

## APPLYING GENERATIVE DESIGN

HOW A NEW APPROACH  
CAN SIGNIFICANTLY  
IMPROVE PERFORMANCE,  
PRODUCTIVITY, AND COST

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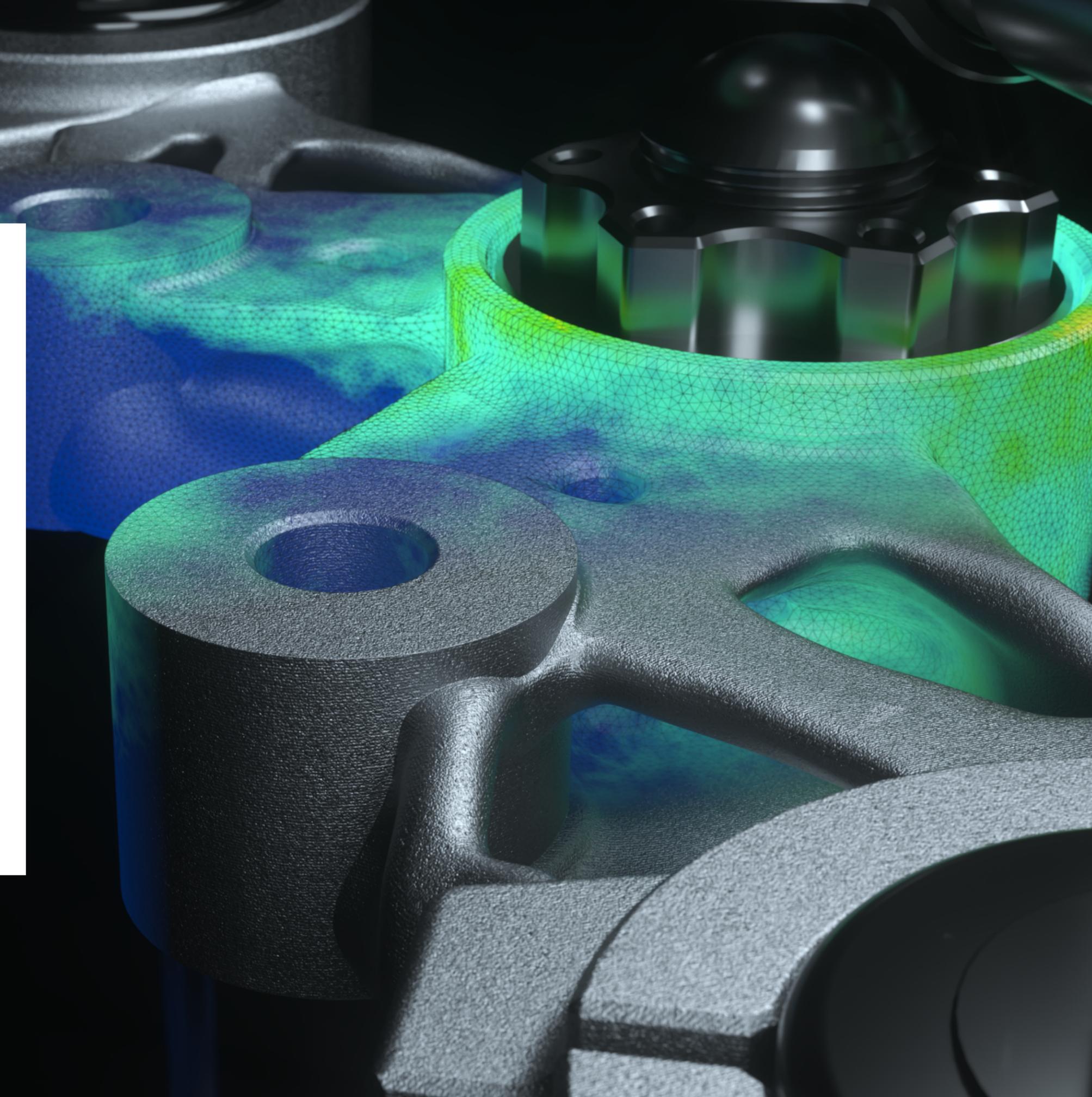
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## INTRODUCTION

# Why generative design is a fitting solution for today's most pressing engineering challenges

Engineers around the world face a seemingly impossible set of demands: make smarter, better, less expensive products in less time. What this really means is that engineers must always be cognizant of three challenges:

- 1 Striking the right balance between performance and cost
- 2 Maximizing innovation within a limited schedule
- 3 Optimizing the capabilities of engineers with varying expertise

“Because generative design takes manufacturing and performance requirements into account early in the development process, it can help bring new products to market faster”

Generative design is a relatively new approach that is helping engineers overcome all three of these challenges simultaneously. Generative design uses the power of artificial intelligence (AI) to rapidly iterate design options based on a specific set of parameters. In the simplest terms, the designer or engineer sets thresholds for part strength, geometry, material, or even manufacturing technique, and the generative design solution produces more options than any one engineer could ever hope to produce in a very short amount of time.

Because generative design takes manufacturing and performance requirements into account early in the development process, it can help bring

new products to market faster. Traditional design can explore only a limited number of unverified concepts, and it requires several rounds of iteration as each concept is modified to meet various performance, manufacturability, and cost standards. In contrast, generative design only explores viable designs, which means engineers can devote less time to verification and iteration and more time to selection and refinement.

