Lightweighting? Topology Optimization? Generative Design? WHERE DO I START?!

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INNOVATION FORGE

Generative Design & Topology Optimization Consultant

- Former Autodesk sales channel application engineer
- Former MSC sales channel application engineer
- Autodesk Pier 9 Resident
- Autodesk Expert Elite
- Autodesk Services Marketplace Provider
- Previous AU Speaker on Generative Design

AUTODESK Certified Professional

AUTODESK EXPERT ELITE

AUTODESK GENERATIVE DESIGN INTENSIVE RESIDENCY

AUTODESK Services Marketplace Provider

AUTODESK Authorized Developer

Learning Objectives

THE LANDSCAPE

Learn how to identify the current Autodesk offerings for lightweight design creation

THE DIFFERENCE

Understand the difference between topology optimization and Generative Design

THE RIGHT PROCESS

Learn how to select the appropriate optimization technique for various projects

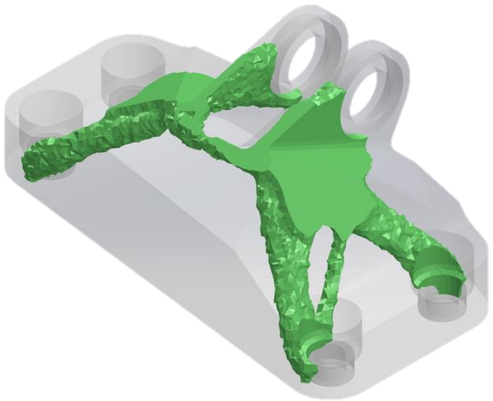
THE BOTTOM LINE

Discover non-design business drivers that can be impacted through optimized design

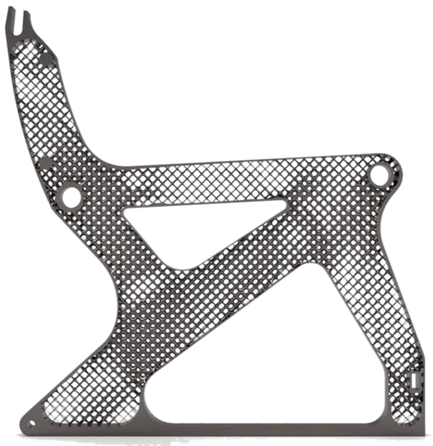
Clearing the Air

Some Confusion

Generative design means different things to different people.



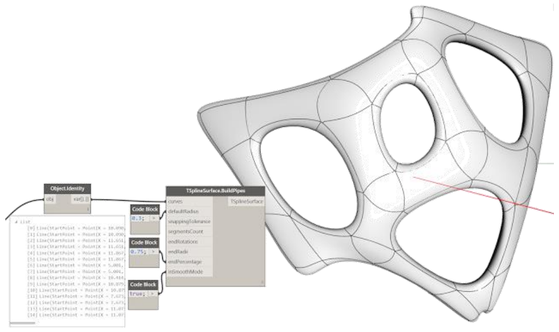
Topology Optimization



Lattice & Skin

Trabecular Structures

Computational Design

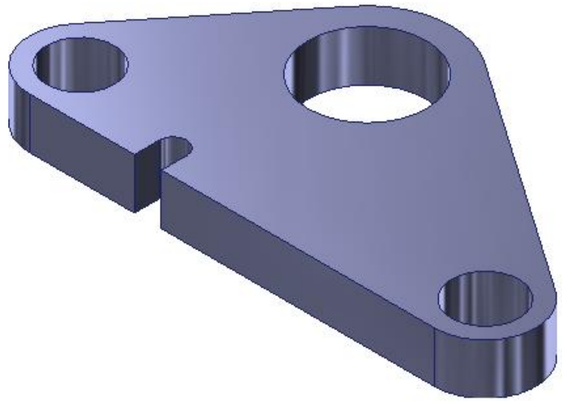


Topology Synthesis

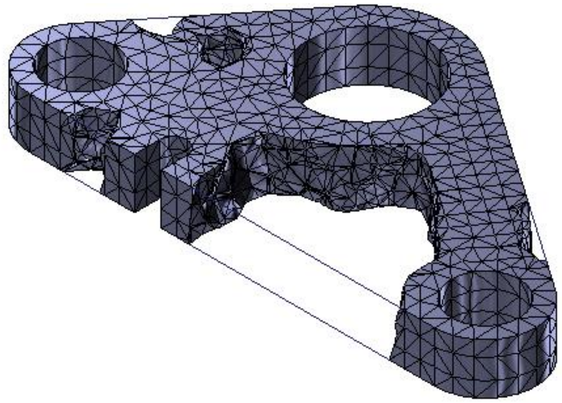
EARLY PROCESS

Computational Design

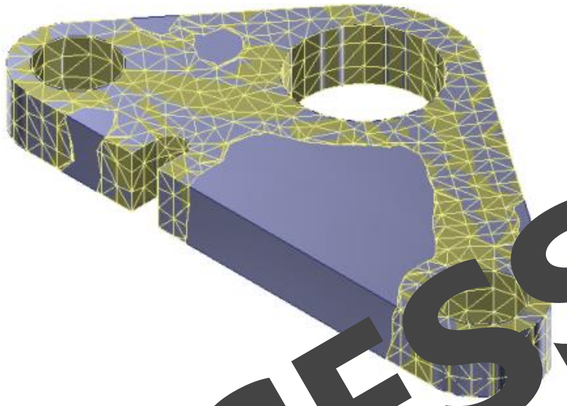
- Dynamo / Fractal
- 3DS Max (with scripting)
- Maya (with scripting)



