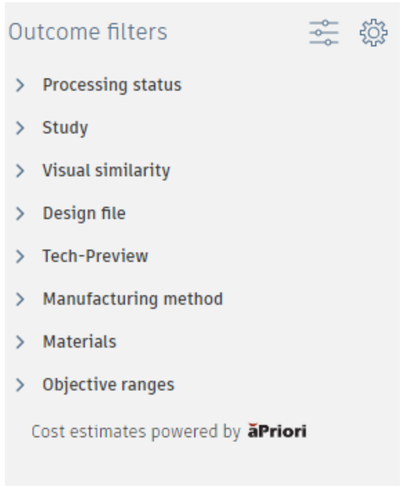
As your results complete, use the tools available to determine which solutions are worth further investigation. This may be a matter of using the scatter plots, visually comparing results, or inspecting the model stress visualizations.





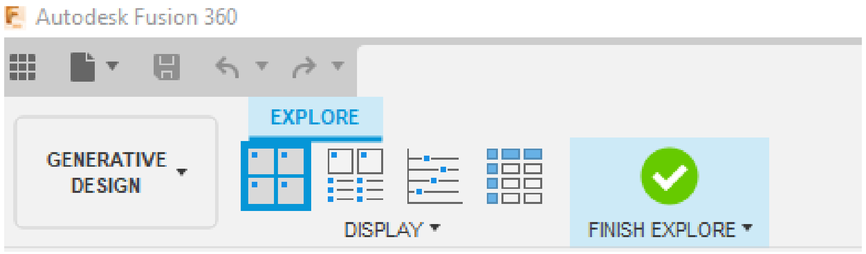
Compare results to initial expectations

Once your results are in, loop back to step one and validate what was generated against what you expected/desired.



