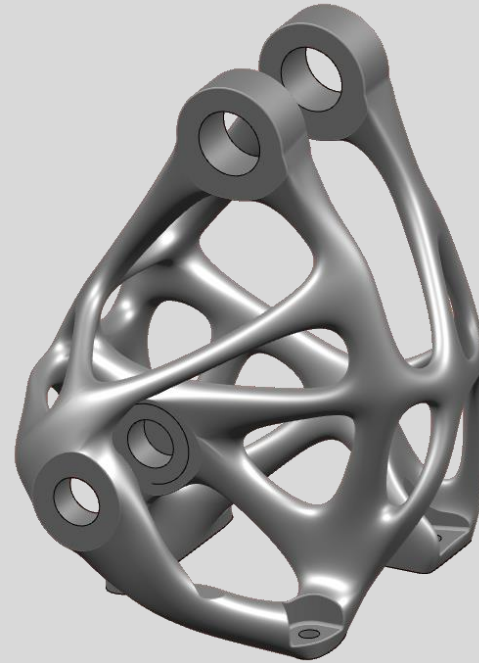


Innovation in mechanical design using guidelines and optimization tools for Additive Manufacturing



Guy Yaros
3D Printing Application Engineer
Systematics



About Systematics

- **Systematics** promotes organizational effectiveness and efficiency by marketing innovative computing technologies and implementing them in advanced work processes.

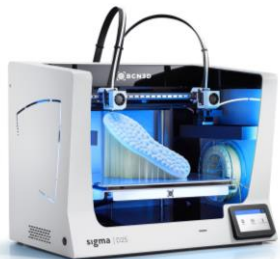
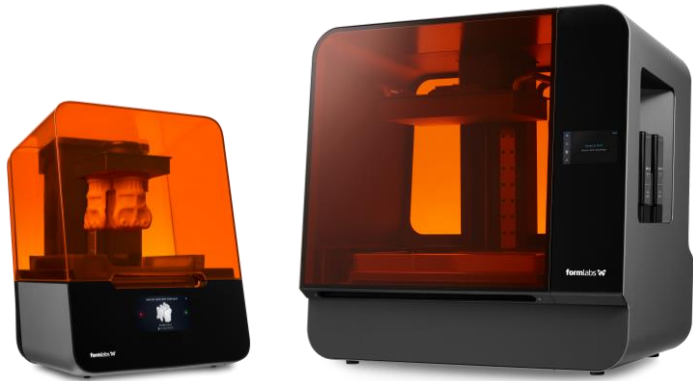
Technologies marketed, distributed, and supported by Systematics include:

- Computer-aided design and product lifecycle management systems (3D CAD/PLM)
- Three-dimensional (3D) printing technologies
- Tools for technical and scientific computing (MATLAB & Simulink)
- Geographic Information Systems (GIS)

Systematics' solutions serve more than 3,500 organizations in the Israeli market.

Customers include institutions from the worlds of industry, government, public sector, military and defense, finance, commerce, and academic institutions.

