Additive manufacturing in Hydraulic products

Fabio Mininel

National Sales Manager

Parker Hannifin Ind. Com. Ltda.

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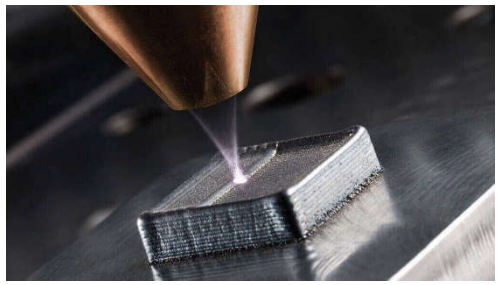
- What is Additive Manufacturing?

Additive **M**anufacturing (**AM**) is an appropriate name to describe the technologies that build 3D objects by ***adding*** layer-upon-layer of material, whether the material is plastic, metal, concrete or one day…..human tissue.

Additive manufacturing, also known as 3D printing, is a process that creates a physical object from a digital design.

The journey from .stl file to 3D object is revolutionizing manufacturing. Gone are the intermediary steps, like the creation of molds or dies, that cost time and money.

For this, we also need to understand what is **Generative Design!**



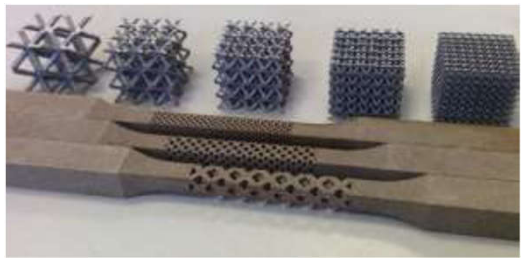
Generative Design

What is it? How do I project? How is it made?

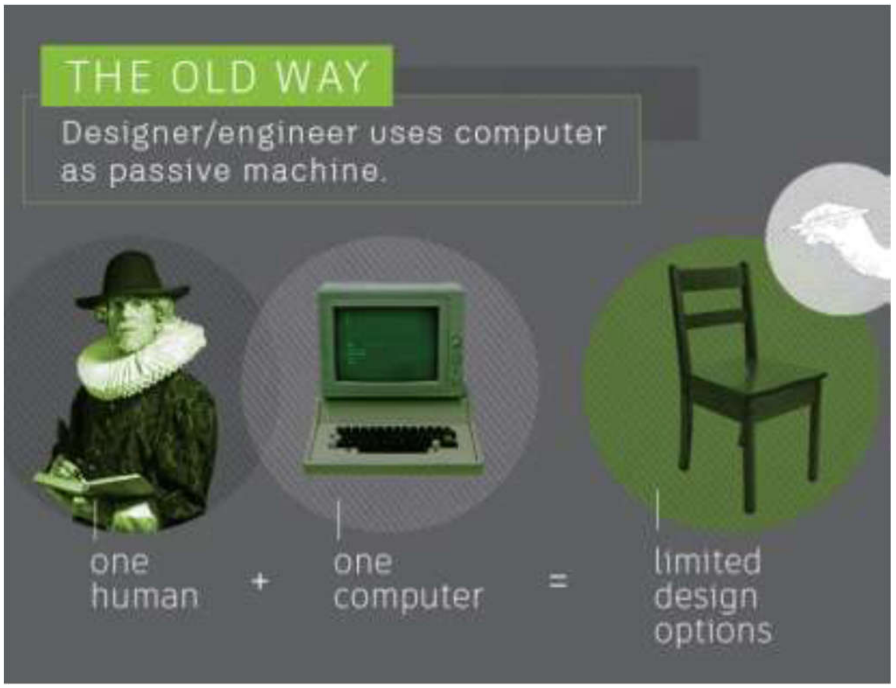
- Lean design tailored to the specified.
- Provides various design possibilities through computational algorithm.
- Method of manufacture: additive through 3D printer (iron or polymer).

