Four key use cases for the Studio System™

Agenda

01	Why/when to print metal
02	Studio System
03	4 Key use cases
03_1	Functional prototyping
03_2	Jigs & fixture
03_3	Manufacturing tooling
03_4	Low volume production

The promise of metal 3D printing

- Rapid prototyping
- Rapid tooling
- **Part consolidation**
- **Complex geometries**
- **Design customization**
- **On-demand manufacturing**
- **Supply chain re-engineering**

Desktop Metal

Desktop Metal was founded in 2015 by leaders in advanced manufacturing, metallurgy, and robotics to **make metal 3D printing accessible for engineering and manufacturing.**

Studio System™

Office-friendly, affordable metal 3D printing. Designed for engineers

Production System™

100x faster. Quality & cost per part needed to scale. Designed for throughput.

Studio System

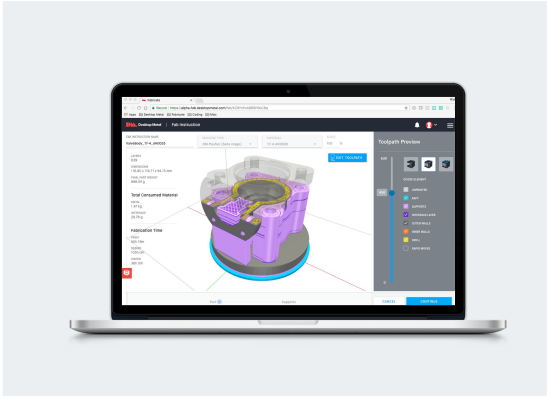
Studio System™

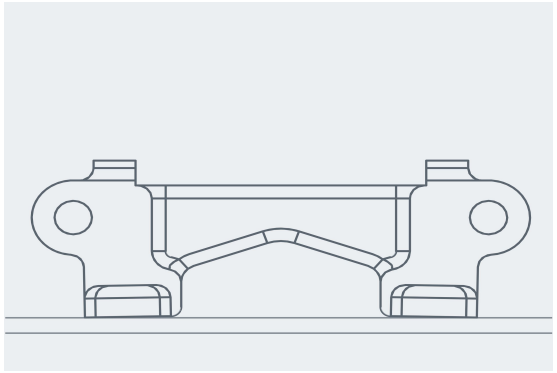
Office-Friendly metal 3-D printing

STUDIO SYSTEM WORKFLOW

1. Prep

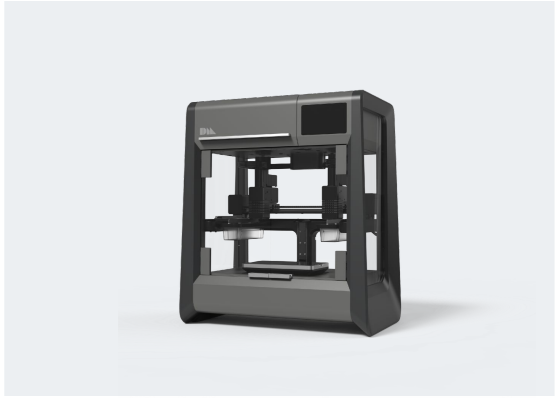
Fabricate prepares the part and guides it through fabrication