Additive Manufacturing Solutions Portfolio



Rapid
Prototype

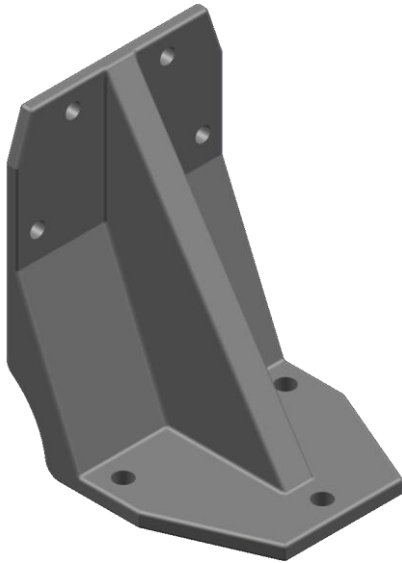
RP / End Use Part

Industrial/Short Run Prod
End use parts

Full production

Design process oriented by the manufacturing process

Sheet metal



CNC Milling

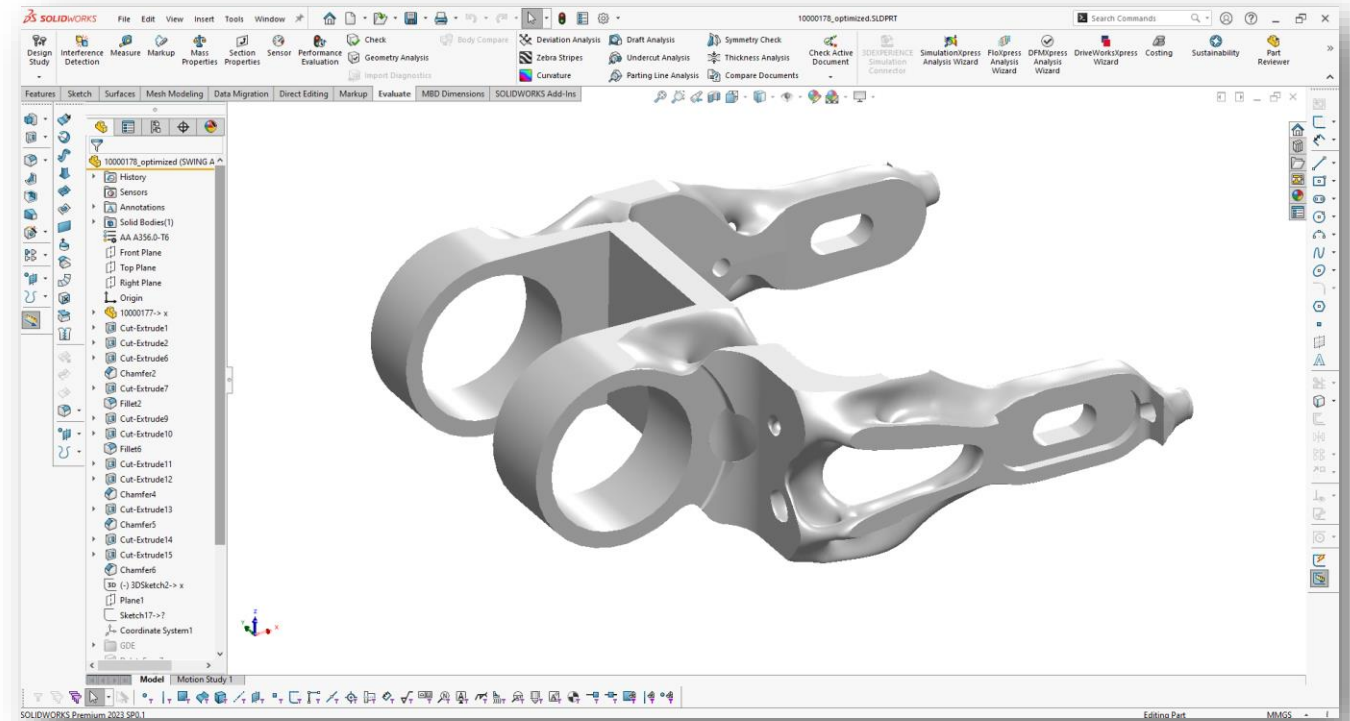


AM



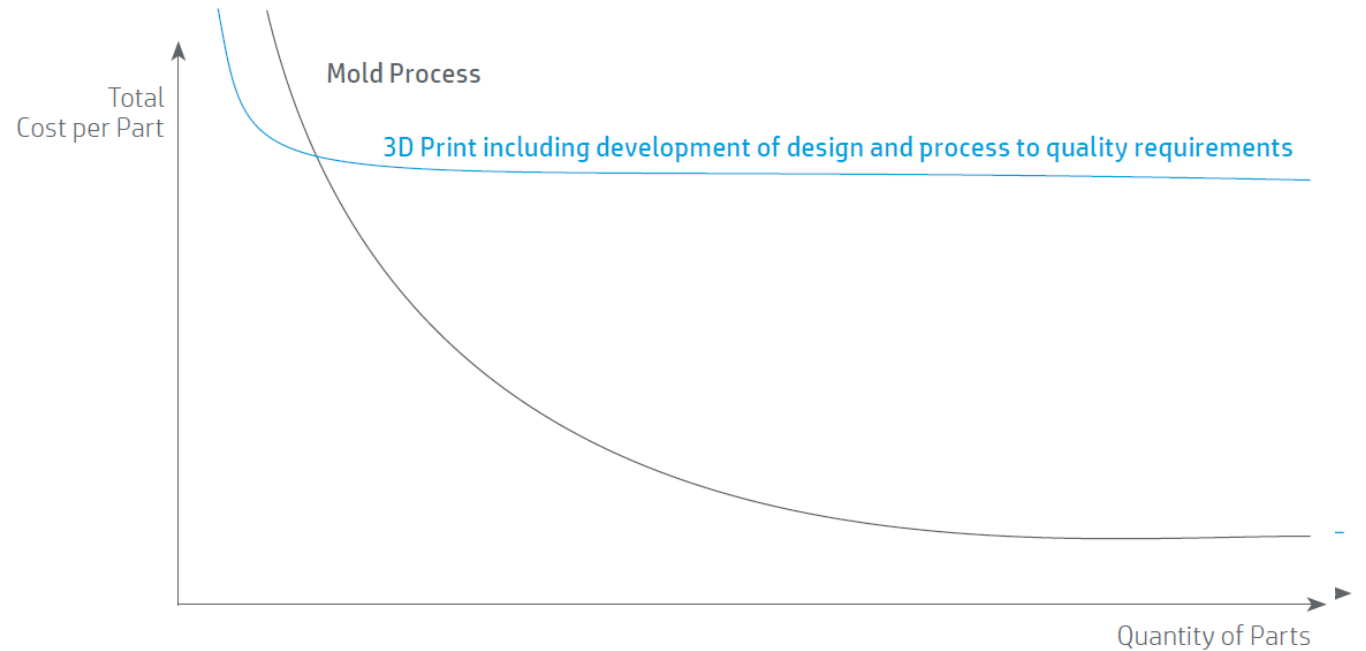
What is Design for Additive Manufacturing?