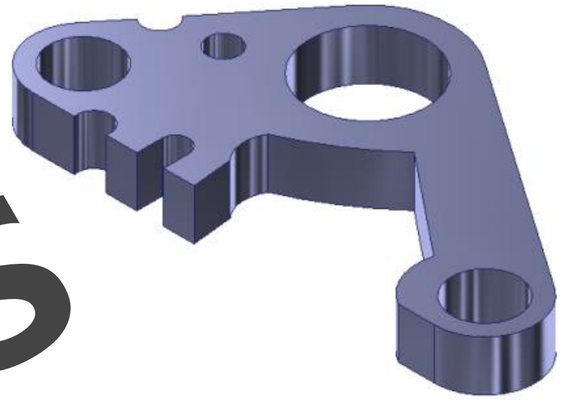
Original Model



3D Mesh model generated in Shape Generator



3D Mes mode promoted to t Part Mo eling

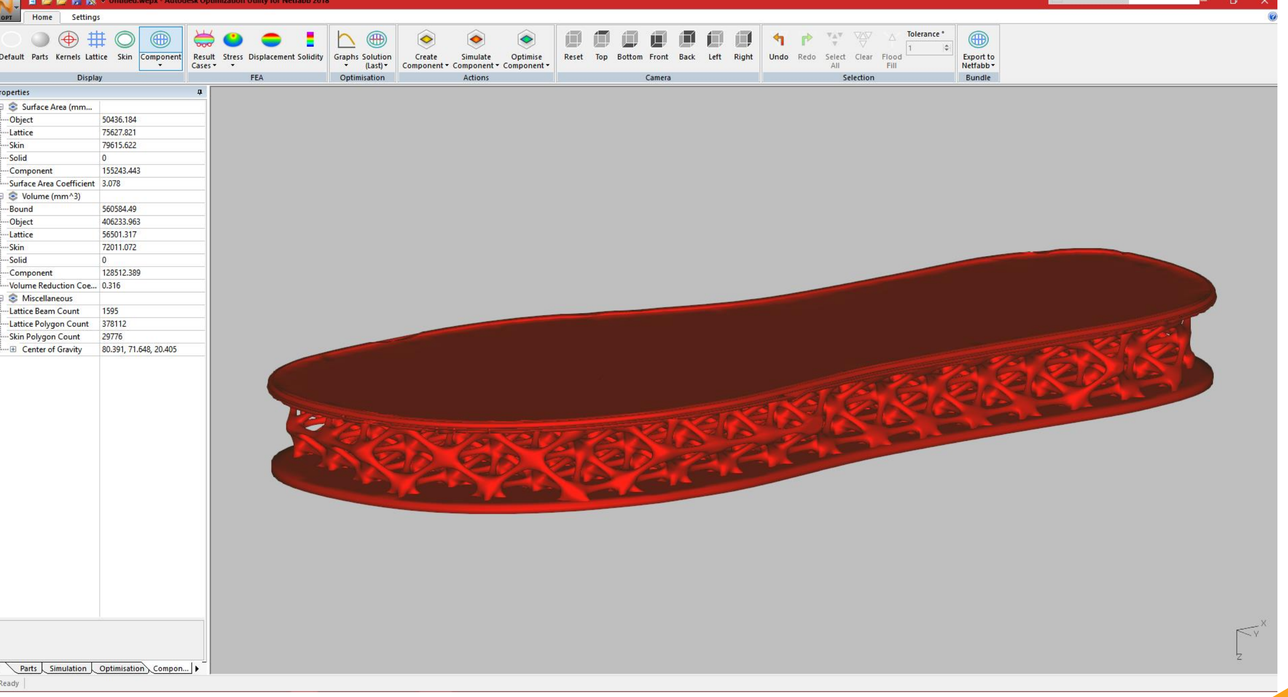


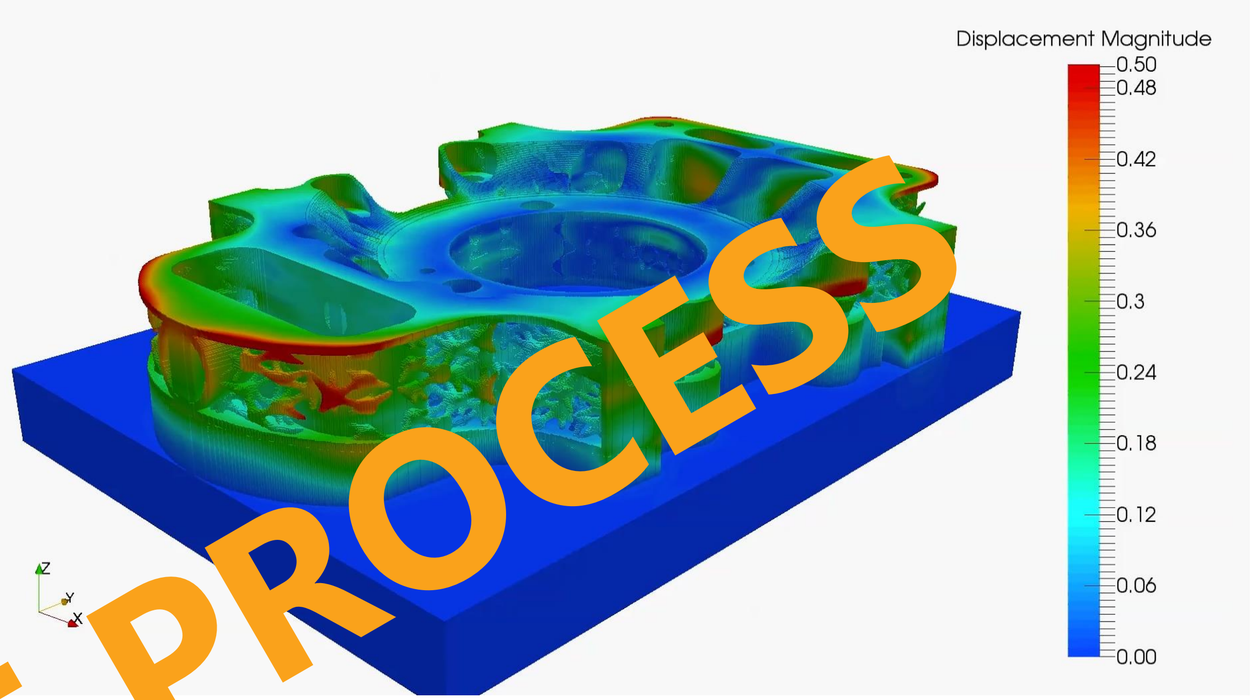
Final Model

LATE PROCESS

Topology Optimization

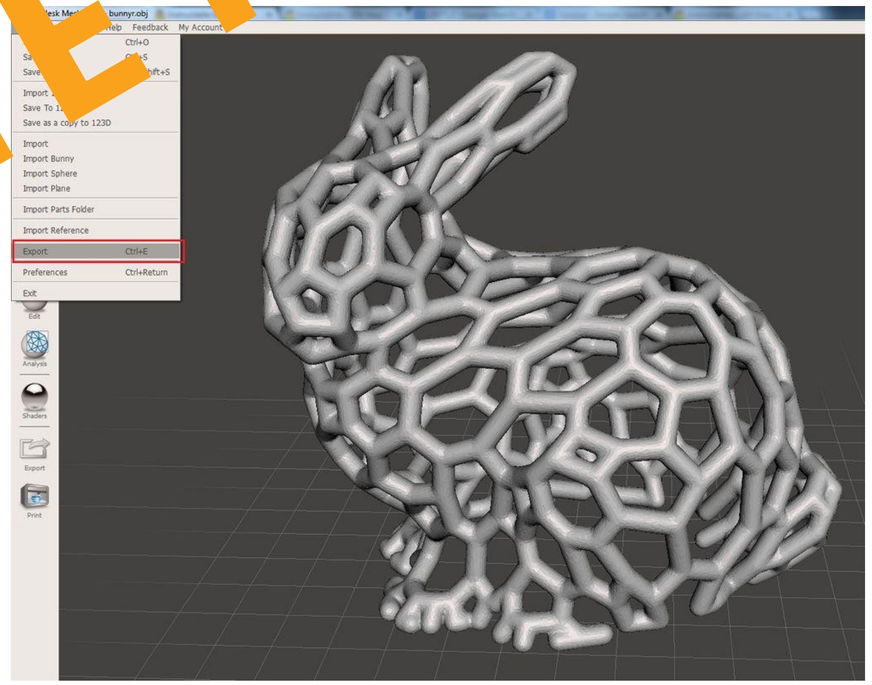
- Inventor Shape Generator
- Nastran In-CAD
- Fusion 360
- Netfabb





Lattice & Skin / Trabecular

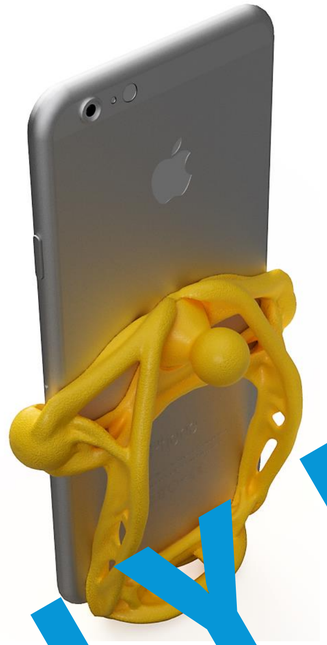
- Netfabb (intelligent)
- Within Medical (semi-intelligent)
- Meshmixer (dumb)