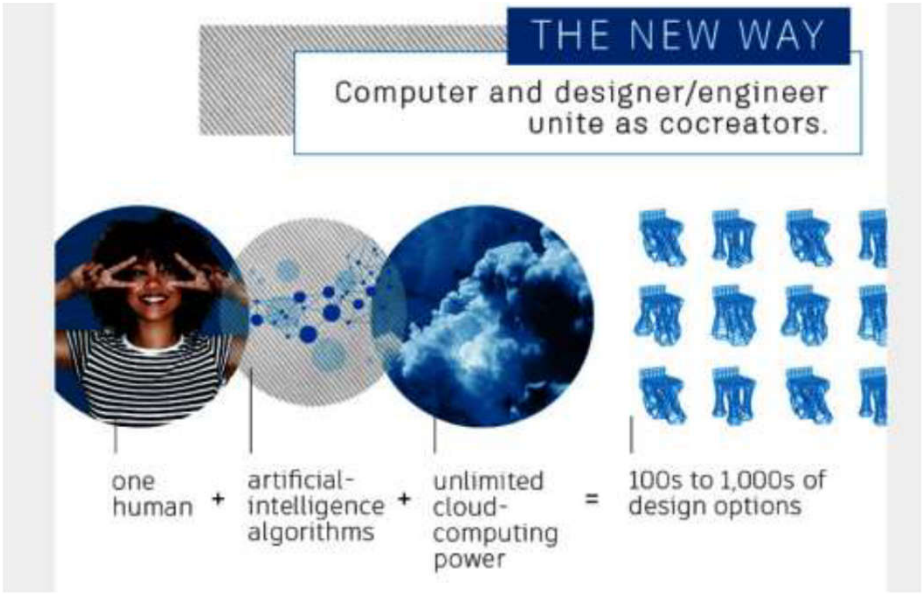
Grid or neural structures:

- Technology whose research was initiated in 2010 by MIT and has made great strides in recent years. Based on observation of the structures of nature: resistance and hardness of corals, human bones, leaf structure, etc.
- Several dozen types of grid structures already defined and programmed in computational algorithms.
- Regenerative design module in Inventor 2017 (shape generator).
- Technology that promises, along with 3D metal printers, to revolutionize engineering and industry in the coming years



Generative Design





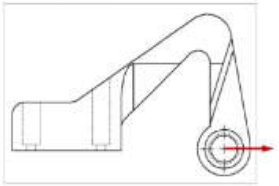
Generative Design – Step by Step

STEP 01:

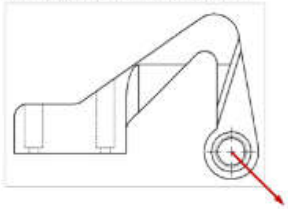
Designer introduces design goals and constraints such as material type, safety factor, stresses, fixations, boundary conditions (space to be preserved, workspace, geometric obstacles).

Loading Conditions

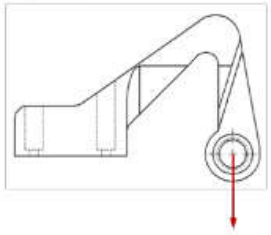
Load case 1: Horizontal load 1,250 lbf



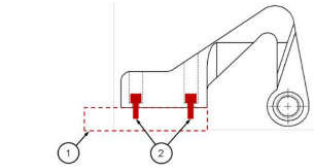
Load case 2: Inclined load 1,875 lbf 45 with the horizontal



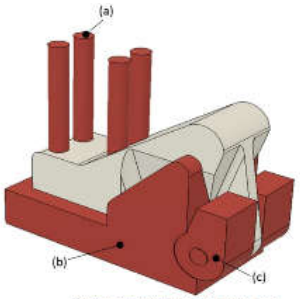
Load case 3: Vertical load 2,500 lbf



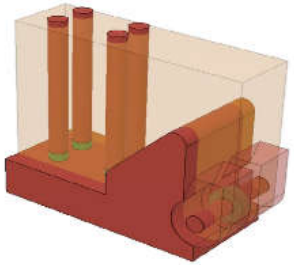
In all load cases, the loading shall be applied statically, through a stiff spherical bearing with .3125in in diameter.



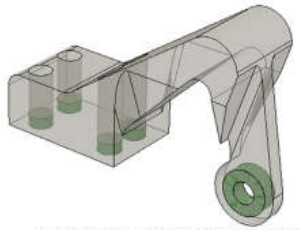
1. Part is simply supported by a stiff plate
2. Part is fastened by four high strength bolts (#10-32)



Original bracket with obstacle bodies (red)