- **DfAM** is a design methodology that aims to improve parts performance by **leveraging the advantage of additive manufacturing**.
- AM is continuously becoming inroads into the mainstream.
- Considering the limitation of AM and avoiding them.



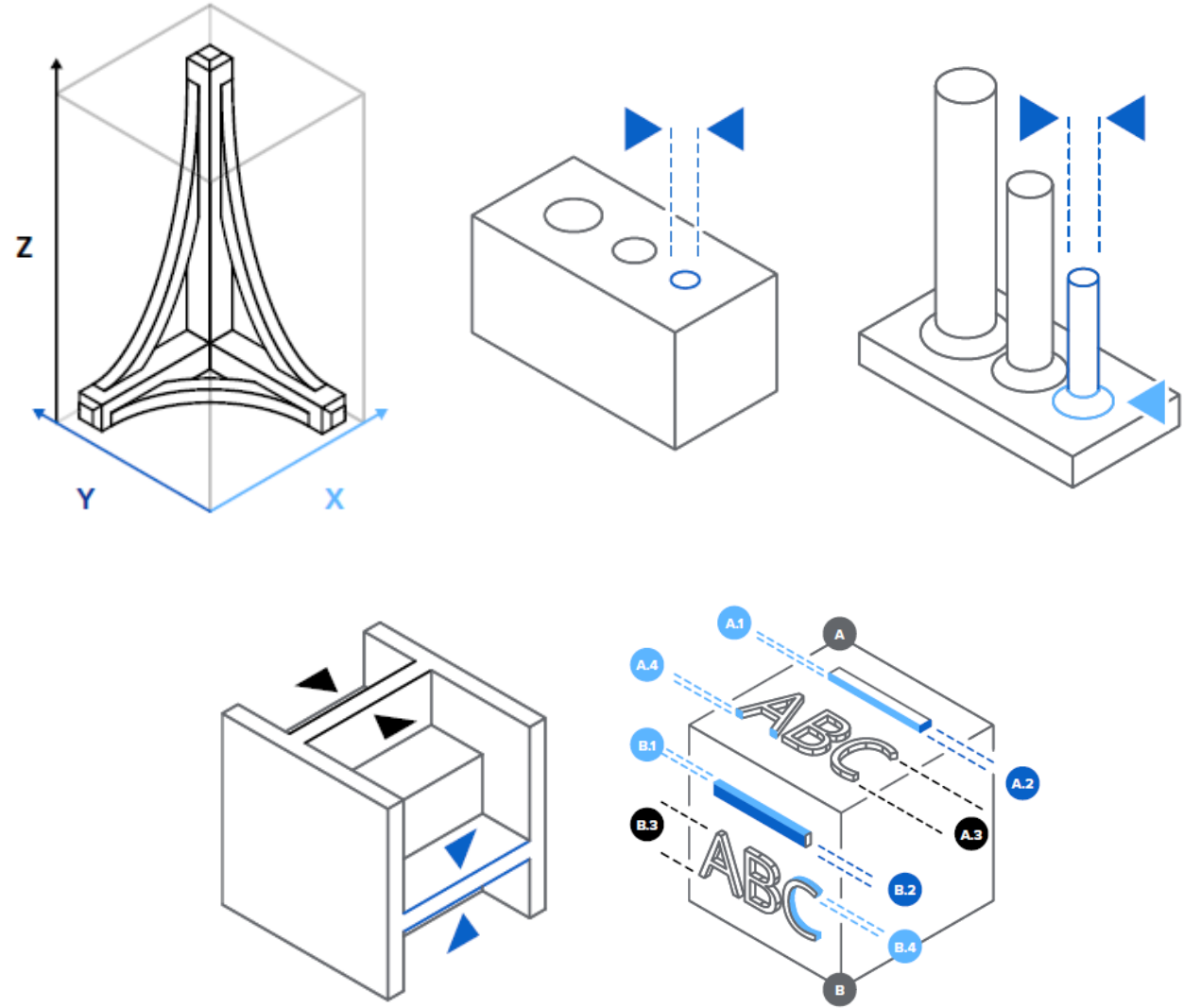
Why to Design for Additive Manufacturing?

- Create parts that are optimized for their intended use.
- Reduce costs and lead time.