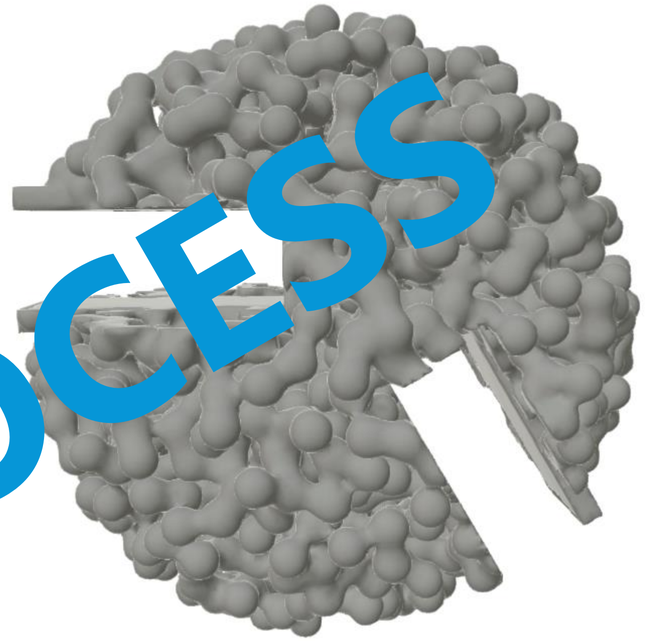


VERY LATE PROCESS

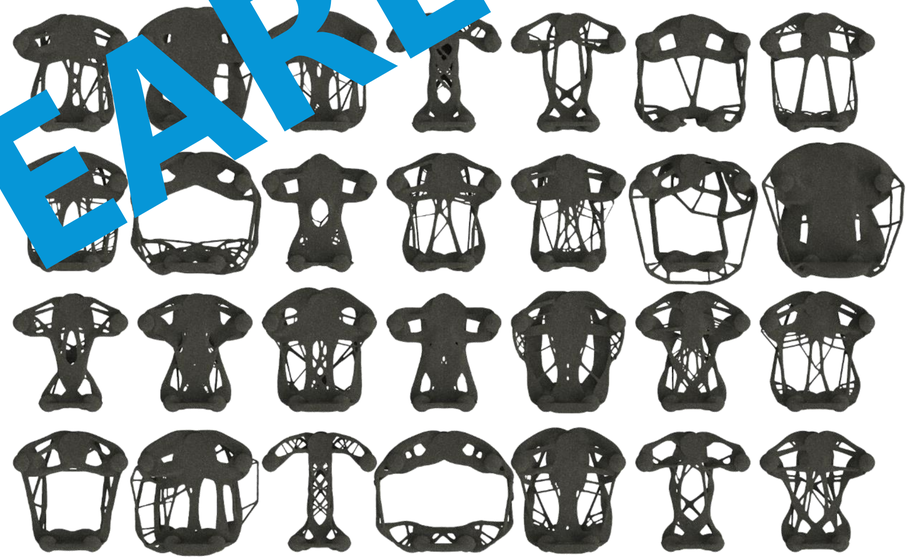
Topology Synthesis

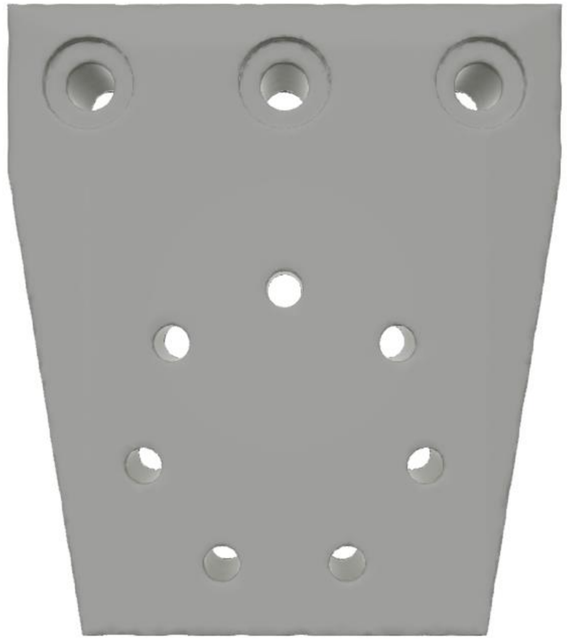
- Fusion 360

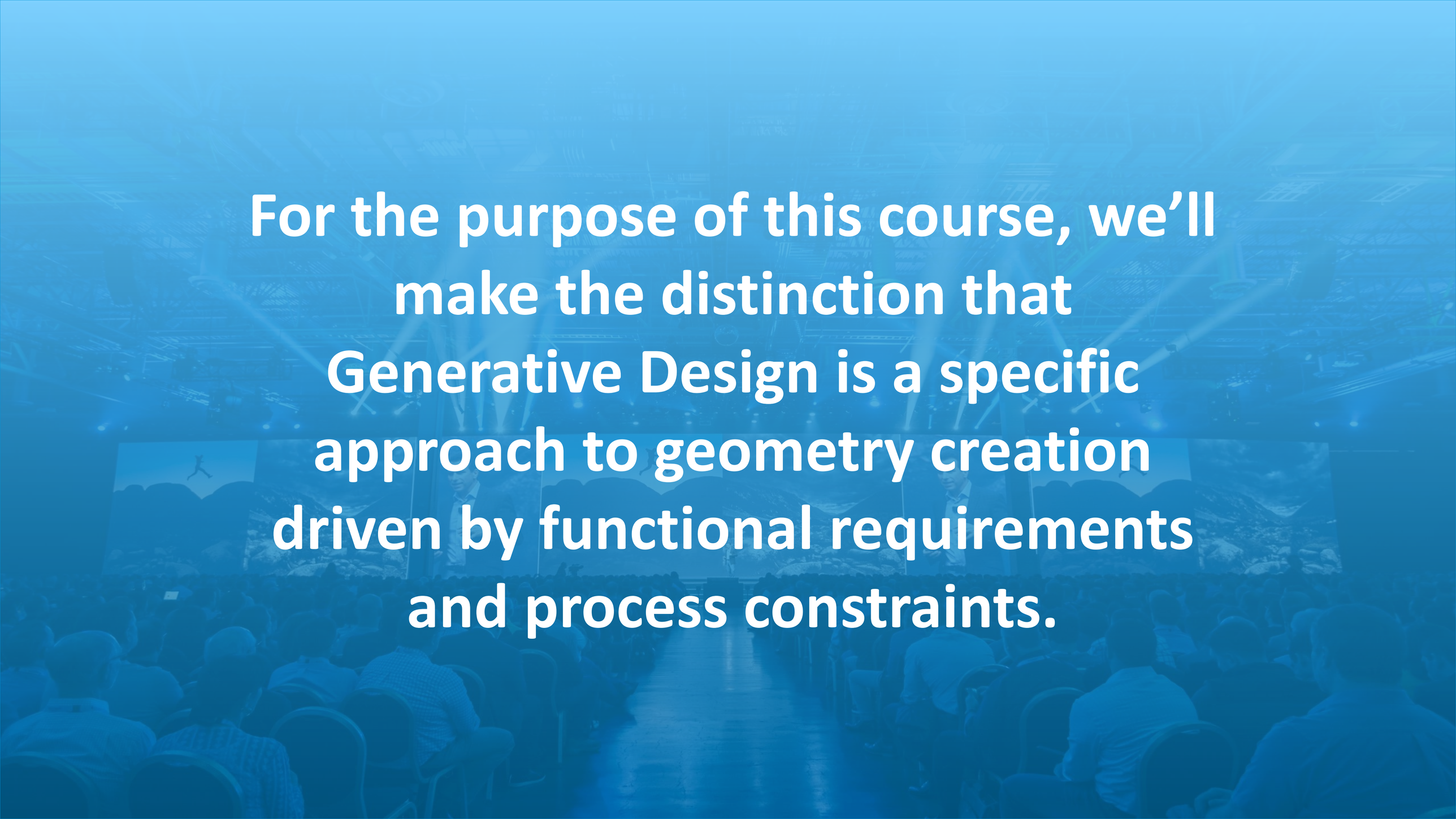


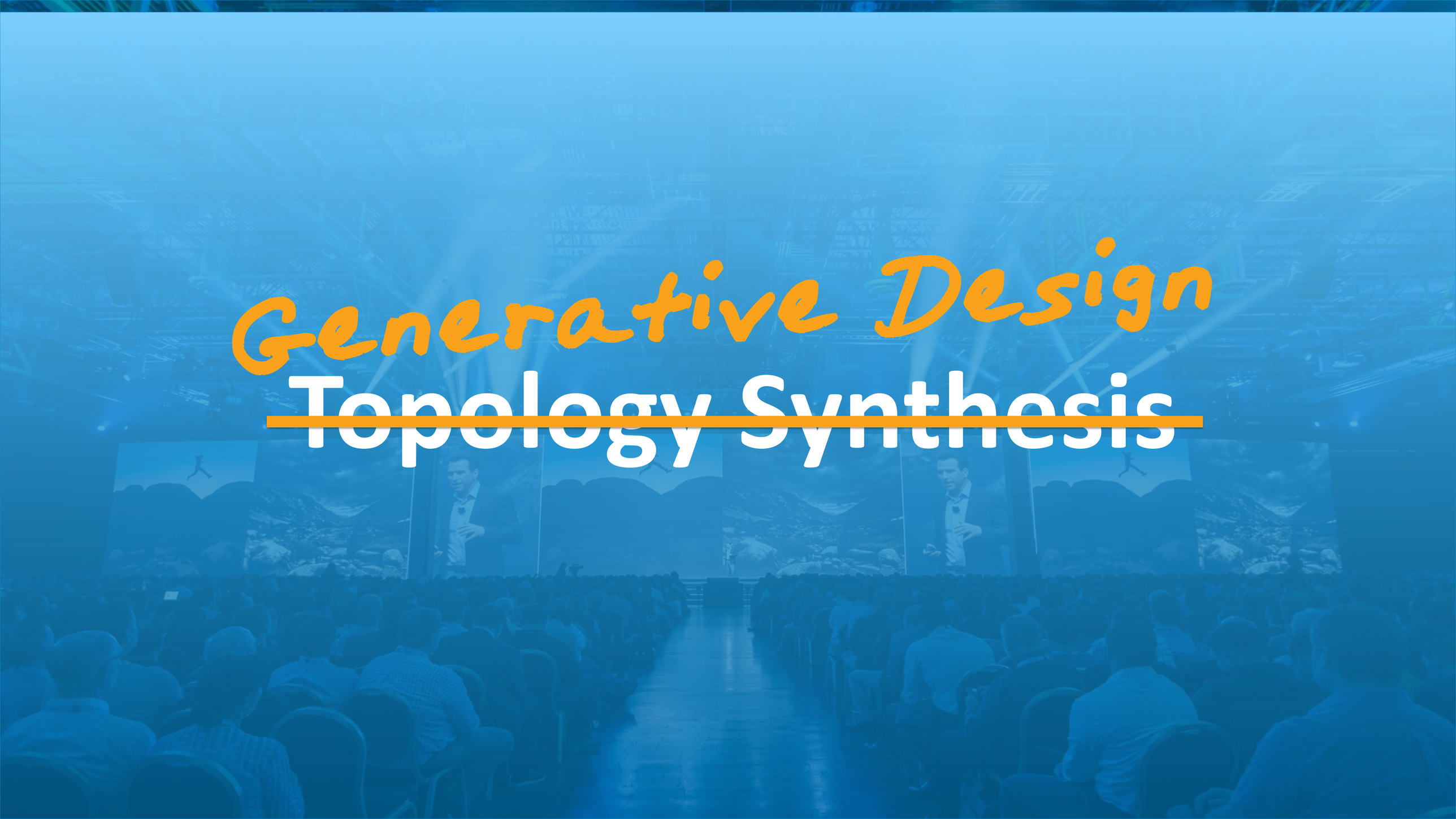


VERY EARLY PROCESS






For the purpose of this course, we'll
make the distinction that
Generative Design is a specific
approach to geometry creation
driven by functional requirements
and process constraints.


Generative Design
Topology Synthesis

Lightweighting

Approaches to Lightweighting

HUMAN BEST-GUESS (MANUAL MODELING / DUMB LATTICES / COMPUTATIONAL DESIGN)