This makes generative design a very powerful tool for improving performance, increasing productivity, and reducing product cost – all on a relatively quick schedule that improves time to market. In this ebook, we will examine how generative design achieves these objectives.

**WHY USE GENERATIVE DESIGN?**

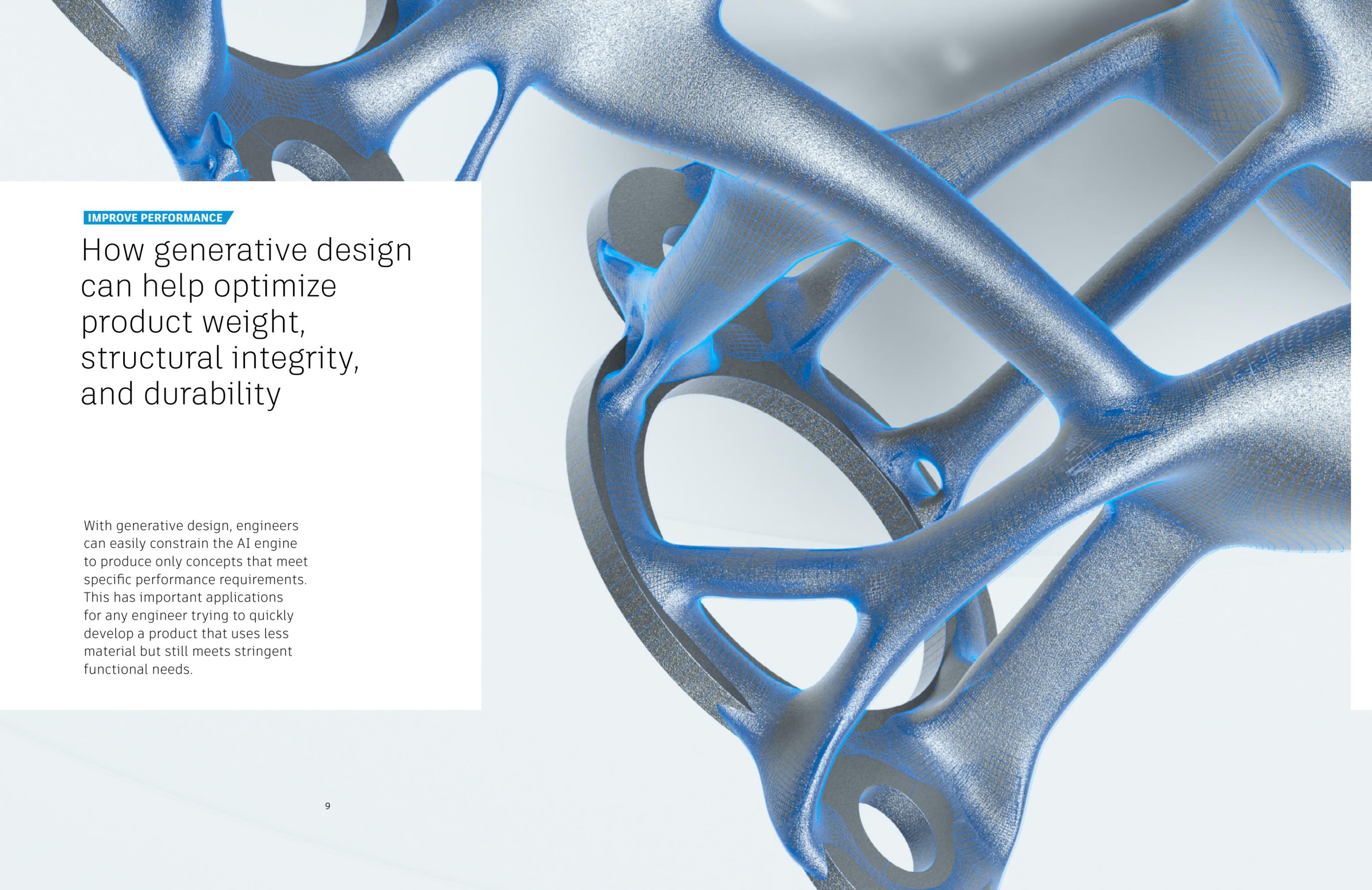
- Improve product performance**
  - Light weighting
  - Increased structural integrity
  - Extended durability
- Increase productivity**
  - Explore more design alternatives
  - Expand beyond human imagination
  - Save engineering time
- Reduce product cost**
  - Part consolidation
  - Reduced raw materials
  - Different manufacturing methods

**WIN MORE BUSINESS**

**IMPROVE TIME TO MARKET**

**IMPROVE PROFIT MARGINS**





**IMPROVE PERFORMANCE**

How generative design can help optimize product weight, structural integrity, and durability

With generative design, engineers can easily constrain the AI engine to produce only concepts that meet specific performance requirements. This has important applications for any engineer trying to quickly develop a product that uses less material but still meets stringent functional needs.



Image courtesy of ADDIT-ION

## 1 Lightweighting

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“Lightweighting” can dramatically reduce fuel efficiency in automotive and aerospace vehicles as well as make other products less expensive to produce. By restricting strength and durability but not material selection or mass, engineers can use generative design to explore and evaluate ideas that weigh less. This may happen by finding unique combinations of materials and manufacturing options (such as additive manufacturing), through part consolidation, or a unique geometry.