Preserved regions, obstacles and starting geometry

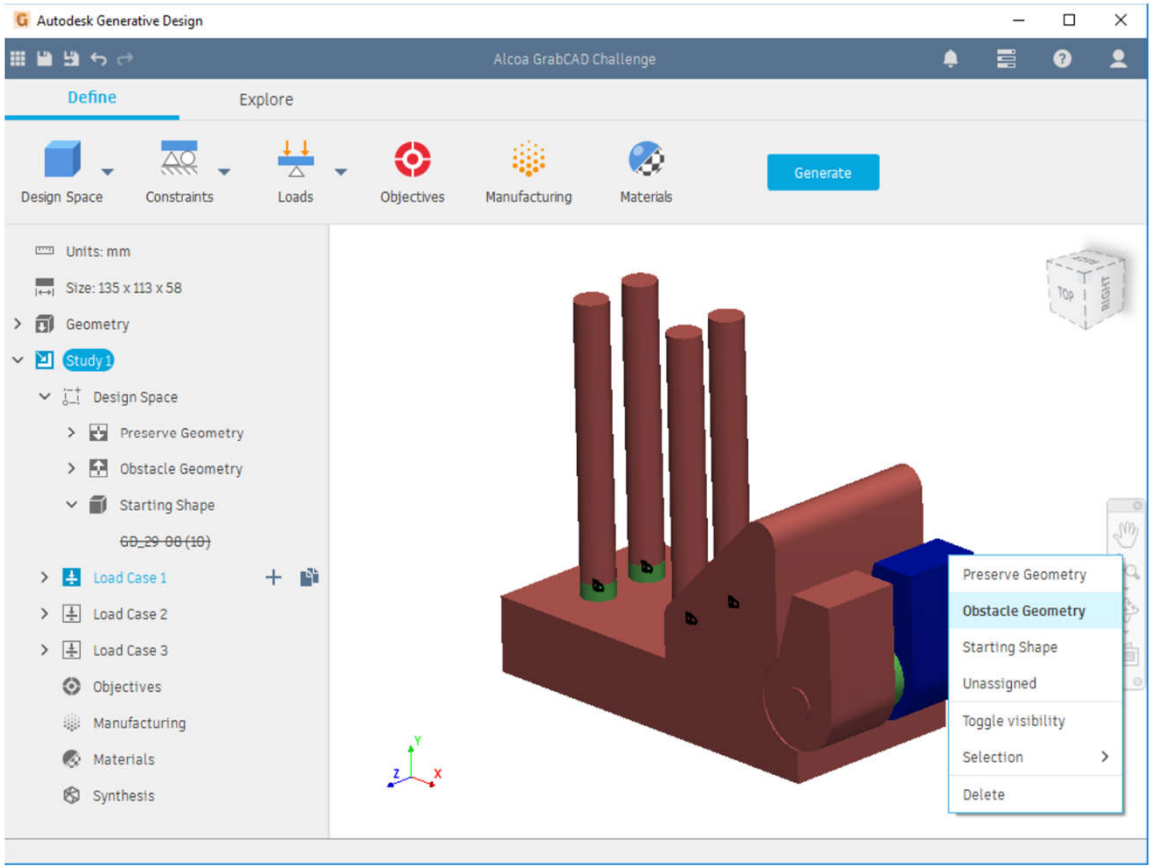


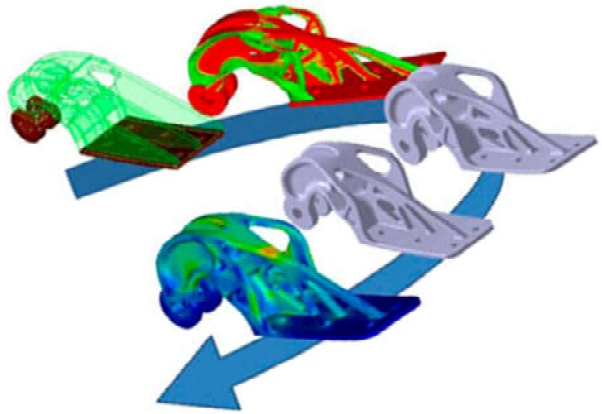
Original bracket with preserved region bodies (green)

Generative Design – Step by Step

STEP 02:

Through a generative design system, the computer uses algorithm to generate hundreds of designs running performance analysis for each of the options.

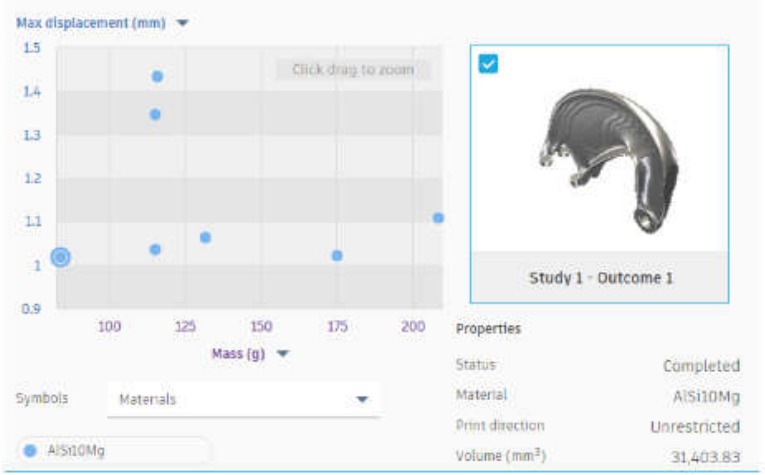




Generative Design – Step by Step

STEP 03:

Designer studies options, modifies goals and constraints. Regenerating the analysis countless times. Human intuition and artificial intelligence identify the most relevant solutions.