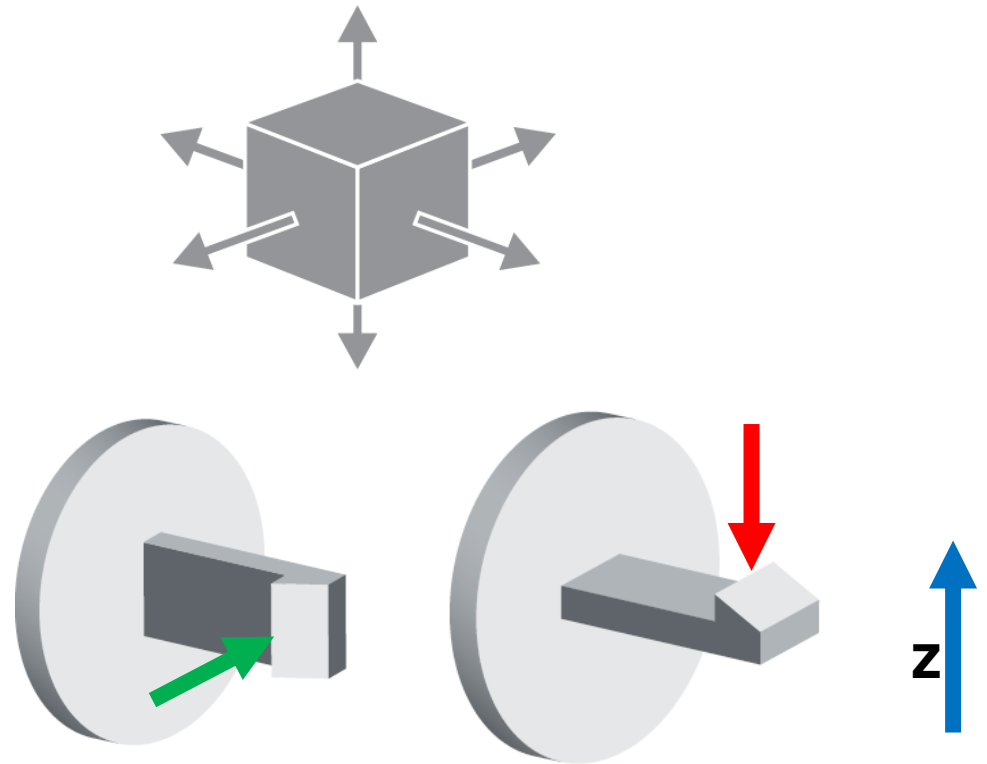
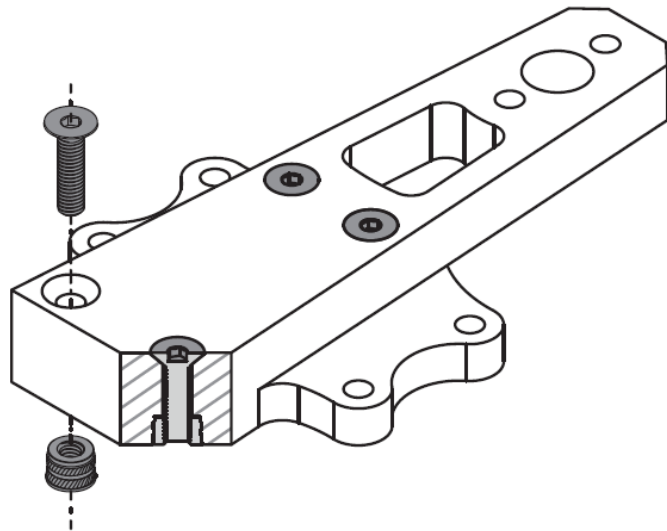
How to DfAM? General Rules and Principles

- Design specifically for process.
Consult printer design guide.
 - Max print volume.
 - Minimum features size.
Holes/Pins dia, Wall thickness,
Emboss/deboss depth



How to DfAM? Directional considerations

- Identify loading conditions and consider for anisotropic properties (*in some AM technologies)
- Achieve Z-axis strength.



How to DfAM? Supports

- Minimize supports.
- Fillet or chamfer edges & improve overhangs.