## 2 Structural Integrity

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Generative design can identify potential points of vulnerability and improve structural integrity. In this instance engineers would restrict

the design’s natural frequencies, displacements, or safety factor on stresses so they stay within allowable tolerances. The AI engine would then produce a range of design options that can be evaluated with respect to the structural integrity-to-cost ratio.

## 3 Durability

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Generative design can be used to optimize and extend product durability as well, by restricting the stress safety factor for multiple load cases. Engineers can establish the limiting safety factor based on desired fatigue life so that the AI engine produces a wide variety of options that meet or exceed the expected life span of the product – so teams can identify the best ones much more rapidly.

**CUSTOMER SPOTLIGHT**  
CLAUDIUS PETERS  
**BUSINESS  
IMPACT**

**256 LBS**  
REDUCED WEIGHT PER UNIT

Small assembly

**16 UNITS**  
**4,096 LBS (2 TONS) REDUCED**

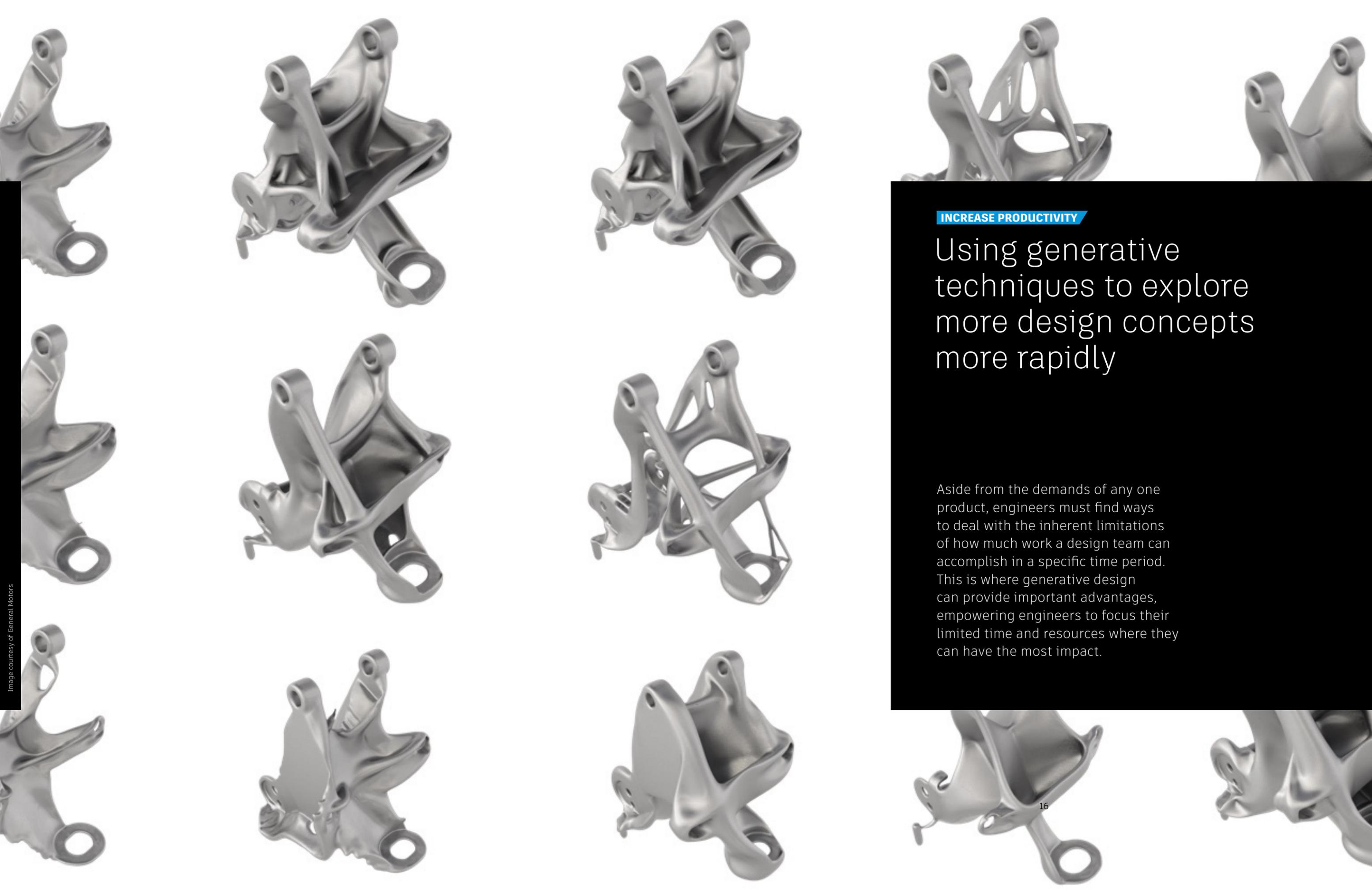
**7 ASSEMBLIES PER YEAR =**  
**28,672 LBS (14.3 TONS) REDUCED**

Large assembly

**65 UNITS**  
**16,640 LBS (8.3 TONS) REDUCED**

**7 ASSEMBLIES PER YEAR =**  
**116,480 LBS (58.2 TONS) REDUCED**





**INCREASE PRODUCTIVITY**

Using generative techniques to explore more design concepts more rapidly

Aside from the demands of any one product, engineers must find ways to deal with the inherent limitations of how much work a design team can accomplish in a specific time period. This is where generative design can provide important advantages, empowering engineers to focus their limited time and resources where they can have the most impact.