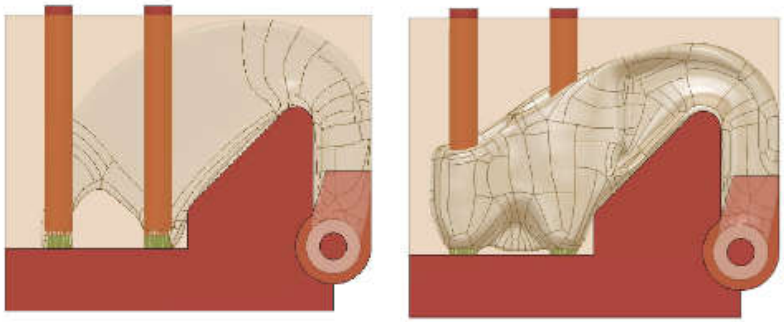
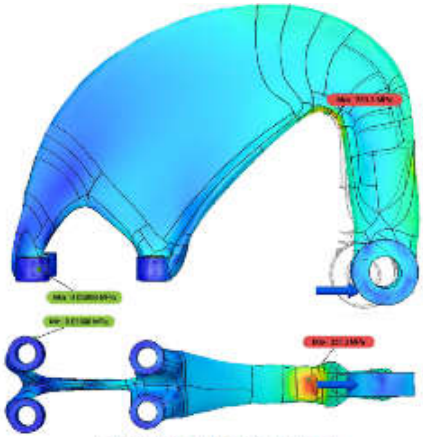


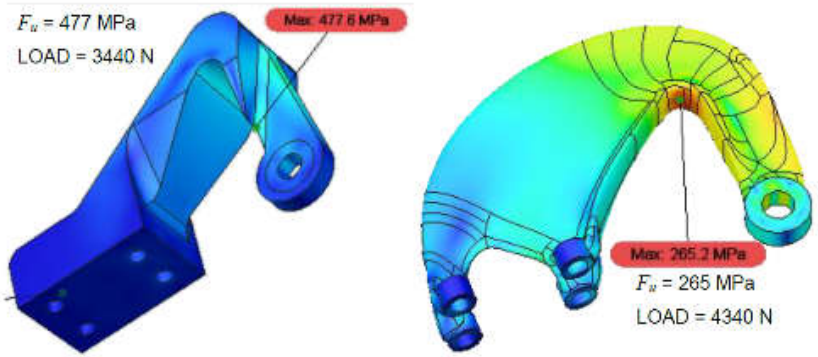
Figure 22 - Unrestricted build (left) and +Y build (right) selected solutions overlaid in starting geometry

Generative Design – Step by Step

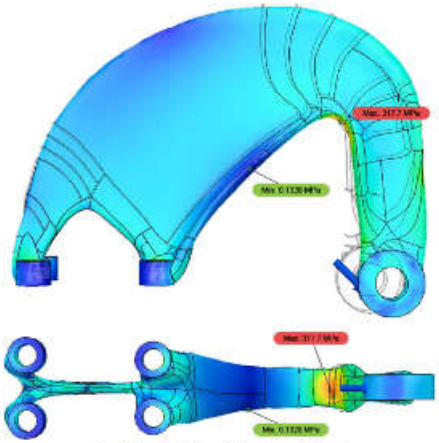
STEP 04:

Performance results determine the best option.

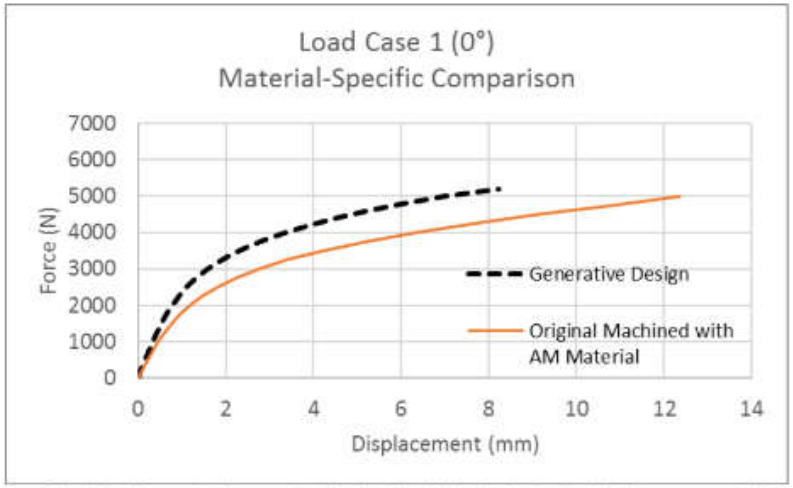




Point at which ultimate strength is first exceeded



Load Case 2 (45°) von Mises stress distribution



Simulated force-displacement at the load lug for both brackets with the same material