Our engineering experience and intuition provides us with a framework to manually develop lightweight designs. This includes designing with pockets, thin sections, punching holes, added ribs, etc. Additionally, this process includes leveraging computational design to develop novel geometry.

BIASED

SINGLE DOMAIN OPTIMIZATION (TOPOLOGY OPTIMIZATION / LATTICE OPTIMIZATION)

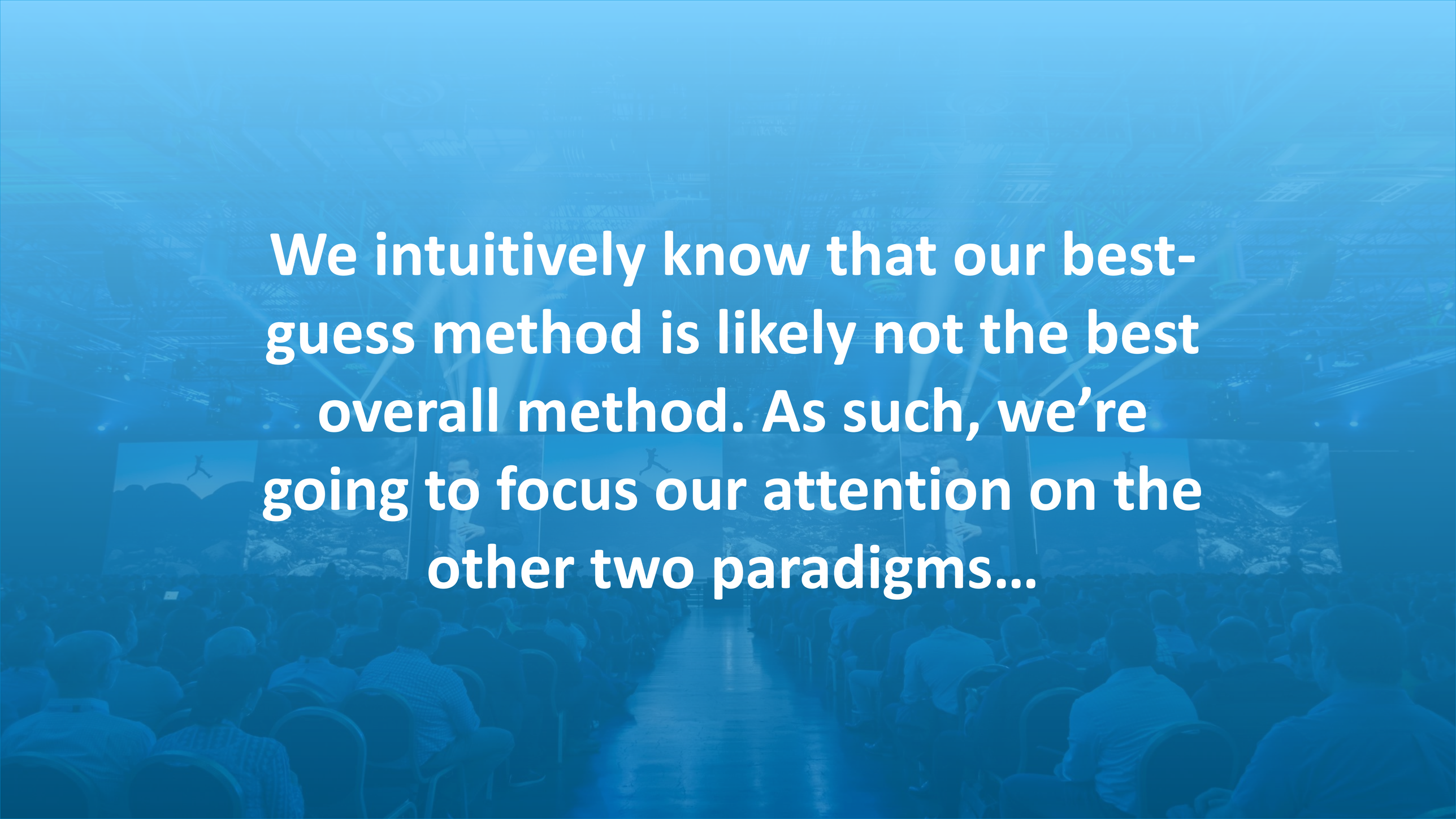
These techniques revolve around topology optimization and lattice structures. This is referred to as single domain because the objective is based upon a design space that is predefined and rigid.