## 1 More Alternatives

One way that generative design transforms the efficiency of product development is through sheer numbers. Most platforms, including Autodesk Fusion 360, are capable of producing many more design options than would be humanly possible. This allows engineers to order, filter, and categorize the options in a variety of ways to compare tradeoffs in material, performance, and manufacturing methods. Ultimately, this streamlines the process considerably, allowing designers to quickly narrow down selections and focus on viable alternatives that conform to available materials or manufacturing capabilities.

## 2 Unique Choices

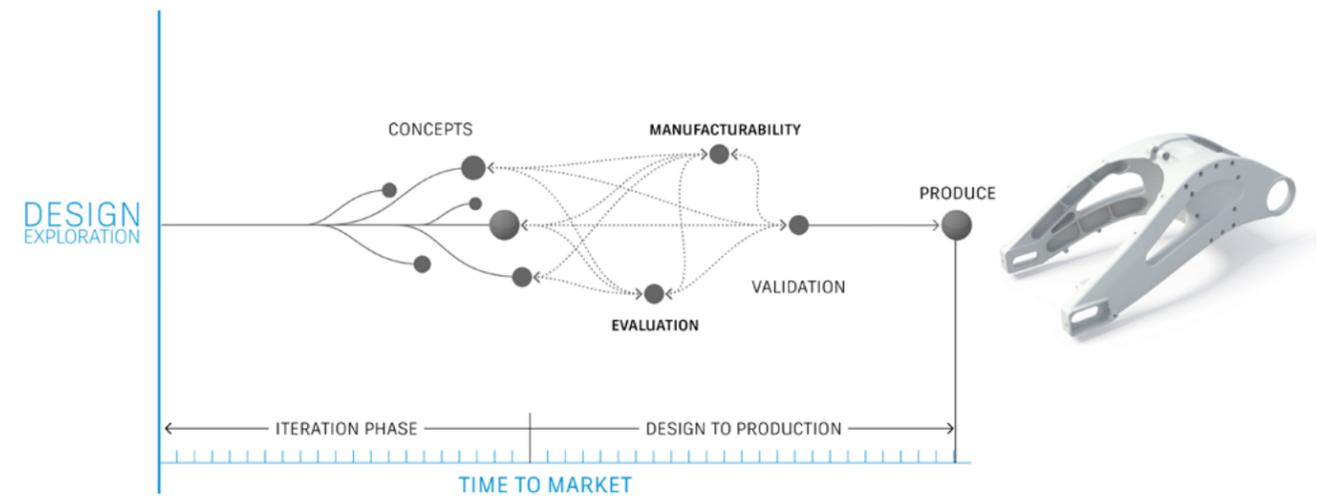
Powered by AI and machine learning, generative design platforms can mimic nature's evolutionary approach to design, producing options that extend

beyond the boundaries of human imagination. Instead of starting from an established design, drawing, or CAD file, generative design tools work from established parameters. Freed from preconceived notions of what the product is "supposed" to look like, generative design can develop unique solutions and part geometries—all of which will be manufacturable. These ideas may inspire engineers to solve familiar problems in surprising ways.