Generative Design – Step by Step

STEP 05:

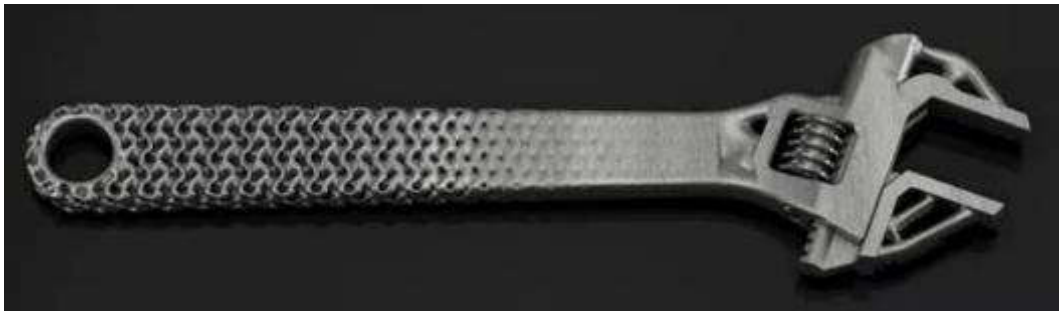
Product ready to be manufactured by the additive or advanced process.

Generative Design – Form Synthesis

The designer enters the goals, data and constraints and frees the software to generate a range of designs in a particular workspace.

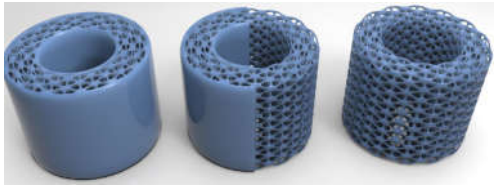
Generative Design – Topology Optimization

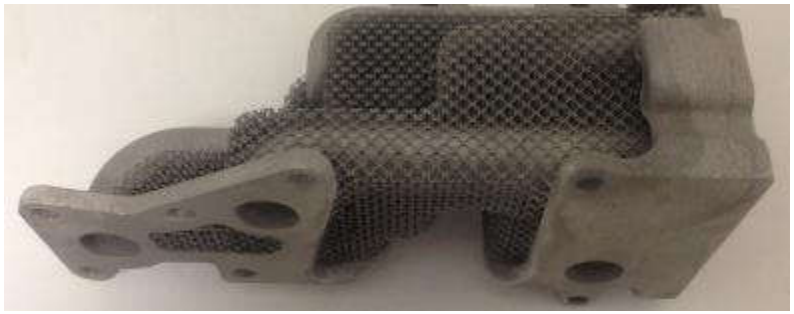
This method wipes out an existing geometry, work area, and geometric area of an existing part. Performs the analysis to remove material while maintaining or exceeding specified performance criteria.