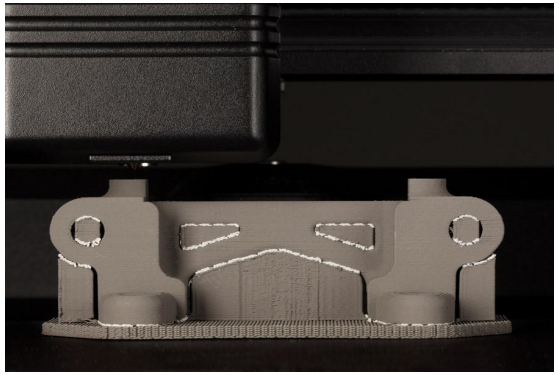




2. Print

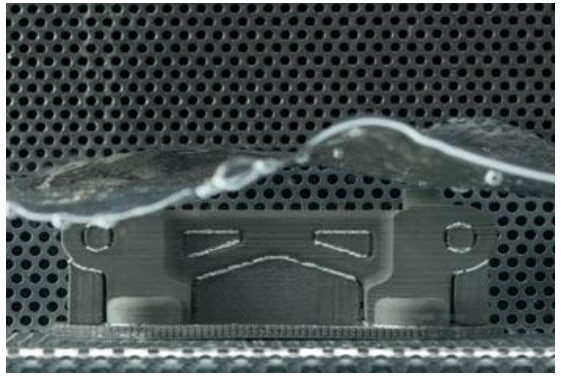
The printer shapes the part





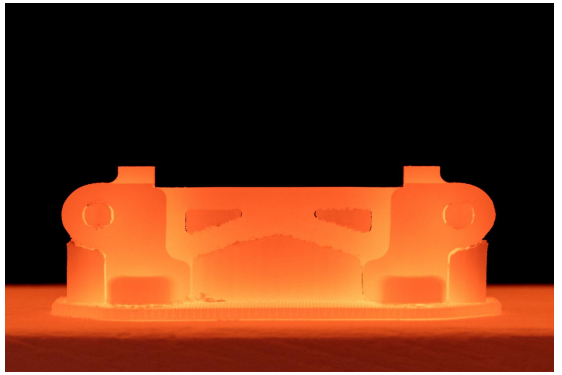
3. Debind

The debinder prepares the part for sintering



4. Sinter

The furnace sinters the part



Near net shape parts can be post-processed like any other metal

- Optimal part size envelope: 5 x 5 x 5 in
- Build volume: 12 x 8 x 8 in
- Resolution, accuracy and surface finish similar to casting
- Dimensional capabilities to ±0.8%
- Critical dimensions can be achieved via post-processing (e.g., CNC, EDM, grinding, etc.)
- Fully compatible with traditional finishing operations (tumbling, media blasting, plating, etc.), welding, heat treating, etc.

To print or not to print?

Great candidates for printing with Studio System:

- Complex geometry
- Multiple machining operations
- Part cost above ~$200
- Weeks of lead time (due to either capacity or tooling)

Cost considerations

Machine Shop / CNC

- Material
- Labor
- Custom fixturing
- Post-processing

SLM

- Build plate
- Materials
- Labor
- Post-processing

Studio System

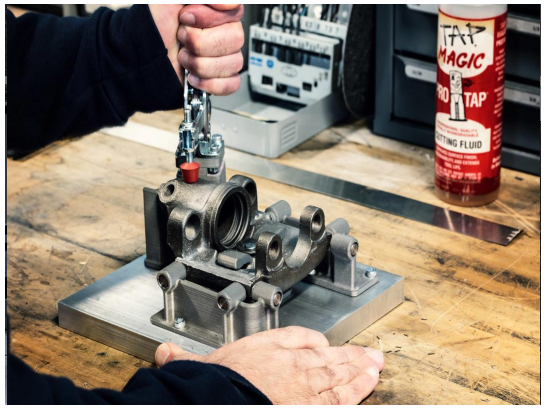
- Material
- Consumables (debinder, gas, electricity)
- Labor
- Post-processing