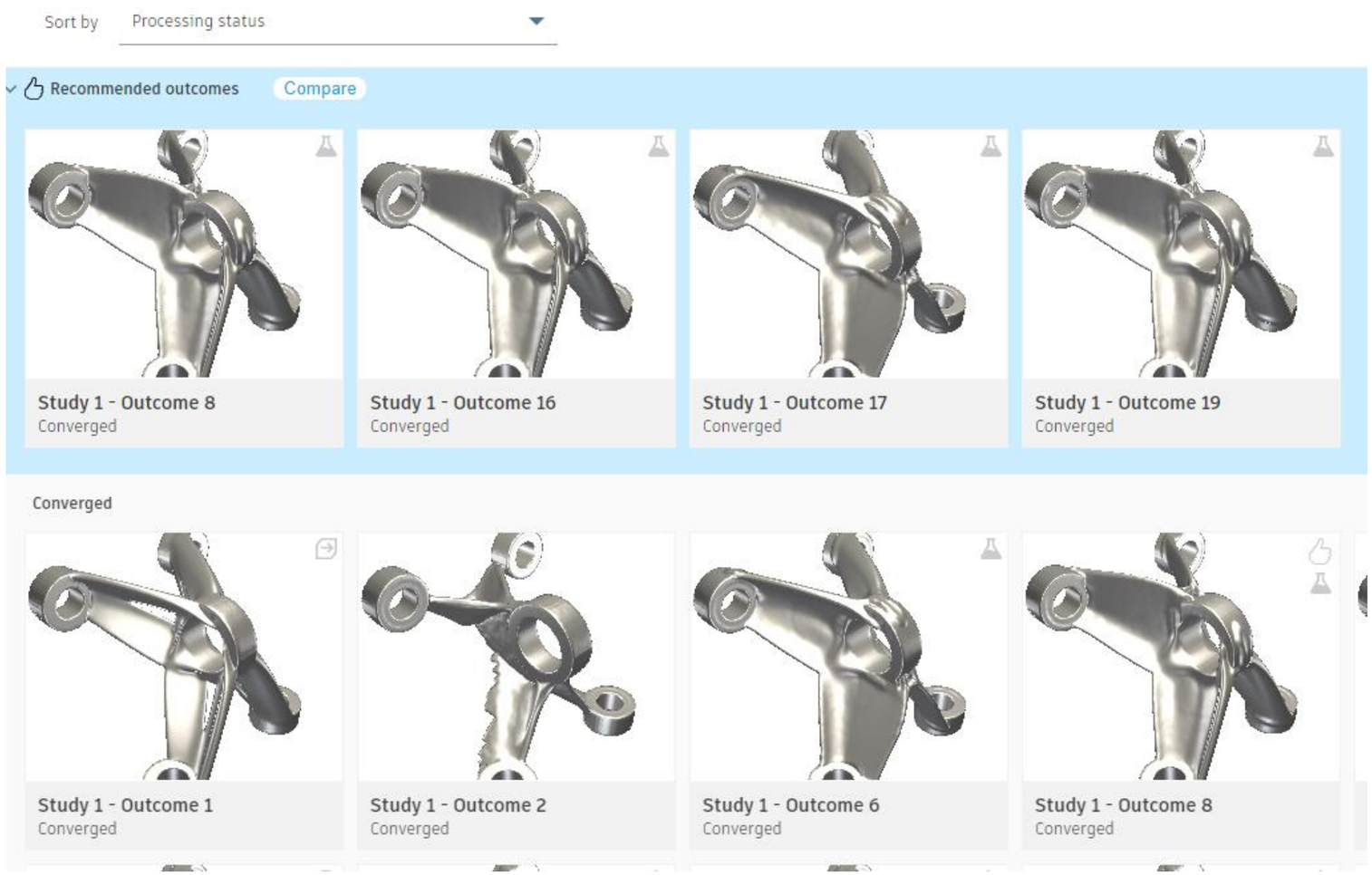
Results

The results are separated in the Outcome Filter

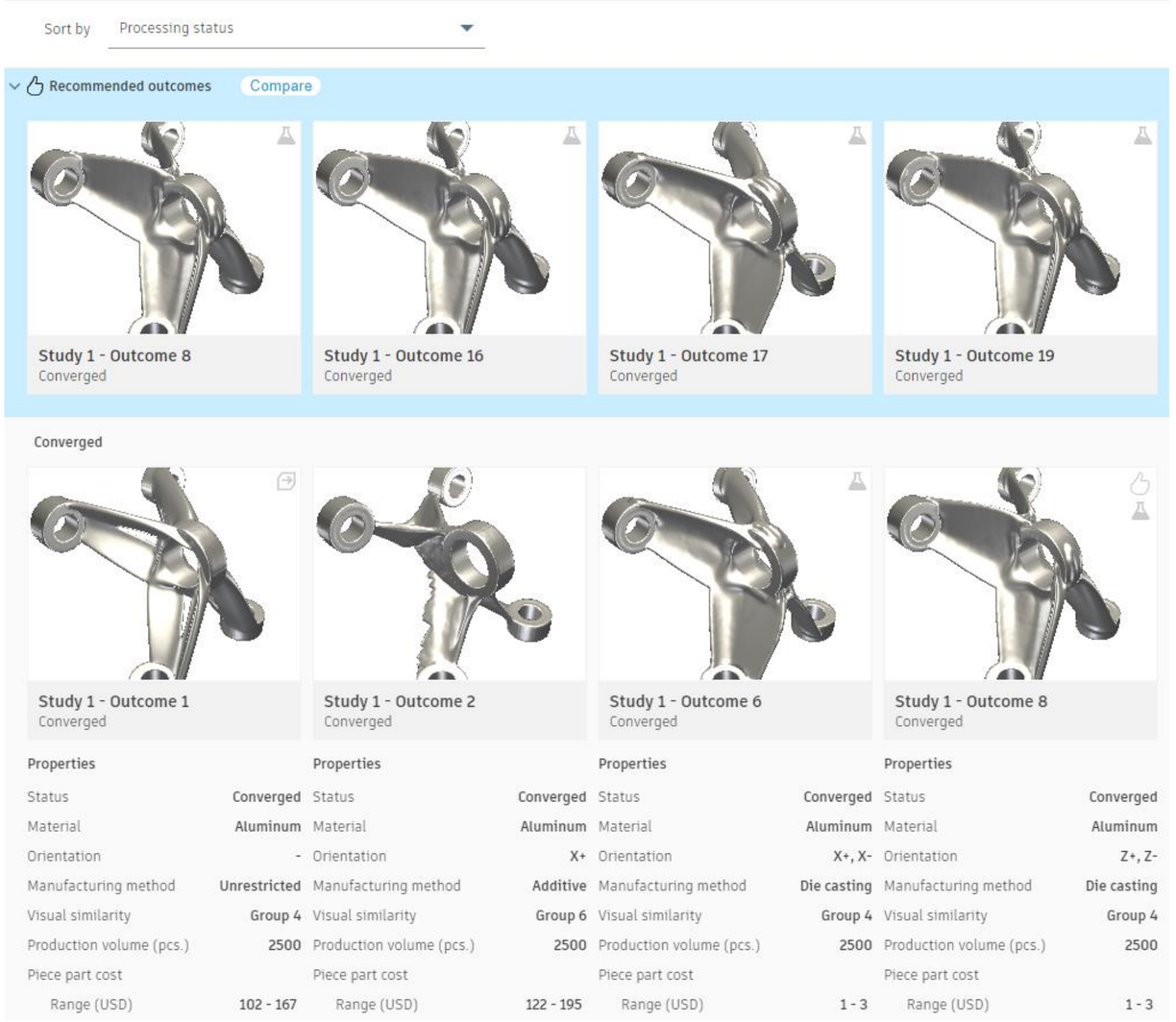


Results

The display of the results can be adjusted between Thumbnail, Properties, Scatter Plot, and Table all of which can be sorted using the dropdown menu at the top of the window.


Sort by
Processing status
Recommended outcomes
Compare
Study 1 - Outcome 8
Converged
Study 1 - Outcome 16
Converged
Study 1 - Outcome 17
Converged
Study 1 - Outcome 19
Converged
Converged
Study 1 - Outcome 1
Converged
Study 1 - Outcome 2
Converged
Study 1 - Outcome 6
Converged
Study 1 - Outcome 8
Converged