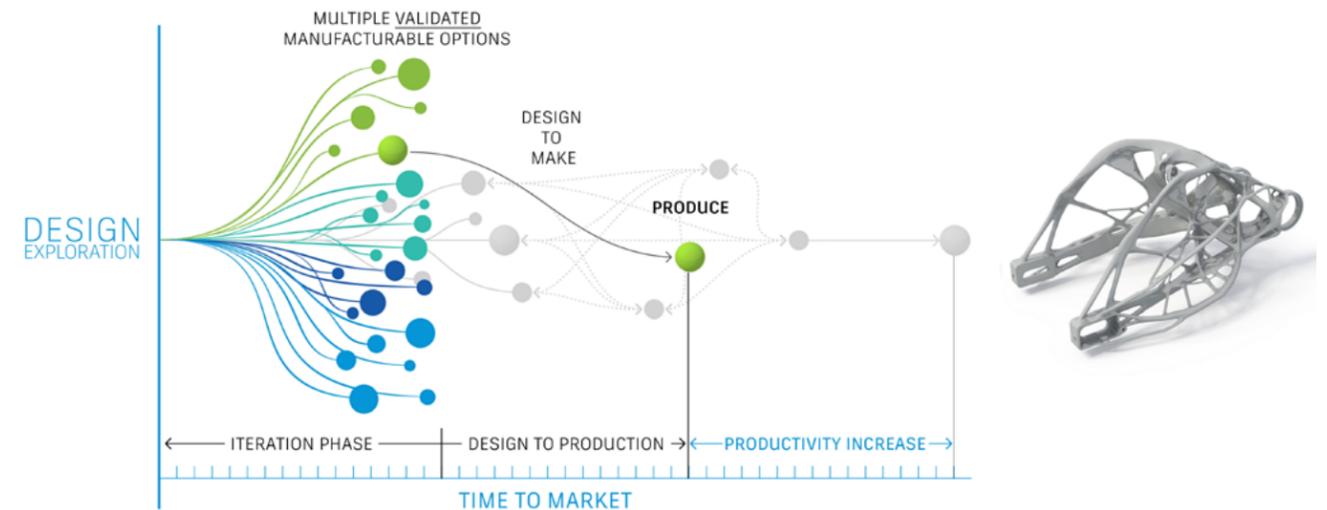
## 3 Less Time

Because generative design options already take manufacturing into account, they put engineers ahead of the game when timetables are tight. Teams can explore more options in less time, select the most promising ideas, and refine them without the normal rounds of verification. With Fusion 360, for example, you can produce CAD-ready editable geometry that is immediately editable or exportable to the CAD software of your choice.

### TRADITIONAL DESIGN



### GENERATIVE DESIGN



## CUSTOMER SPOTLIGHT

MATSUURA

# BUSINESS IMPACT

### WEEKS TO HOURS

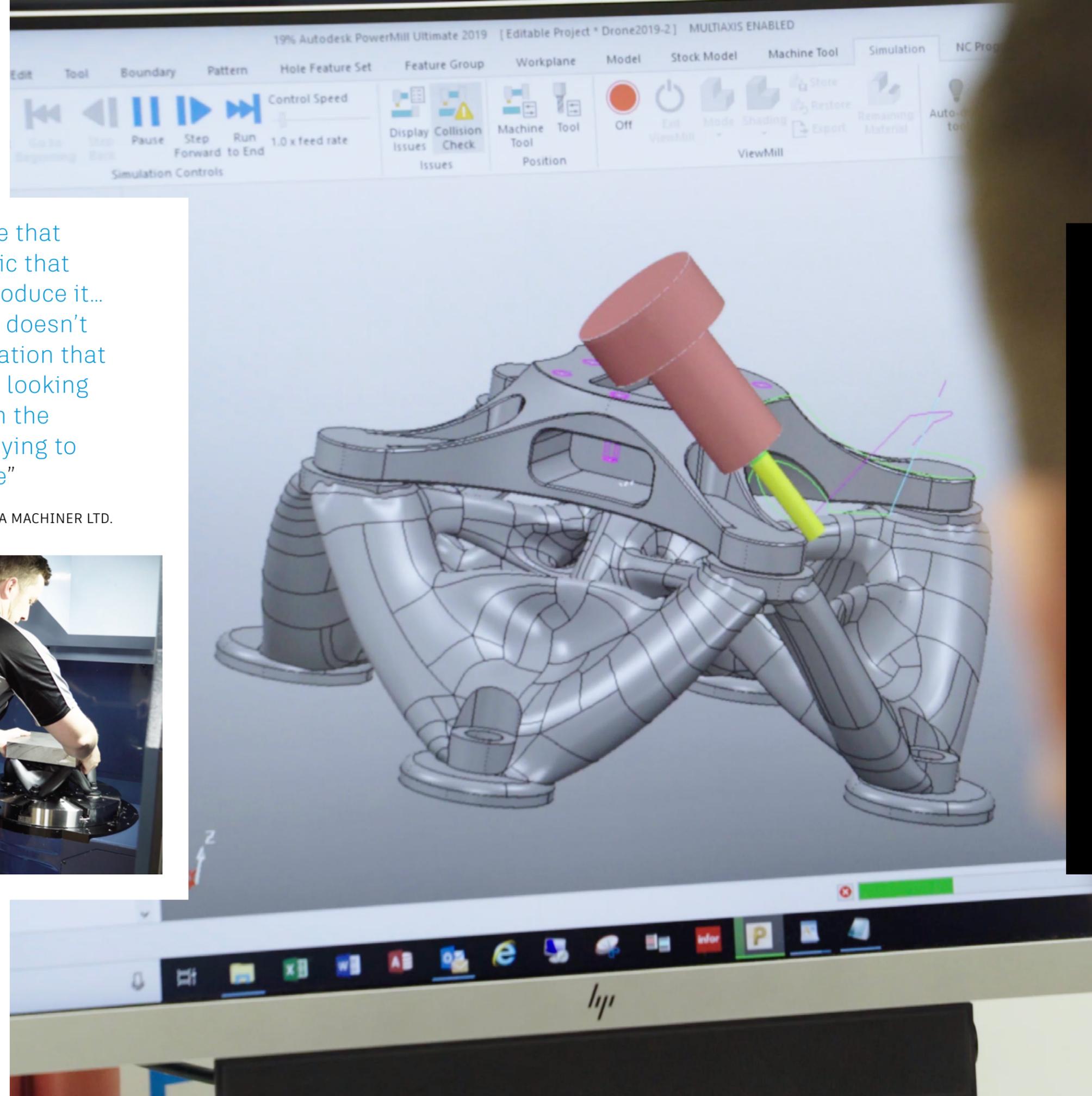
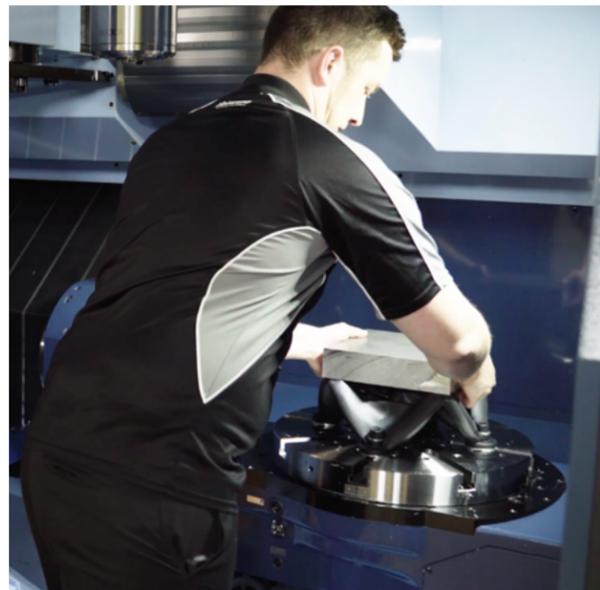
Before getting to the stage of cutting metal on a machine, Matsuura had to figure out how to hold the work piece during the machining process