How to DfAM? Generative design

- Structural/Fluid Generative design. based on AI algorithm
- Ideally manufactured by AM

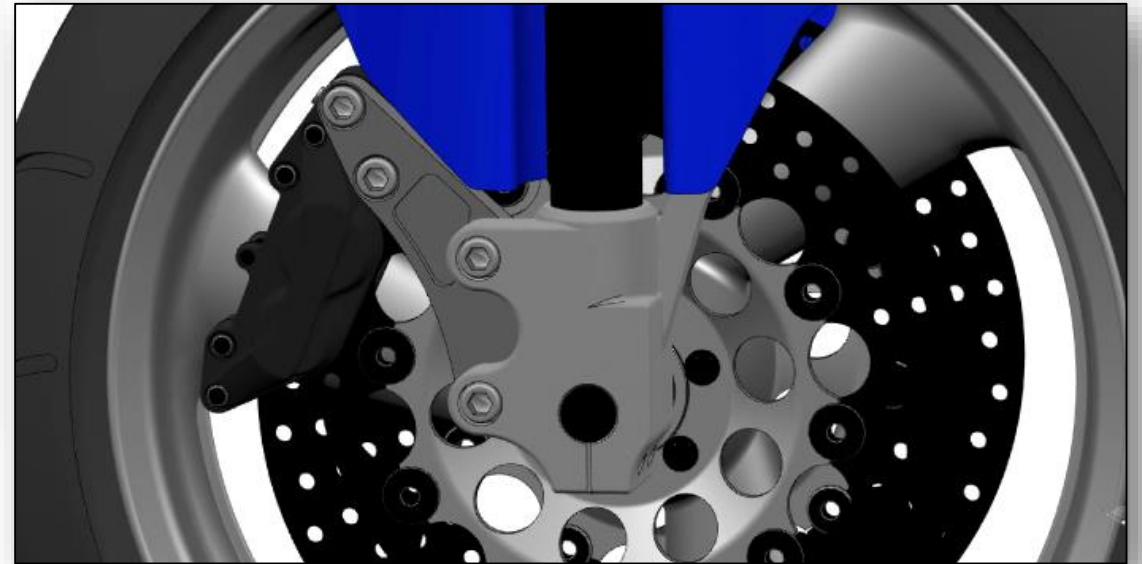


How to DfAM? Lightweight design

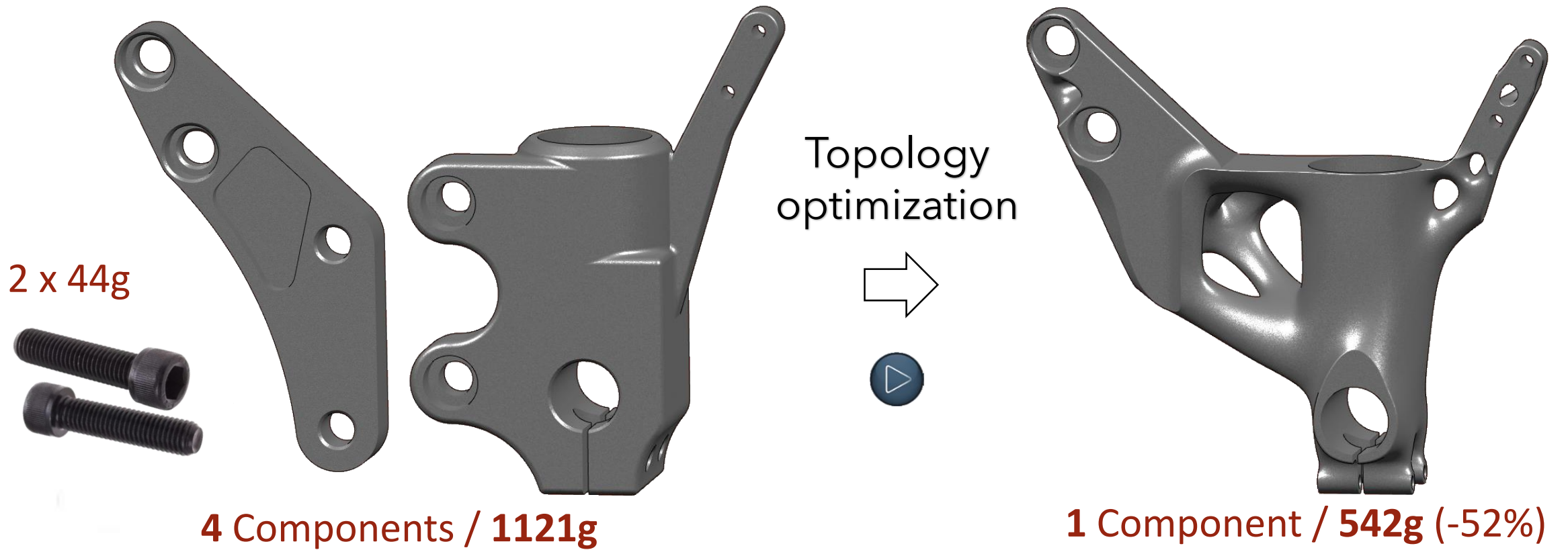
- Remove excessive material using Topology optimization tools.