Thumbnail


Sort by
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Study 1 - Outcome 8
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Study 1 - Outcome 16
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Study 1 - Outcome 17
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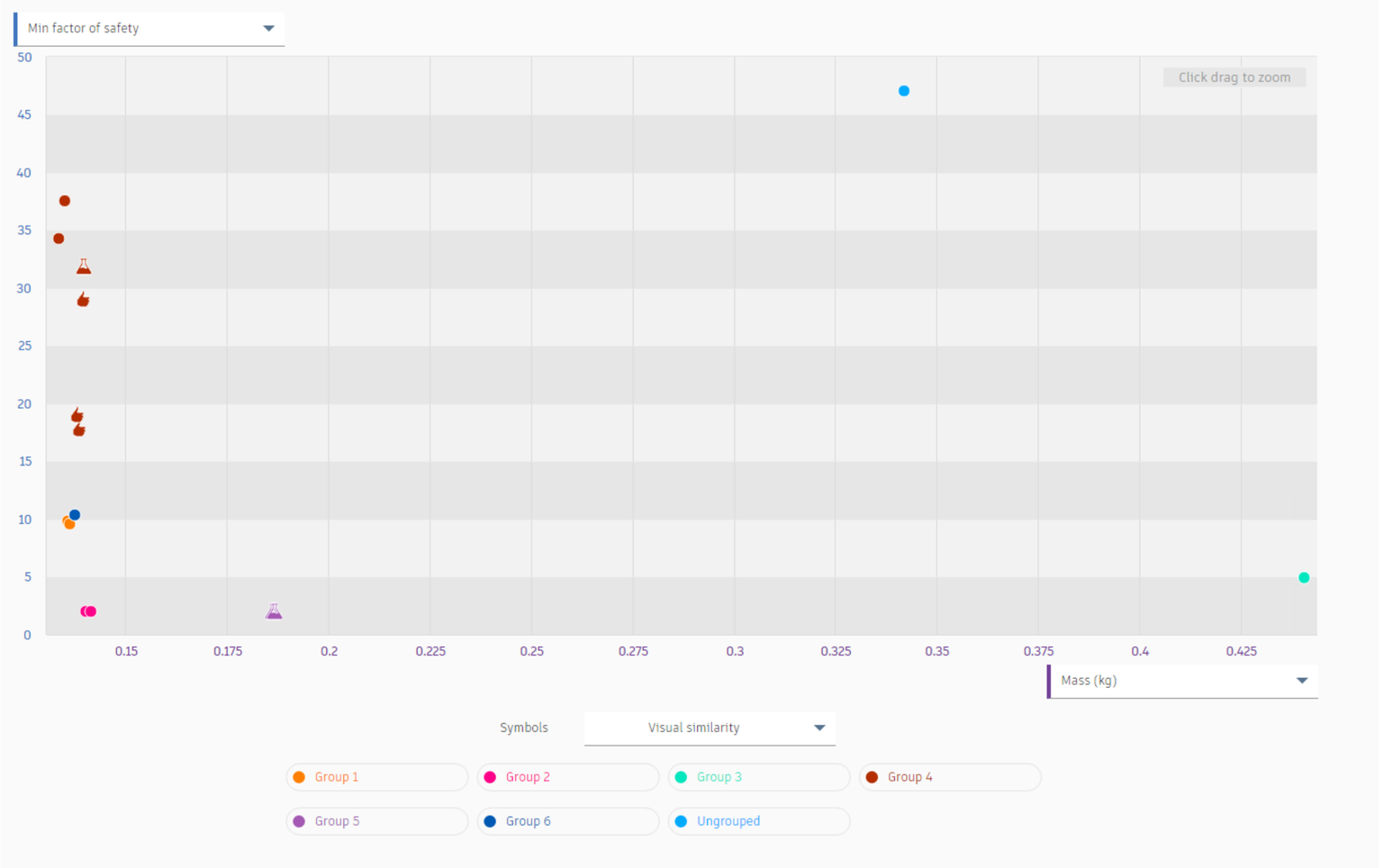
Study 1 - Outcome 19
Converged
Converged
Study 1 - Outcome 1
Converged
Study 1 - Outcome 2
Converged
Study 1 - Outcome 6
Converged
Study 1 - Outcome 8
Converged
Properties
Status Converged
Material Aluminum
Orientation -
Manufacturing method Unrestricted
Visual similarity Group 4
Production volume (pcs.) 2500
Piece part cost
Range (USD) 102 - 167
Properties
Status Converged
Material Aluminum
Orientation X+
Manufacturing method Additive
Visual similarity Group 6
Production volume (pcs.) 2500
Piece part cost
Range (USD) 122 - 195
Properties
Status Converged
Material Aluminum
Orientation X+, X-
Manufacturing method Die casting
Visual similarity Group 4
Production volume (pcs.) 2500
Piece part cost
Range (USD) 1 - 3
Properties
Status Converged
Material Aluminum
Orientation Z+, Z-
Manufacturing method Die casting
Visual similarity Group 4
Production volume (pcs.) 2500
Piece part cost
Range (USD) 1 - 3