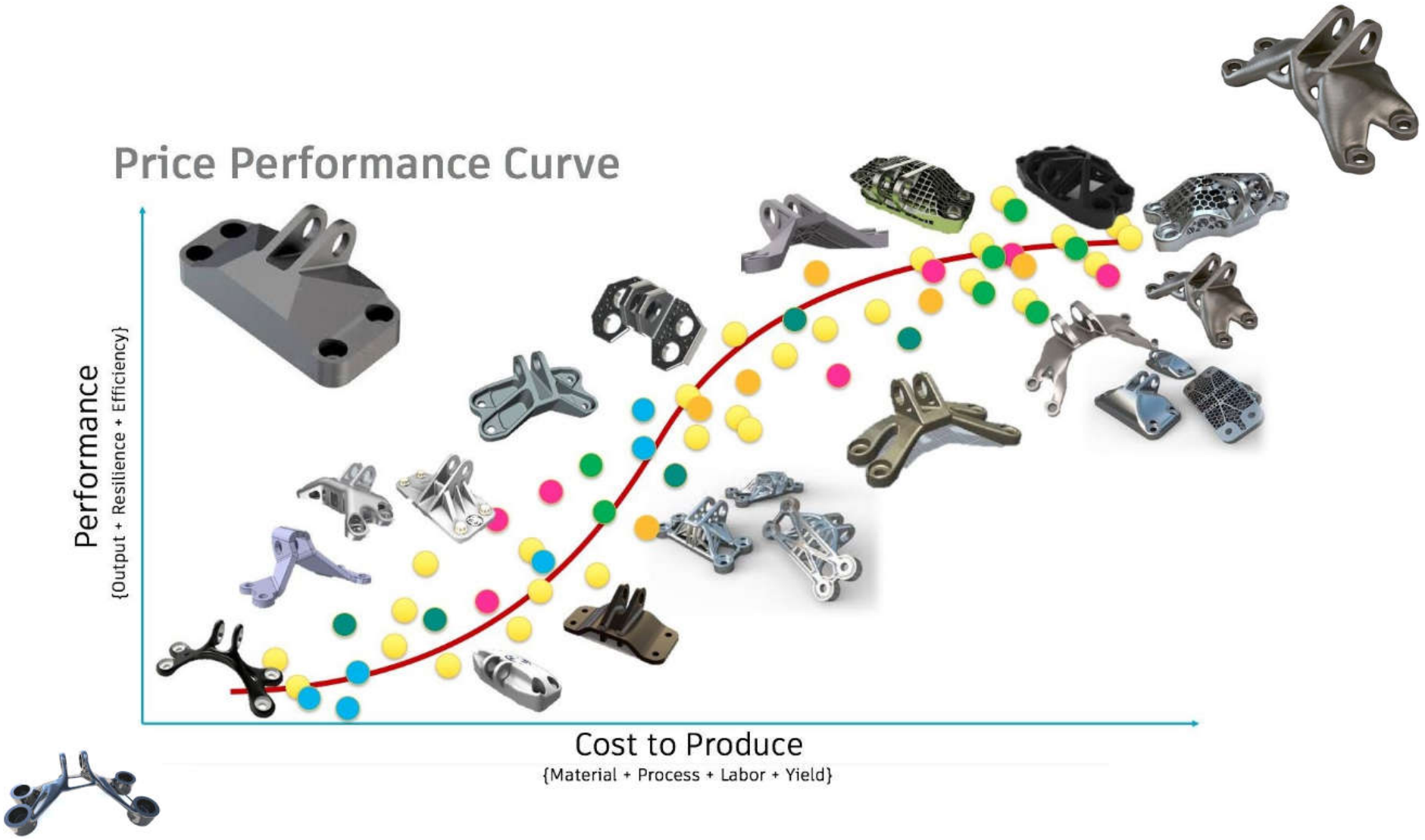
Generative Design – Lattice and Surface Optimization

This method applies internal trusses and optimized surface structures on an existing component to make it lighter and stronger. Used after Method 1 or Method 2. The skin of the piece can be maintained or not.





Generative Design – All Together



Parker in Additive Manufacturing

Advanced Manufacturing Learning and Development Center AMLDC - Macedonia/OH-USA

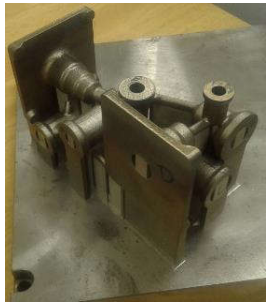
Team formed in August/2017.

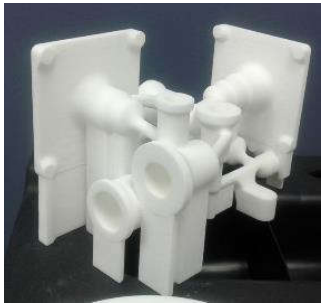
Research and develop 3D design, security, additive process operation, additive manufacturing opportunities, robotics, machine vision and augmented reality.

Provide personal development / learning for Parker people and products.

Features to make prototypes, devices and low-volume 3D production.