Four key use cases

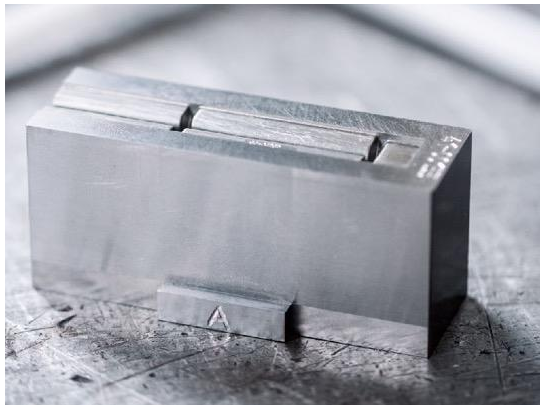
Studio System™

Four key use cases

Functional prototyping



Jigs & fixtures



Manufacturing tooling

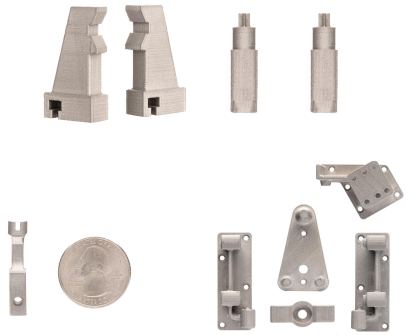
Low volume production

Studio System™

Four key use cases

Functional prototyping

1 Extruder nozzle
2 Shock absorber piston
3 Static mixer

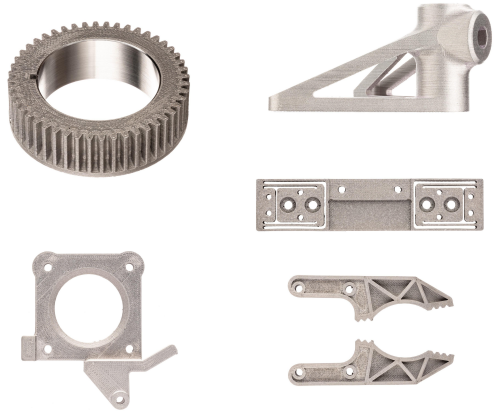


Jigs & fixtures

1 Robotic end effectors
2 Custom nut drivers
3 Brake caliper fixture

Manufacturing tooling

1 Injection mold inserts
2 Extrusion dies
3 Asthma inhaler mold insert
4 Zipper mold inserts



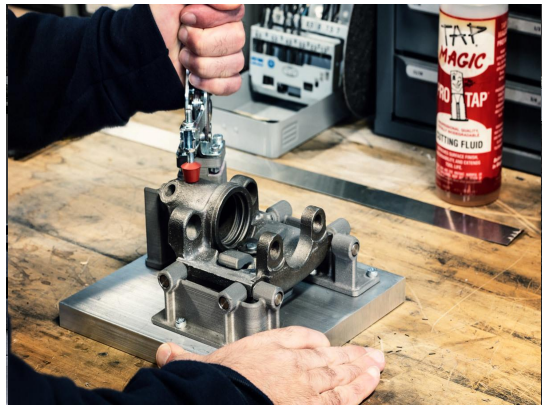
Low volume production

1 Lathe gear
2 Battlebot SawBlaze backstop
3 Motor mount
4 Motion stage flexure
5 End effectors

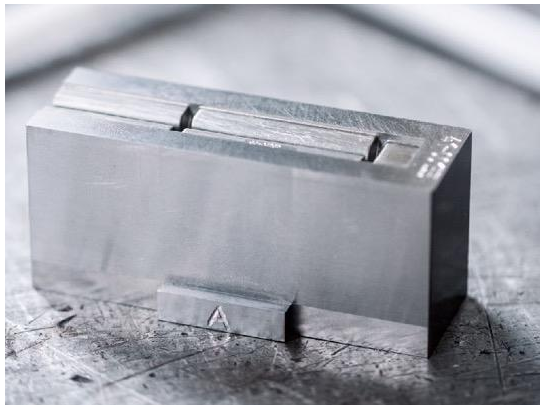
Studio System™

Four key use cases

Functional prototyping



Jigs & fixtures



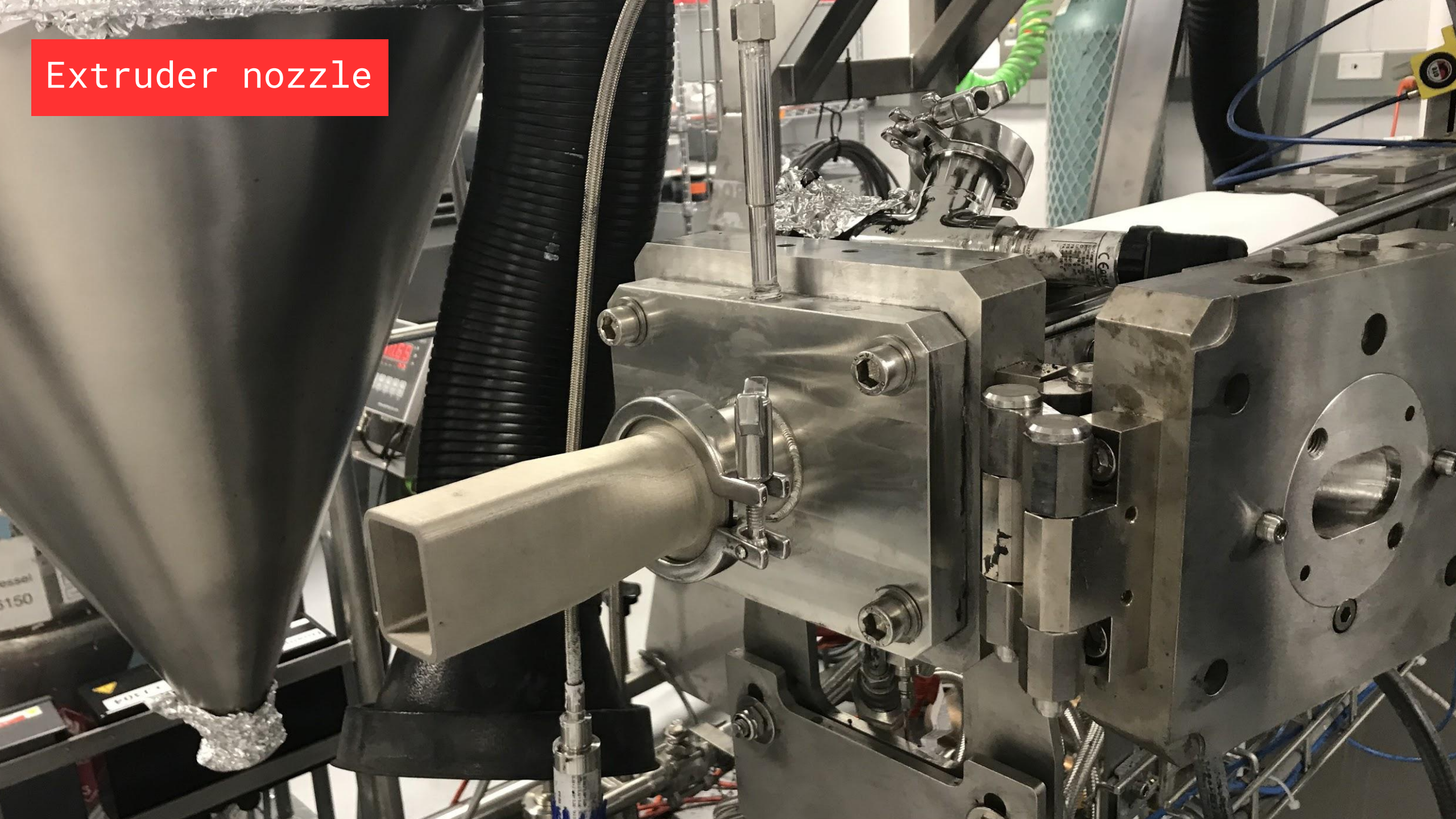
Manufacturing tooling

Low volume production

Functional Prototyping

- Rapid prototyping accelerates product development
- Test not just form and fit, but also function
- Strength, stiffness
- Thermal and chemical resistance
- No tooling required
- Avoid CNC backlog and lead times

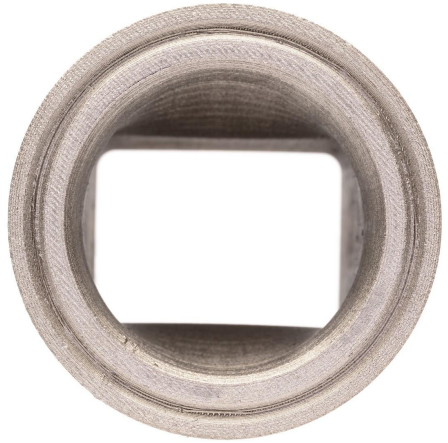
Desktop Metal


Extruder nozzle

Extruder nozzle

- Nozzle for twin screw extruder
- Mixing two highly loaded (75-80%) ceramic slurries
- Complex loft to direct flow and define shape