Properties

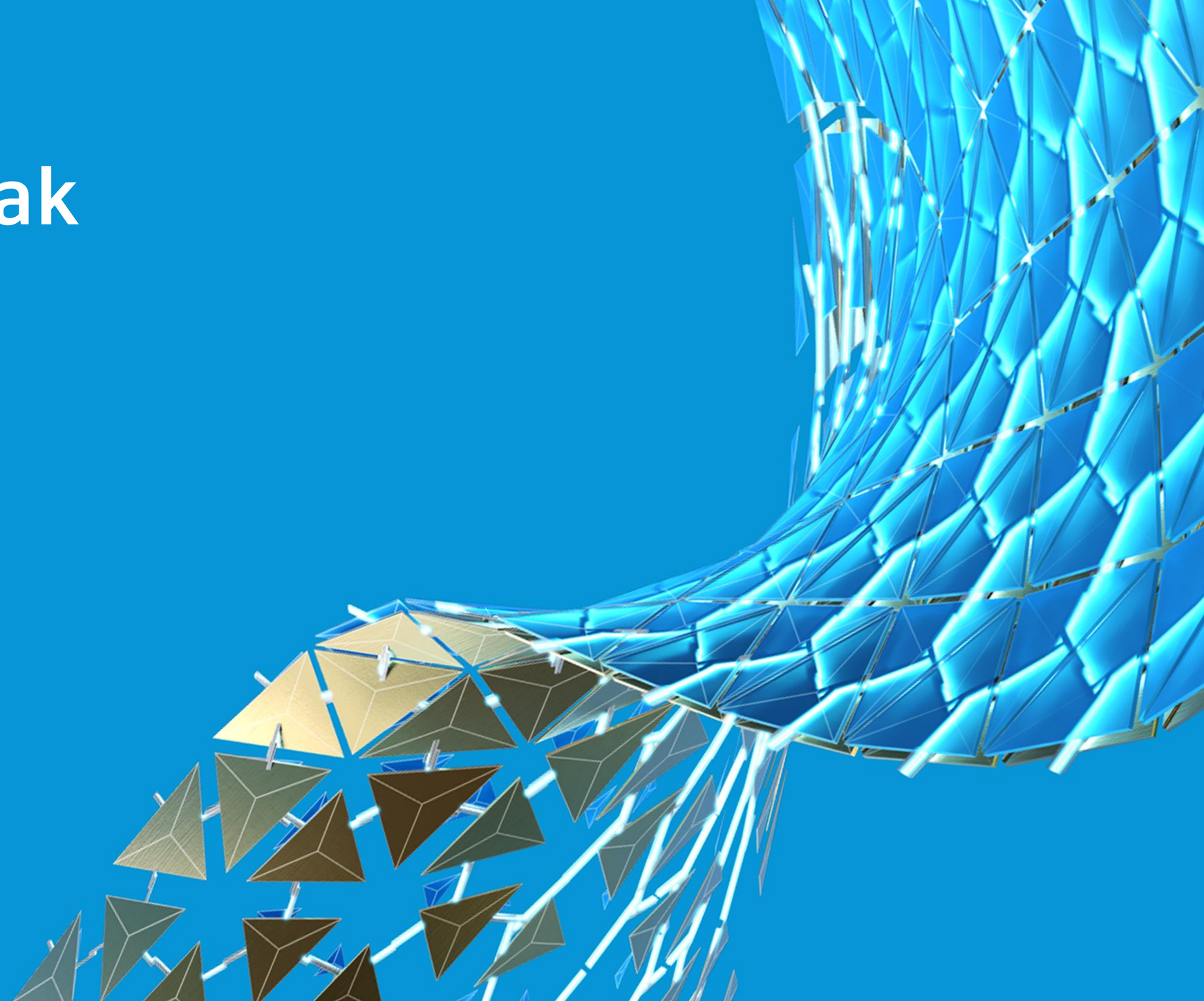


Scatter Plot

	Name ↓	Tech-Preview	Recommendation	Processing status	Material	Manufacturing method	Visual similarity	Piece cost range (USD)	Piece cost median (USD)	Full cost range (USD)
	Study 1 - Outcome 1		91 %	Converged	Aluminum	Unrestricted	Group 4	102 - 167	143	102 - 167
	Study 1 - Outcome 2		55 %	Converged	Aluminum	Additive	Group 6	122 - 195	169	122 - 196
	Study 1 - Outcome 3		72 %	Completed	Aluminum	Additive	Group 2	127 - 208	179	127 - 209
	Study 1 - Outcome 4		60 %	Completed	Aluminum	Additive	Group 1	117 - 198	169	117 - 199
	Study 1 - Outcome 5		0 %	Completed	Aluminum	3 axis milling	Group 3	46 - 106	62	46 - 107
	Study 1 - Outcome 6		92 %	Converged	Aluminum	Die casting	Group 4	1 - 3	2	9 - 21
	Study 1 - Outcome 7		88 %	Completed	Aluminum	Die casting	Group 5	2 - 4	3	8 - 19
	Study 1 - Outcome 8		92 %	Converged	Aluminum	Die casting	Group 4	1 - 3	2	8 - 19
	Study 1 - Outcome 9		91 %	Converged	Aluminum 6061	Unrestricted	Group 4	102 - 167	143	102 - 167
	Study 1 - Outcome 10		55 %	Converged	Aluminum 6061	Additive	Group 6	122 - 195	169	122 - 196
	Study 1 - Outcome 11		72 %	Completed	Aluminum 6061	Additive	Group 2	127 - 208	179	127 - 209