BIASED

MULTI-DOMAIN OPTIMIZATION (GENERATIVE DESIGN)

This is Generative Design – an approach which considers multiple variables, design spaces, and process constraints to achieve rapid divergent design.

NOT BIASED



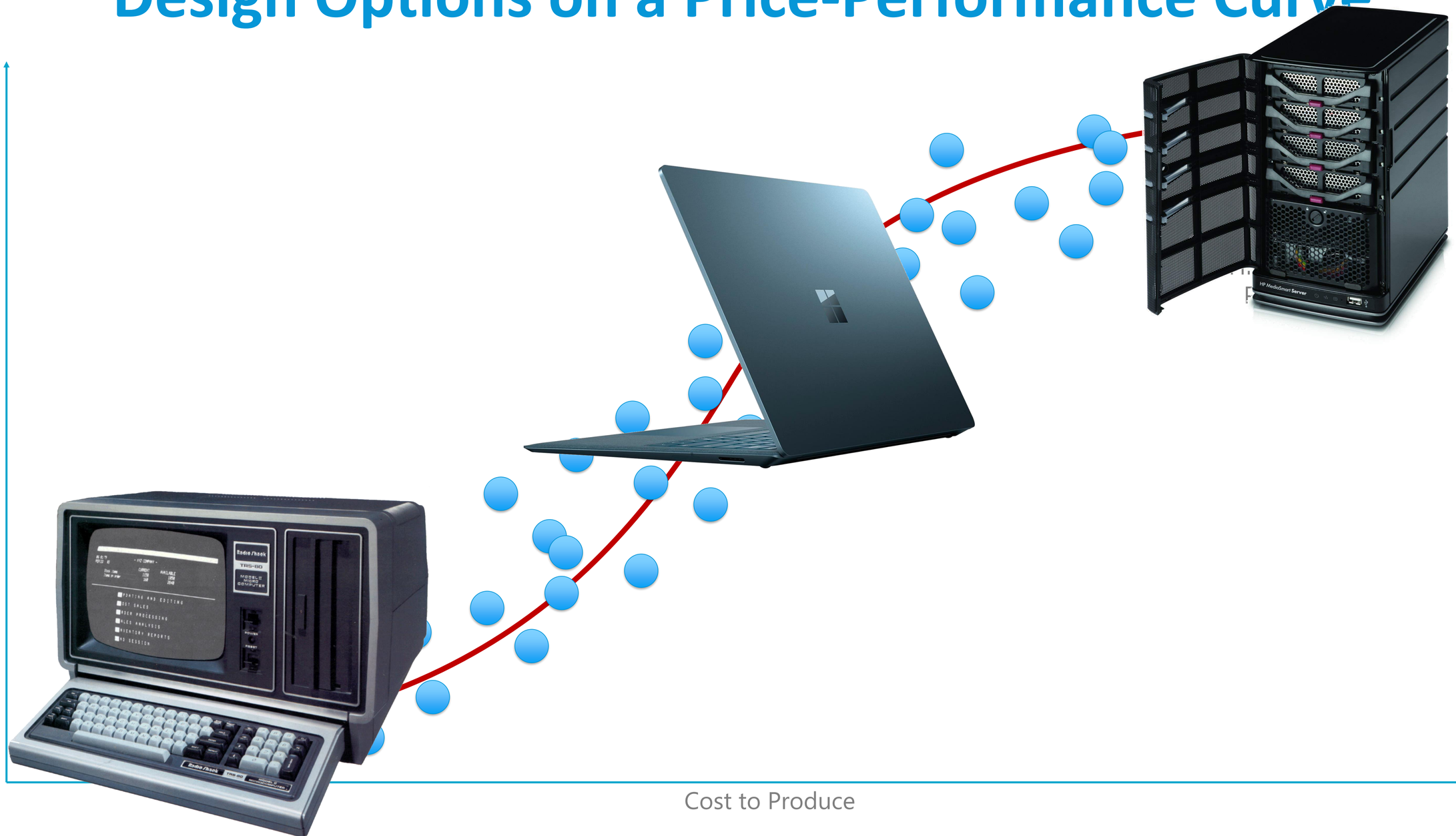
We intuitively know that our best-guess method is likely not the best overall method. As such, we're going to focus our attention on the other two paradigms…

Engineering Outcomes

The ultimate goal for any engineering activity is to strike the **right balance between performance and cost** to produce for a given design challenge or market opportunity.

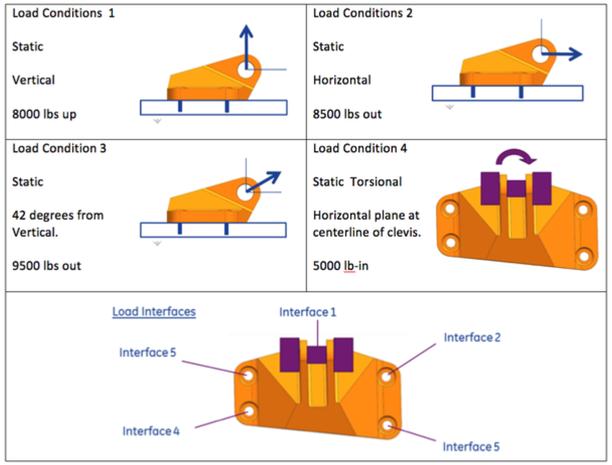
Engineers are limited in the time and energy they can spend on any design problem to fully explore the options that encompass the design space.