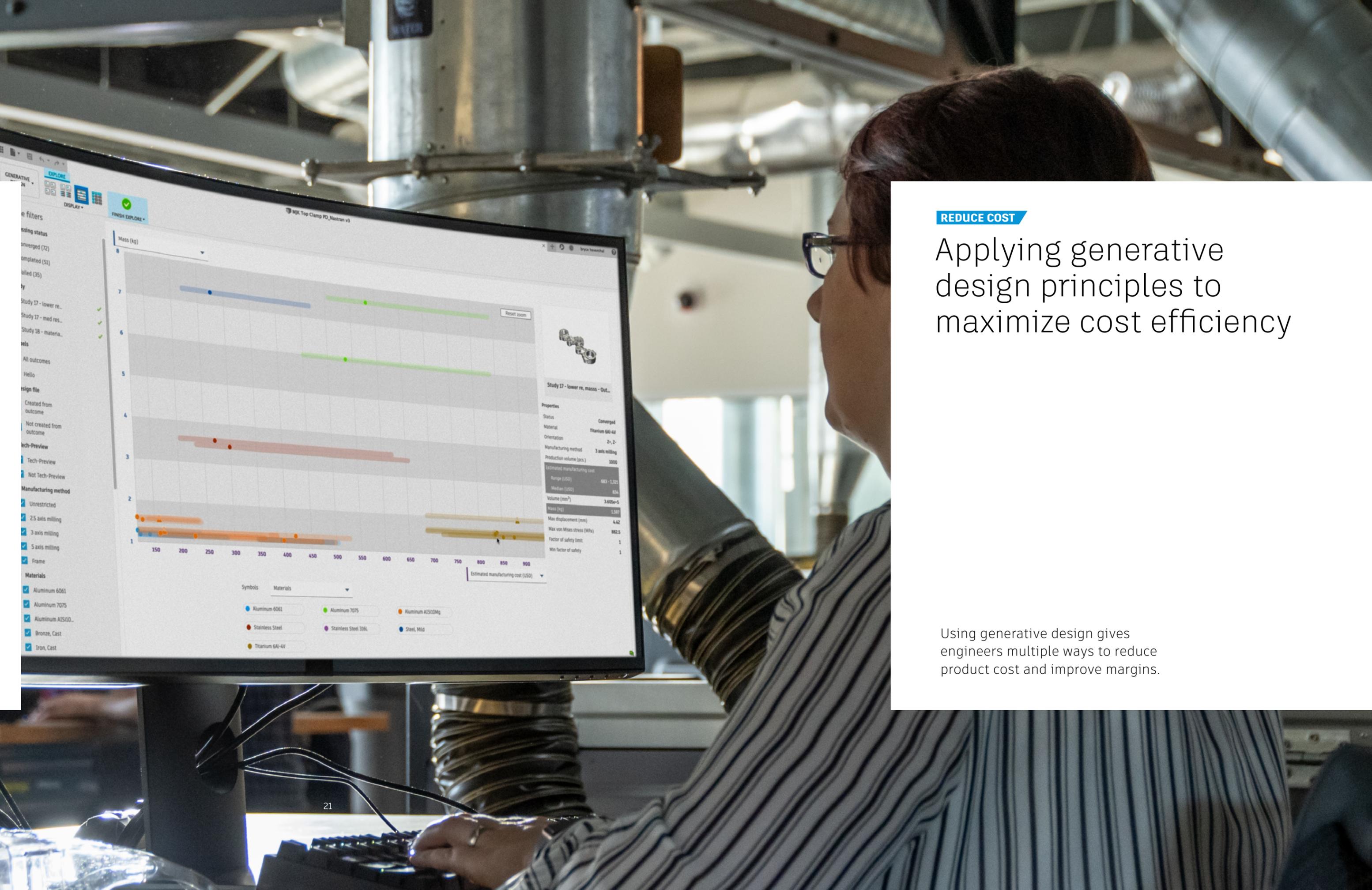
Using the generative design technology in Fusion 360 Matsuura was able to produce hundreds of light optimal options for the work holding.

They were able to go from concept to manufacturing in one package using Fusion 360.