	Study 1 - Outcome 12		60 %	Completed	Aluminum 6061	Additive	Group 1	117 - 198	169	117 - 199
	Study 1 - Outcome 13		0 %	Completed	Aluminum 6061	3 axis milling	Group 3	46 - 106	62	46 - 107
	Study 1 - Outcome 14		92 %	Converged	Aluminum 6061	Die casting	Group 4	1 - 3	2	9 - 21
	Study 1 - Outcome 15		88 %	Completed	Aluminum 6061	Die casting	Group 5	2 - 4	3	8 - 19
	Study 1 - Outcome 16		92 %	Converged	Aluminum 6061	Die casting	Group 4	1 - 3	2	8 - 19
	Study 1 - Outcome 17		92 %	Converged	Aluminum A356 T6	Die casting	Group 4	1 - 3	2	9 - 21

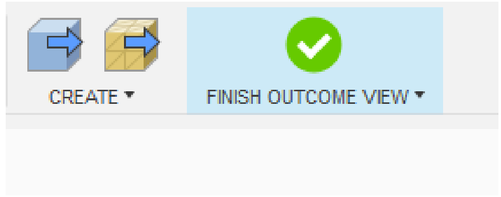
Table

Section Break



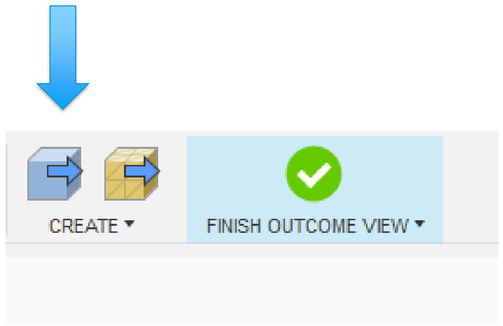
Downloading the file, we want to use

Once you have made your decision on which one is write for you, you can download the file in one of two options Solid or Mesh.



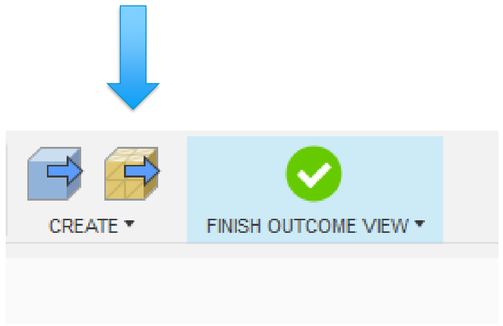
Integrate back into the base

Once you've generated a result that you're satisfied with, export it as a BRep/TSpline and place it back into the base model to inspect the context again. Begin thinking about next steps with regards to CAM, 3D printing, CAE validation, etc. Add in required features like machining operations or modify the TSpline as needed to achieve your contextual requirements.