How to DfAM? Ultra effective design

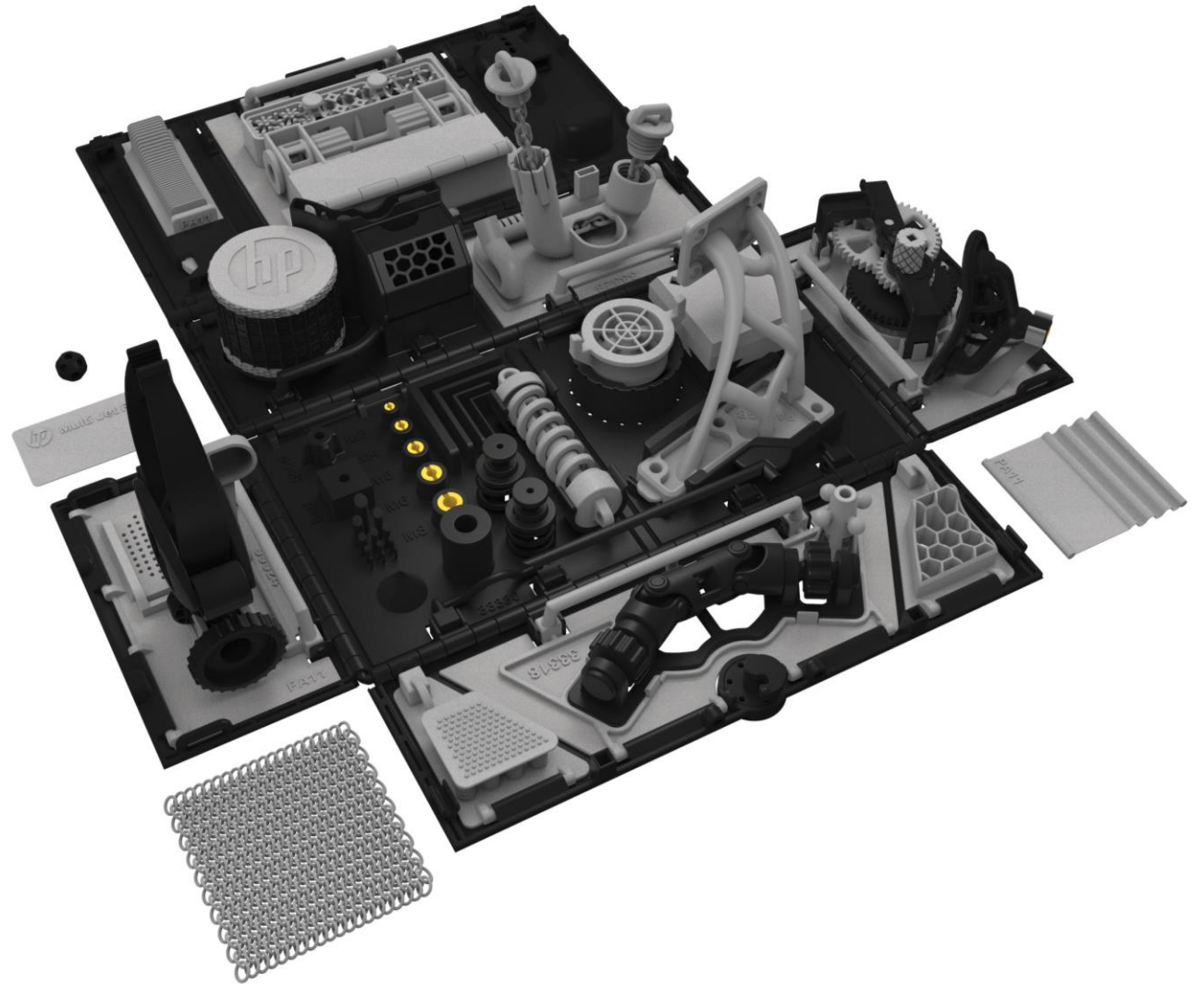


How to DfAM? Ultra effective design



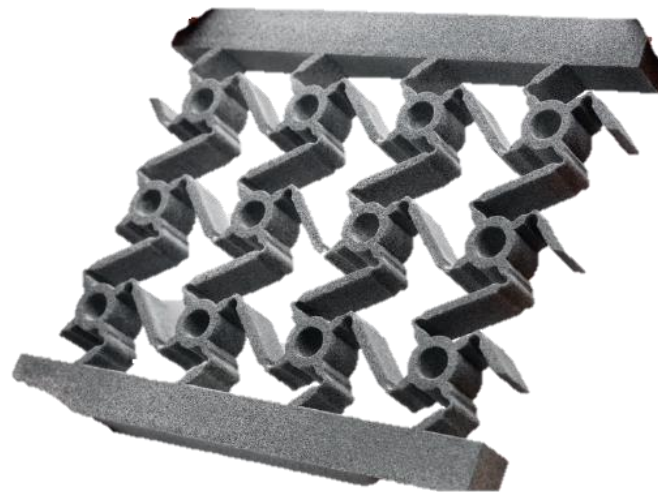
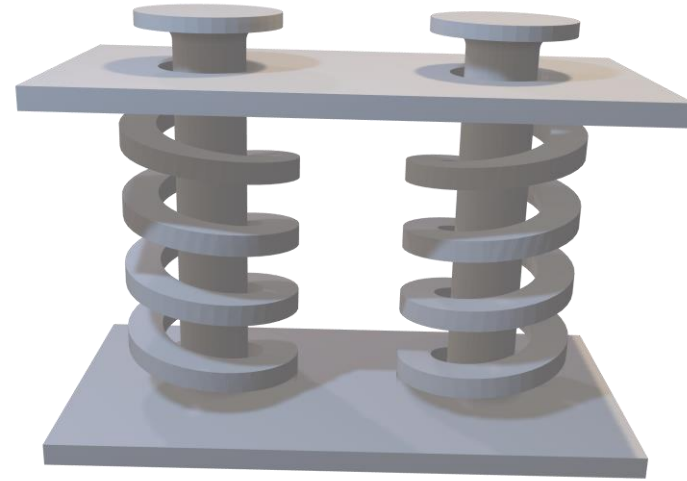
How to DfAM? Moving parts