“We got a fixture that looks so organic that you couldn’t produce it... But Fusion 360 doesn’t have that limitation that you have when looking at a drawing on the screen while trying to design a fixture”

PETER HARRIS MATSUURA MACHINER LTD.

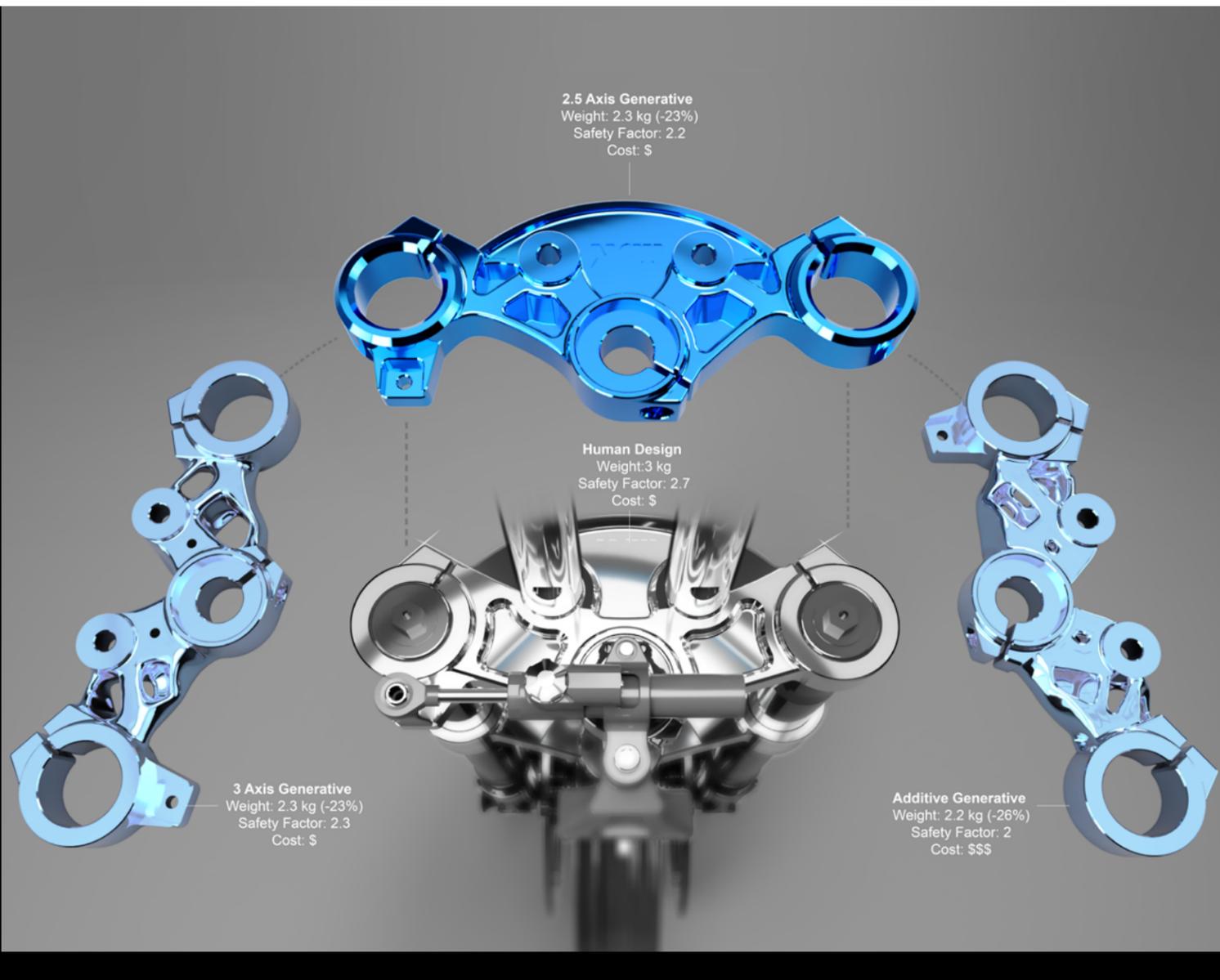




**REDUCE COST**

Applying generative design principles to maximize cost efficiency

Using generative design gives engineers multiple ways to reduce product cost and improve margins.



# 1 Consolidate Parts

The unexpected design options generated with these platforms often create opportunities to consolidate multiple components into a single, solid part. This allows teams to not only explore the potential of additive manufacturing, but it also allows teams to simplify complex supply chains as well as reduce the number of potential vulnerabilities or points of failure in the entire product.

# 2 Reduce Materials

Lightweighting, part consolidation, and other design improvements allow generative design users to minimize the mass of each part and use less raw material. Generative design may also allow teams to explore using less expensive

materials. Either way, engineers can be confident that the resulting design options will conform to performance standards and manufacturing constraints.

# 3 Compare Methods

The way a product is manufactured can have a significant impact on its cost. Traditional design makes it very time-consuming to explore all of the scenarios for producing a part with different methods, including additive and hybrid manufacturing. Generative design speeds up this process, creating viable alternatives that can be constrained to a particular method. In Fusion 360, these options are also paired with production volume-based cost insights, so teams can quickly see which method may yield the best overall result.