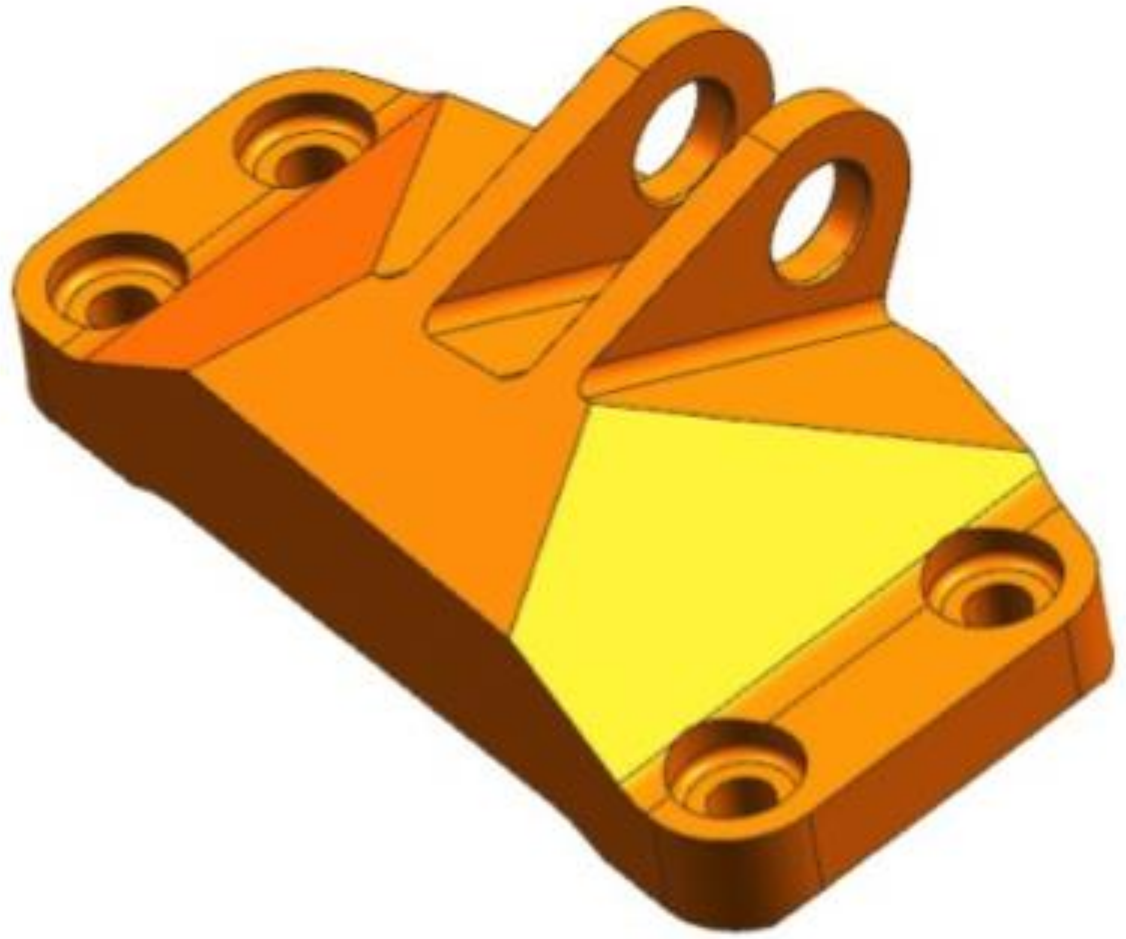
Design Options on a Price-Performance Curve



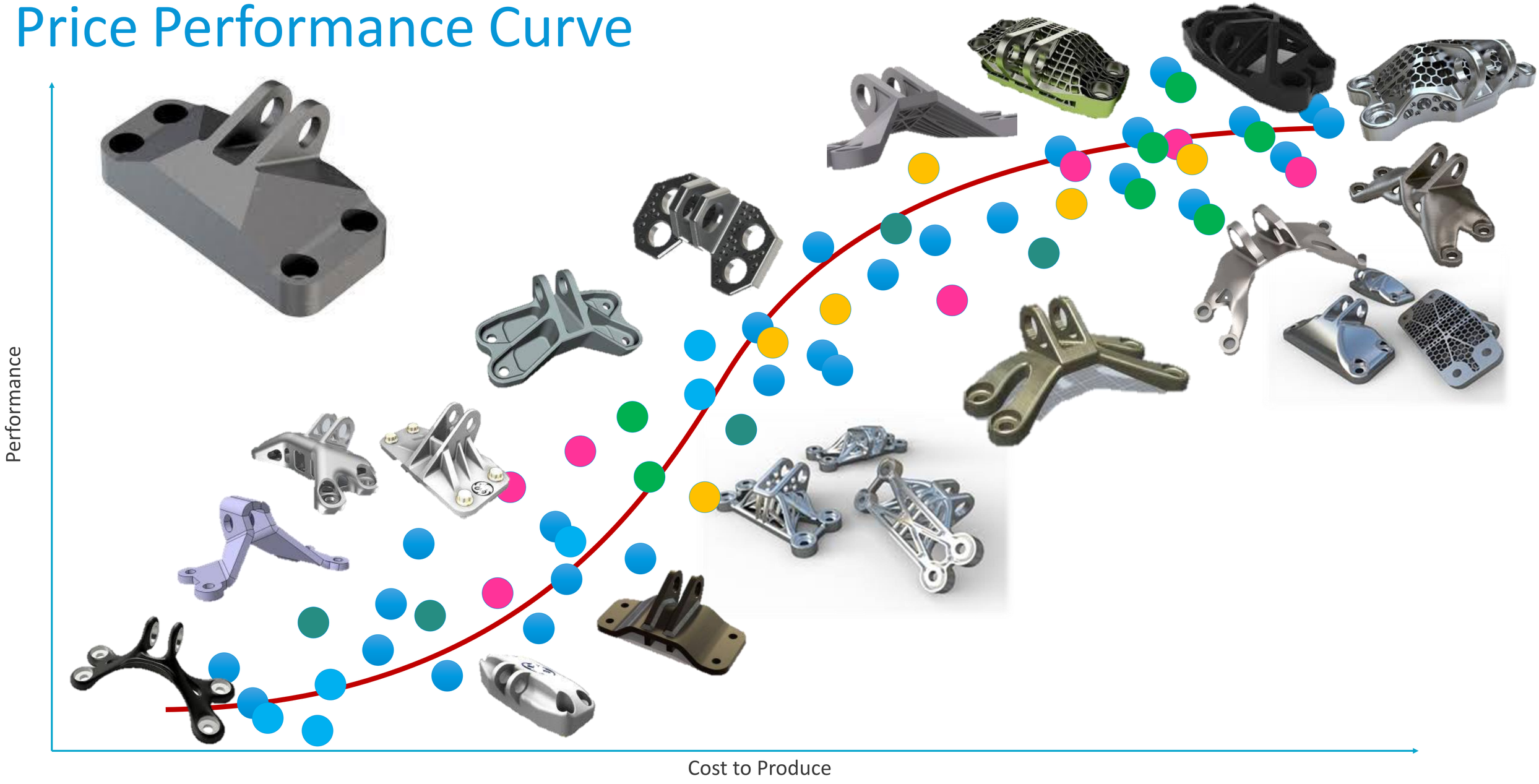
A Sample Design Problem

GrabCAD and GE Aerospace teamed up to host a design challenge to create a lightweight jet engine hoist bracket. The expected performance was well established, the manufacturing method well documented, and the criteria for success well understood.