- Interlocking parts.
Chains, captive components
- Quad-based fabrics.



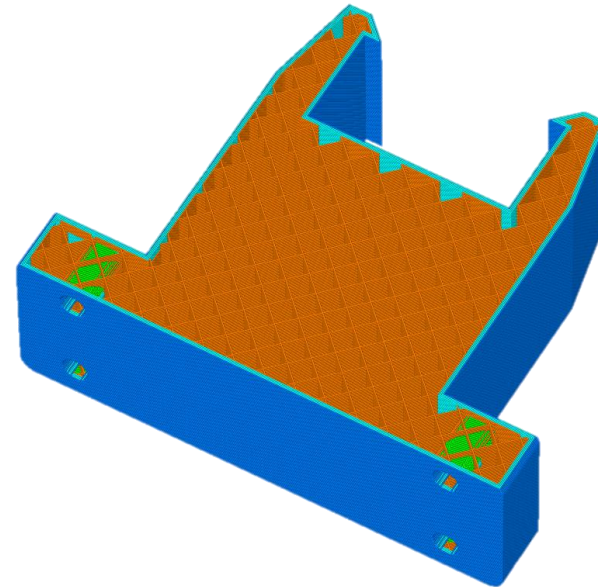
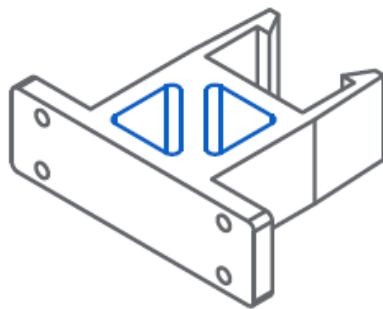
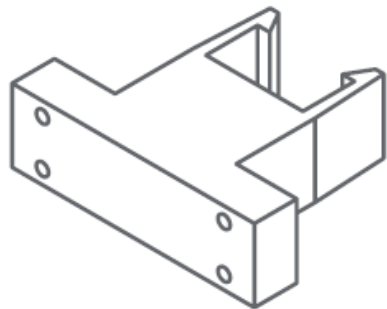
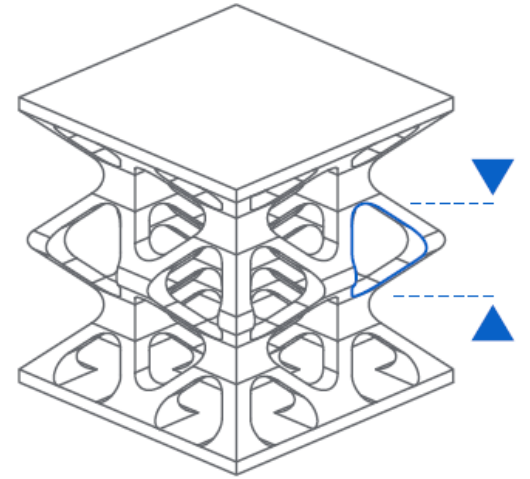
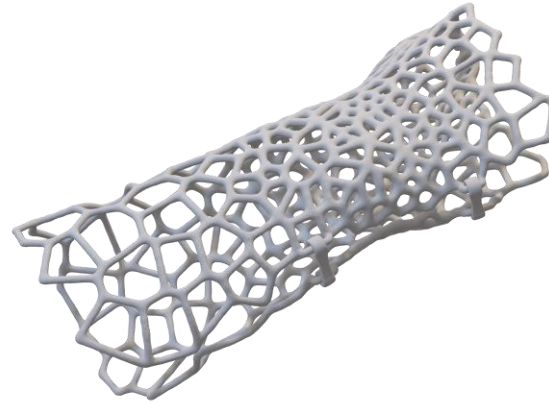
How to DfAM? Elastic parts