**CUSTOMER SPOTLIGHT**  
GENERAL MOTORS  
**BUSINESS  
IMPACT**

**8**  
COMPONENTS TO ONE PART

3D PRINTED SEAT BRACKET:

**40%**  
LIGHTER

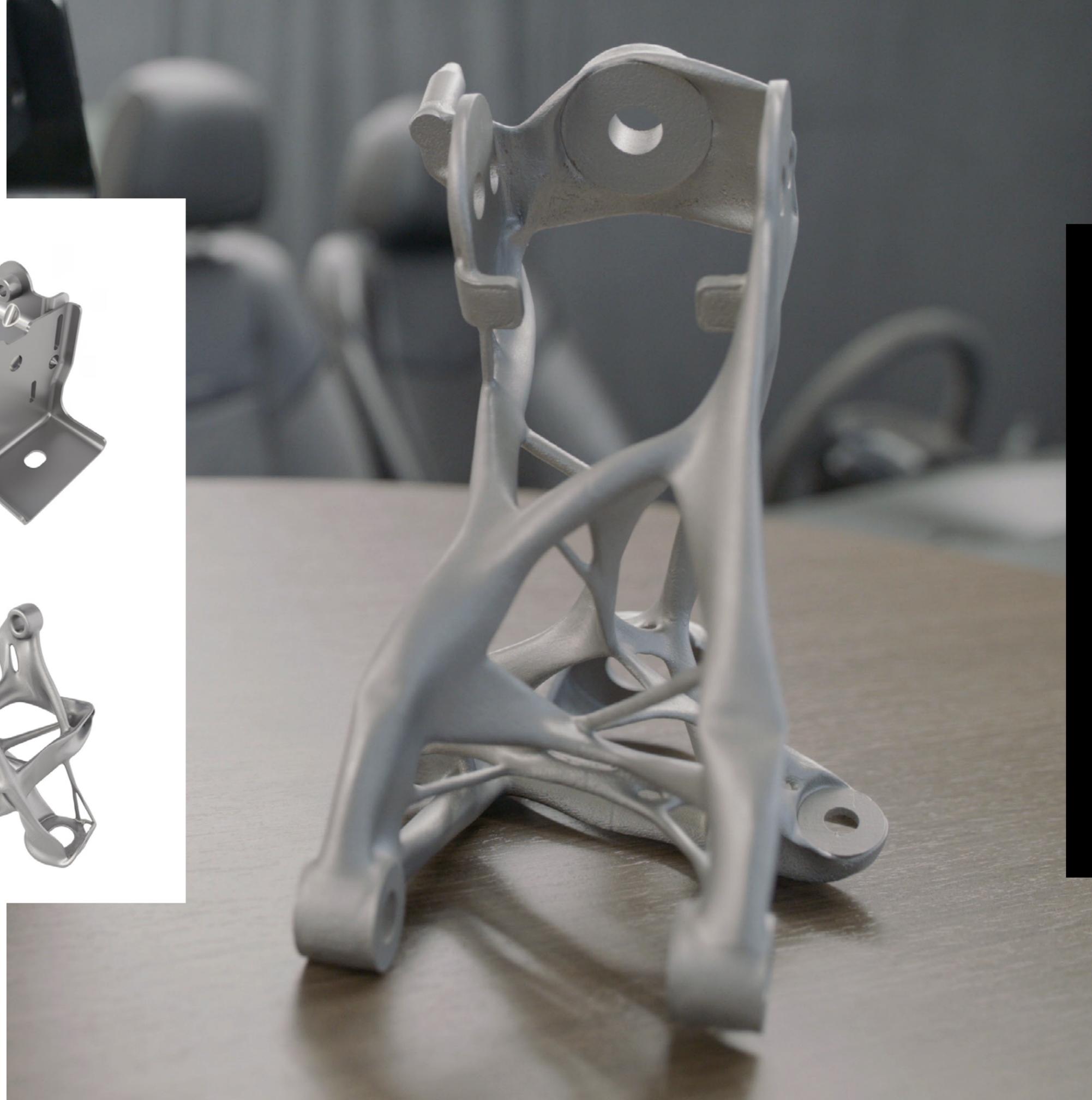
**20%**  
STRONGER

IDENTIFYING NEW DESIGN  
SOLUTIONS THAT WOULD BE  
OTHERWISE IMPOSSIBLE FOR  
ENGINEERS TO IMAGINE

OLD PART  
8 COMPONENTS



NEW PART  
1 PART  
40% LIGHTER  
20% STRONGER





**CONCLUSION**

## Steps manufacturers can take to get started with generative design

Getting started with generative design is easier than you might think. The best place to start is with your specific design objectives:

### **Improve performance**

Investigate improvements in strength or durability with a well-known product to see what generative design can do. Or choose a problematic one to see if generative design can find a better solution.

### **Increase productivity**

Get a sense of how many options generative design can produce by using parameters from a recently completed project, a particularly challenging project, or a new project.

### **Reduce costs**

Explore potential cost reductions by allowing generative design to iterate on a completed design with well-understood costs. You can also try a project with the potential for part consolidation or one that can be manufactured with a variety of methods.

### **Start today**

Autodesk Fusion 360 offers a complete generative design platform. Get a **free 30-day trial** to produce more manufacturing-ready outcomes in less time.

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 **AUTODESK**. Make anything.