Price Performance Curve



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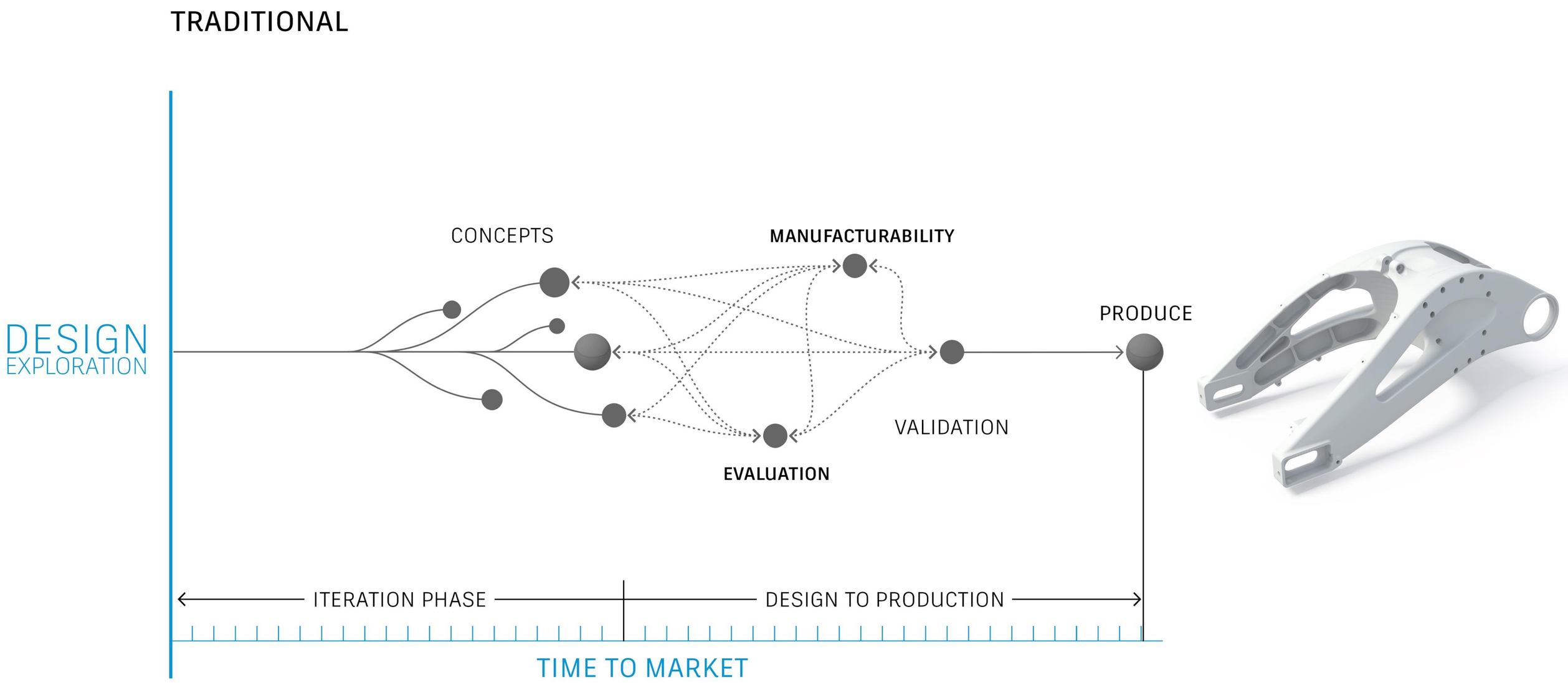
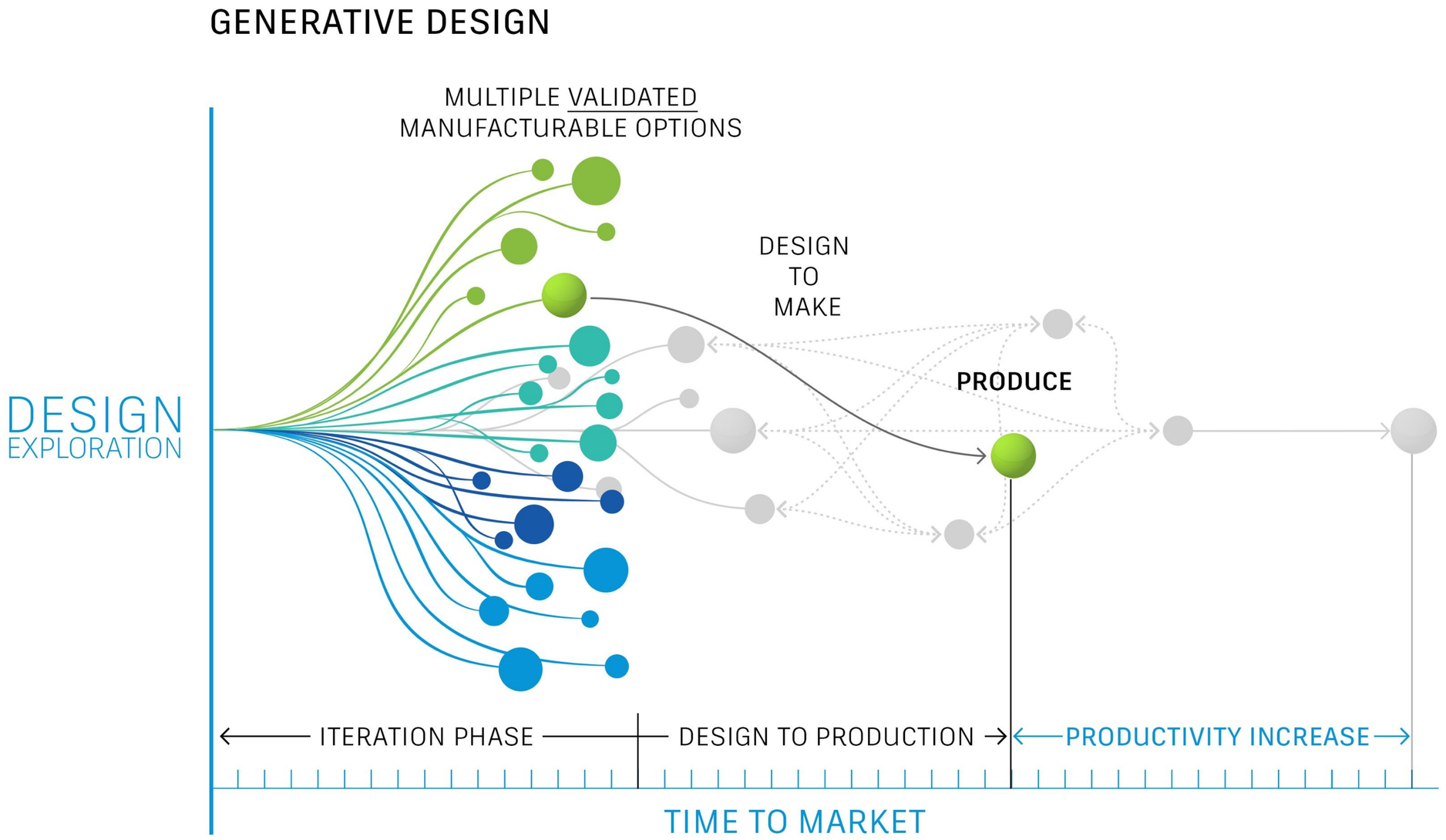
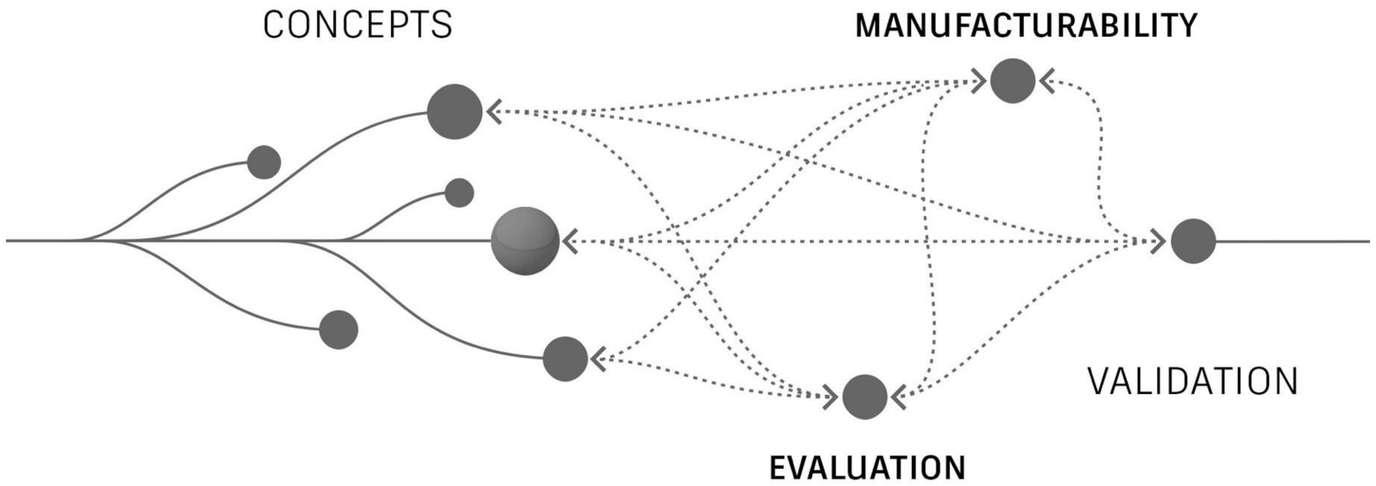
How Each Individual Challenger Worked