- Elastic parts
- Springs
- Living hinges
- Snap fit



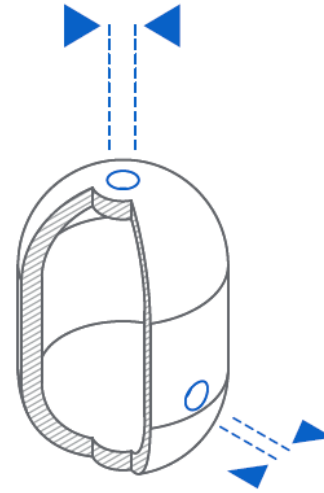
How to DfAM? Lattice & Partial fill

- Design with lattice structure.
- Partial infill.



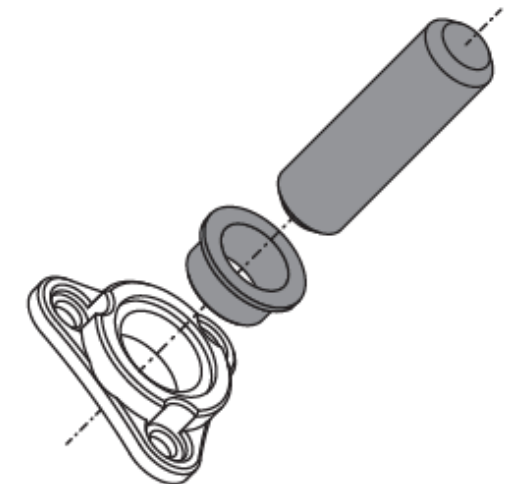
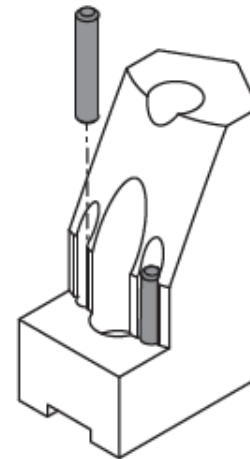
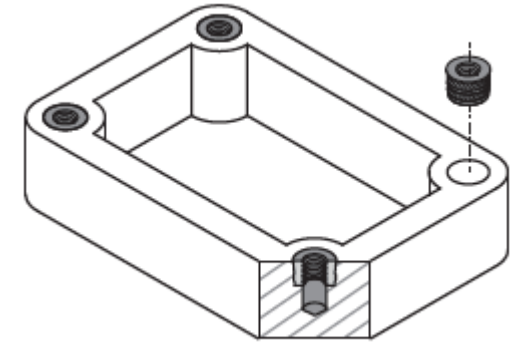
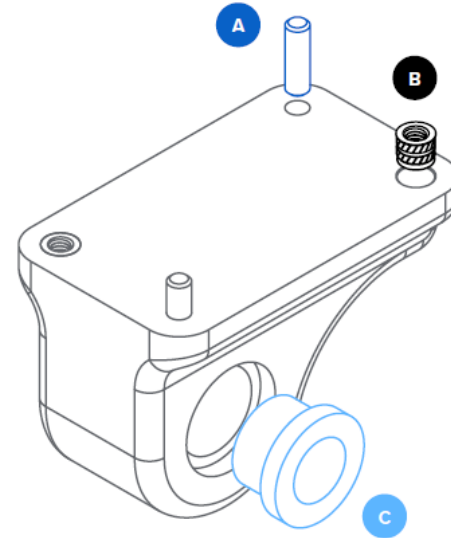
How to DfAM? Post-process

- Consider for post process requirements
 - Drain holes, Internal cleaning aids



How to DfAM? Post-process

- Consider for post process requirements
 - Drain holes, Internal cleaning aids
- Hardware integration
 - Dowel pins, Threaded inserts, Bushings
- Secondary post process
 - Sanding, Polishing, Painting, Dyeing, Coating



How to DfAM? AM FEA Simulation

- Using AM Simulation tools, validate and optimize the printed design.

SIMULATION CONFIGURATION
Set up a Load Case

Load Case

Target Safety Factor	?	1.5
Max Deflection (mm)	?	2

Anchor 1

- 100 N
- 100 N

Edit Load Case

Max. Deflection: 2.00 mm

Min. Safety Factor: 2.35

Anchor 1

NO DISPLACEMENT

0x 0x 2x

CURRENT	OPTIMIZED	REINFORCED	MORE OPTIONS	
SAFETY FACTOR	DEFLECTION	PRINT TIME	PRINT MASS	PRINT COST
2.35	2.00	1d 11h ▲ +18h 21m	163.23g ▲ +73.5g	\$205.69 ▲ +\$182.13

How to DfAM? Composites

- Using 3D printed Composites, to replace conventional metal parts.
- Lightweight and more durable parts, contains continuous fibers