Parker in Additive Manufacturing

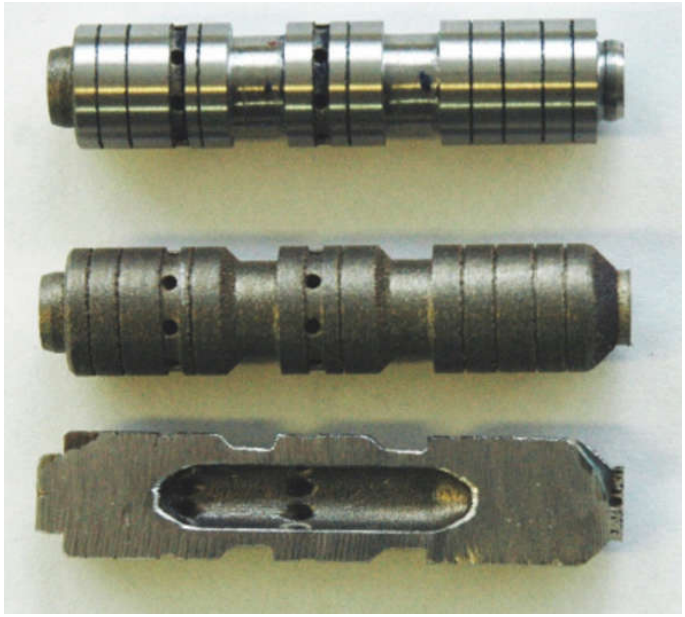


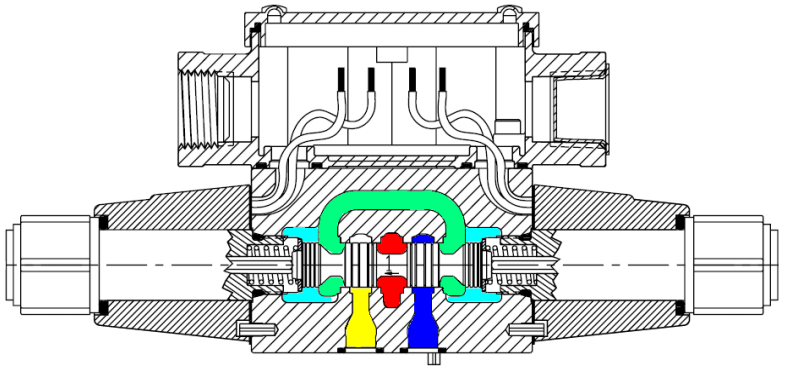


Additive Manufacturing in Parker Fluid Power

Valve Enhancement:

- Hollow spool valves for NG06 size.
- Conventional spool: lots of machining and manual rework.
- Additive part: less machining and no manual rework.
- Spool only needs to be turned and hardened before being rectified.





Additive Manufacturing in Parker Fluid Power

Emergency actuation for NG10 valves:

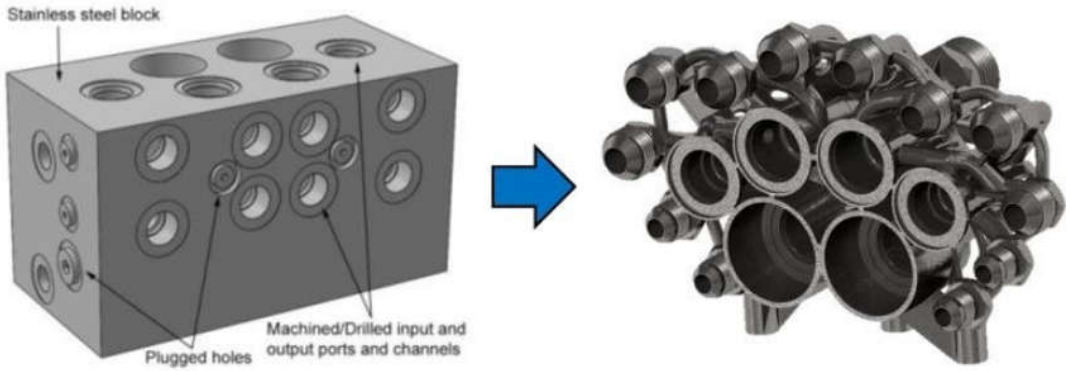
- Conventional part: challenging mounting, many adjustments needed and time.
- Additive part: it fits applying little pressure, quick assembly, twisting / locking movement performed by metal hook comparable to plastic parts.

Additive Manufacturing in Parker Fluid Power

Manifold Blocks:

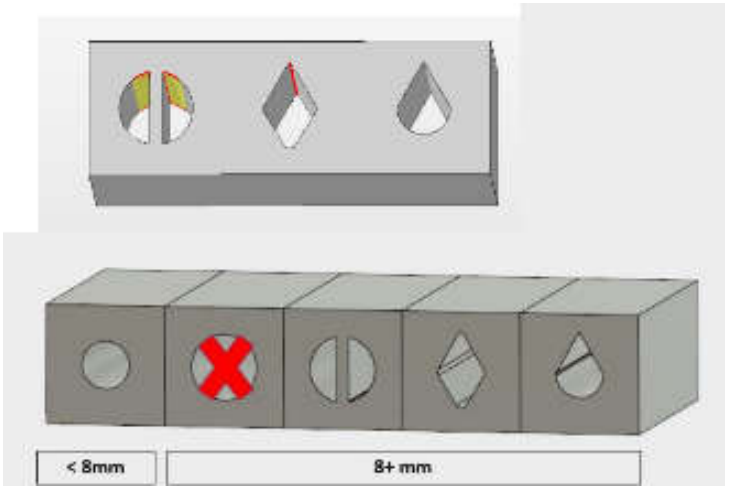
- Weight reduction, rounded fluid pathways, drastic decrease in load loss, less heat generated, flow performance increase over 60% compared to traditional manifolds.