How the Entire Challenger Cohort Worked



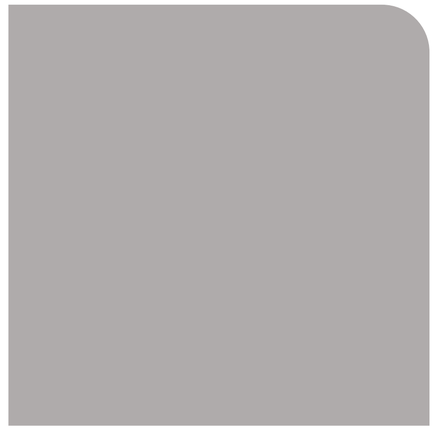
When to Use What…

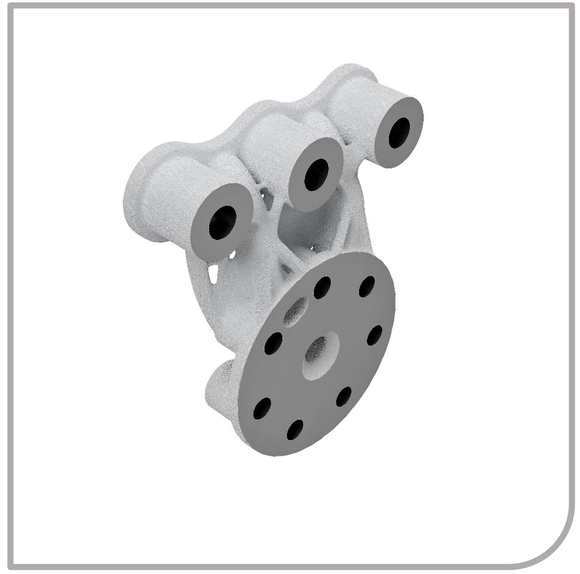


Where in the process are you?

The first consideration when trying to determine which process to use is to evaluate where along the development spectrum your project is. If you are just beginning the process of design and you're actively working to setup a problem – Generative Design is the appropriate approach. If your project is in a modeling to validation stage, topology optimization would make better sense – though if the need arises to loop backwards, Generative Design may be beneficial.

Generative Design is not an immediate shortcut to production geometry!





Realizing the True Value of Generative

Reworking existing models into Generative Design should be taken with a grain of salt. The largest value proposition with Generative Design is in exploring off-the-wall potential solutions – not because they are exotic, but because they afford you the opportunity to synthesize your own best path forward from a multitude of viable solutions.

Show Me the Money

The biggest reason to leverage
these tools is that the bottom line
can grow when all the tertiary
business processes are folded in.

LESSONS FROM RACING TEAMS

In the highest levels of motorsports the average lap time difference between cars (and their drivers) is usually less than ¼ of a second. Teams in Formula 1, Le Mans, and similar top tier competitions work tirelessly to advance their cars by hundredths of a second over hundreds of minor changes. The result ends up being dramatic in that the right pile of small changes amounts to more than that margin of separation. The real competitive advantage stems from the minor increases, not the major changes. Your business competes with lots of others in the same race as you, and odds are you're in very tight competition. Any little improvement adds up…

SOME NON-R&D BUSINESS IMPACTS

QUALITY ASSURANCE

A change of process can often times alleviate headaches surrounding quality issues. For example, a component with internal flow passages for hydraulic systems may need heavy QA on a sand casting, but very little on an additive part.

LOGISTICS

Lighter parts are cheaper to ship, plus you can put more of them in the same volume. Reducing the number of operations on a component means less hands-on time moving between processes.

PROCUREMENT

Less material uses directly translates to less material expense. Furthermore, by optimizing manufacturing processes, we can improve tool life which translates into a lower COGS.

ENVIRONMENTAL IMPACT

Fewer operations, less energy expenditure per part, lower CO2 emissions, less chips, etc. all translate to direct impacts on both the local and global environment. Imagine if we could cut the power consumption of a foundry by 20% what the benefit to the earth would be.

Recap

Learning Objectives - Recap

THE LANDSCAPE

Inventor, Fusion 360, Netfabb, Within Medical, Meshmixer, Dynamo, Max/Maya.

THE DIFFERENCE

TO focuses on a pre-determined design space and occurs late in the dev process. GD has a shotgun approach and is used as a mass ideation tool.

THE RIGHT PROCESS

The best process is the one that matches up with the project timeline, current state, and contextual requirements.

THE BOTTOM LINE

Lightweight and optimized designs can positively affect logistics, quality, procurement, maintenance, and other business silos outside of R&D.

Questions?

Join the conversation about Generative Design…

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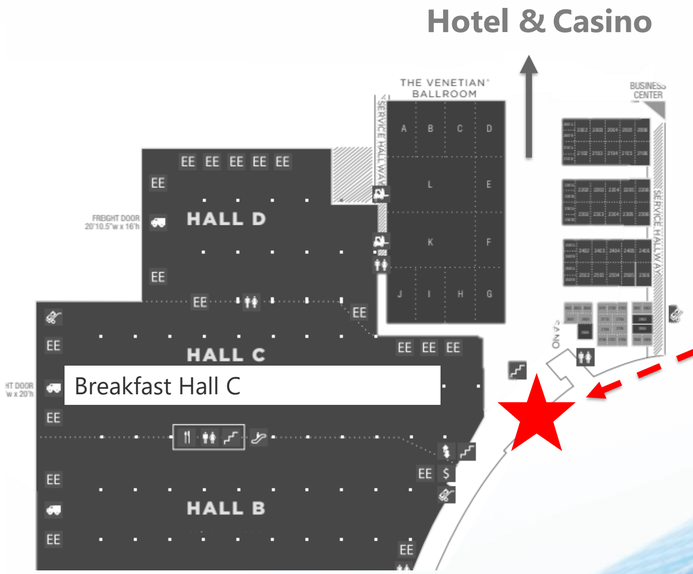
Learn best practices to set-up your problem (workshop)

Share your experince and path to manufacture. Additional topics include

- Guided walkthrough (new users)
- Automated Obstacle Tool
- Beam / Truss weld method
- Simplified Manufacturing
- Clustering generated results

Join the conversation about Generative Design…



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