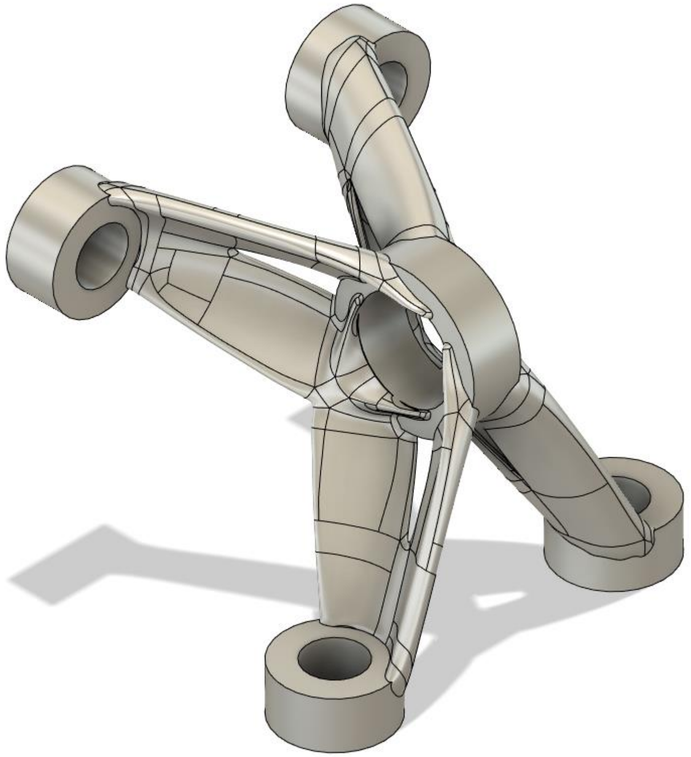
Solids Option

Creates an editable solid that can be modified using T-Splines or used in an Assembly.