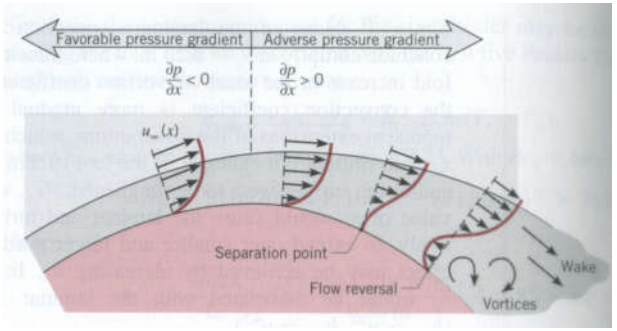
The hydraulic block manifold went through two redesign iterations, each iteration reduced the mass and increased the performance of the component

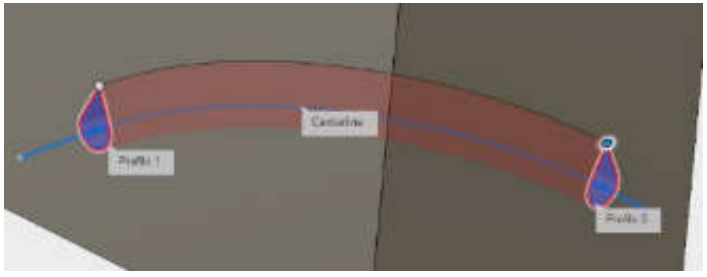


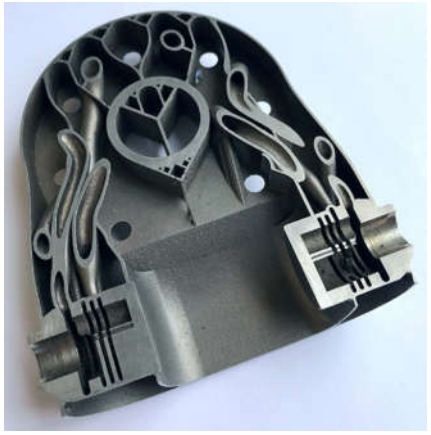
Traditional internal channels x High performance channels:

- Drastic reduction of fluid turbulence with channel walls (linear flow) for diameters greater than 8mm.
- Less heat generated.
- Increased flow performance (over 60% on average).





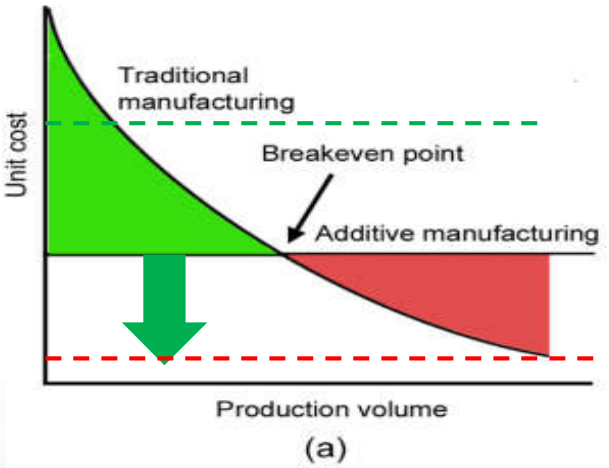


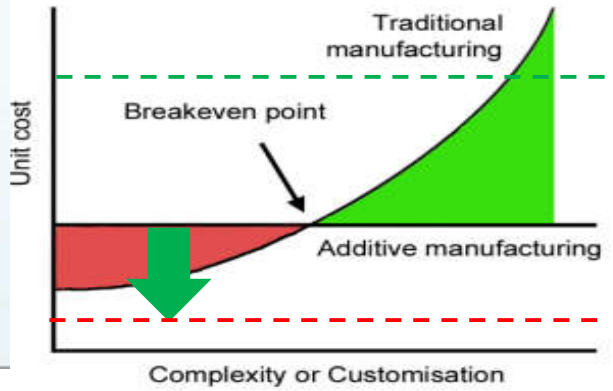


Point of Disruption / Business Impact

Additive Manufacturing x Traditional:

- 3D Line Printing Cost of additive manufacturing is falling exponentially over time.
- Increasingly faster, more capable 3D printers, decreasing costs, more efficient and reliable printers.
- Innovation X Disruption: At some point the disruption point will occur, this will change the **"business game"**.





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Thanks for listening

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fabio.mininel@parker.com