Mesh Option

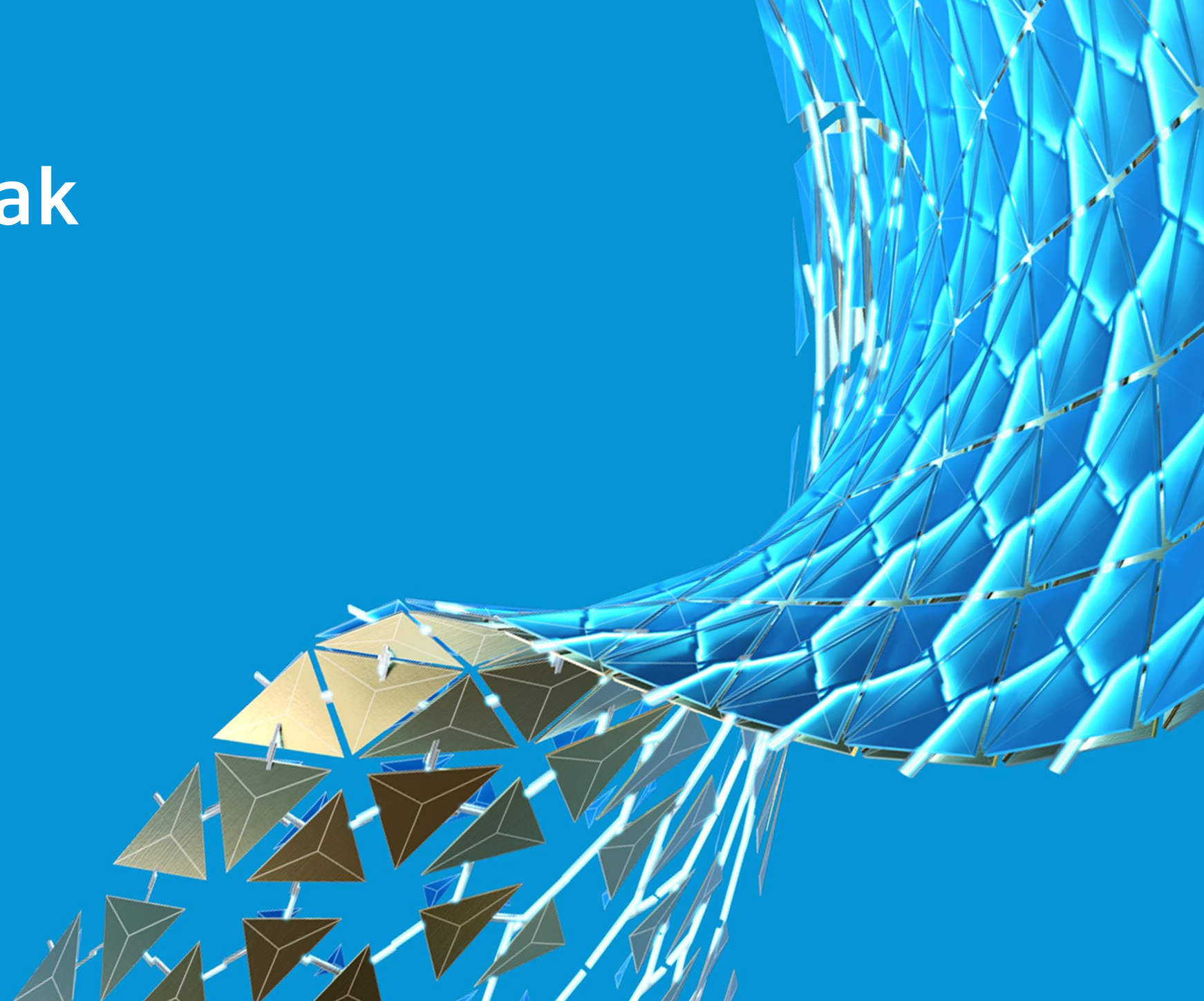
Creates a mesh-based file good for 3D Printing.



Take next steps

Take your final model out to CAM, CAE, 3D printing software, or whatever the next stage is for your design.

Section Break

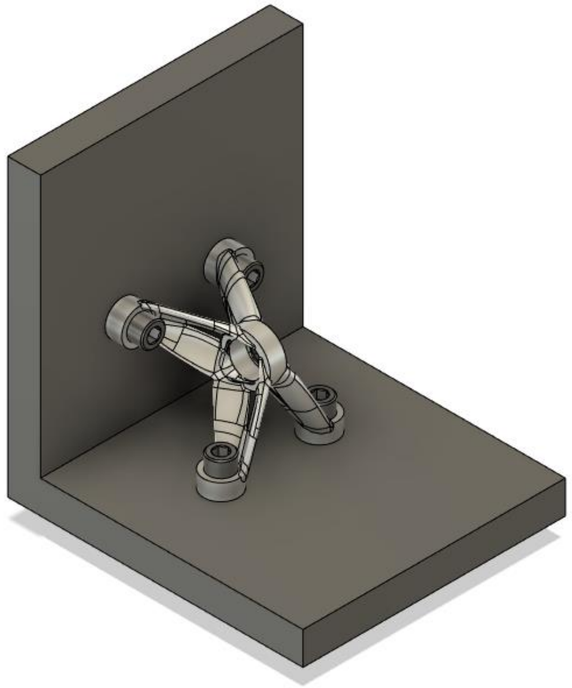


Modify and use the file in an Assembly

Now that you have your part downloaded lets see what we can do with them.

Modify the Part

Once you've generated a result that you're satisfied with, export it as a BRep/TSpline and place it back into the base model to inspect the context again. Begin thinking about next steps with regards to CAM, 3D printing, CAE validation, etc. Add in required features like machining operations or modify the TSpline as needed to achieve your contextual requirements.



Use in an Assembly

Since this comes in as a solid you can constrain this to other parts.

Section Break