- Must be metal due to: Strength, stiffness, thermal resistance
- To achieve extremely smooth internal surface: sanding in “green” state may be easier/faster than extrusion honing
- 2.5 x 2.5 x 5.0 in (6.4 x 6.4 x 12.7 cm)

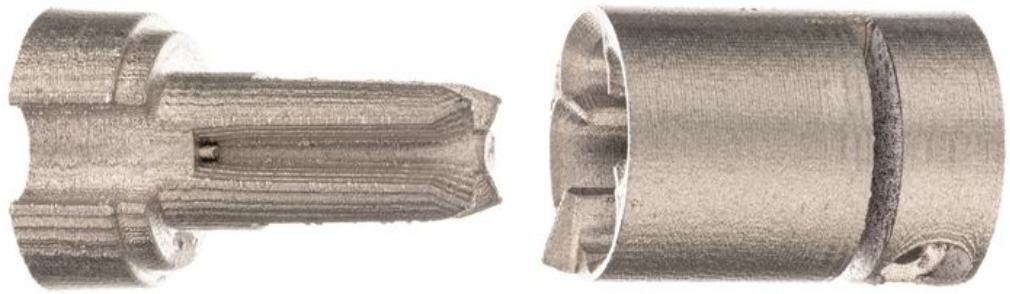
	Studio System™	SLM	CNC	Savings
Cost	$64	$1,800	$1,170	>95% cheaper
Lead time	4 days	2-3 wks	2 wks	4x faster



Custom mechanical coupling

Custom mechanical coupling

- Custom coupling for rotary power transfer between custom piece of machinery
- Complex geometry to attach to optimize power transfer in complex situation
- Must be metal due to: Strength, stiffness, and lifetime requirements
- Part 1: 1.0 x 0.9 x 1.6 in (2.6 x 2.3 x 4.3 cm)
- Part 2: 0.9 x 0.9 x 1.4 in (2.3 x 2.3 x 3.6 cm)



	Studio System™	SLM	CNC	Savings
Cost	$32	$519	$1,170	>95% cheaper
Lead time	4 days	2-3 wks	2 wks	4x faster

Worm gear

- A common component in gear drives used to transfer power
- Worm gears are an excellent selection when confined space is necessary for a reduction
- Must be metal due to: Strength, stiffness, and lifetime requirements
- 17-4 PH Stainless Steel
- 3.4 x 5.5 x 1.375 in (8.6 x 13.9 x 3.5 cm)

	Studio System™	**SLM**	**CNC**	**Savings**
Cost	$95	$812	$1,913	>95% cheaper
Lead time	4 days	2-3 wks	2 wks	4x faster

Roller screw

- An essential component of roller screw linear actuators
- Traditionally manufactured in 5 different components and assembled (5 - 1 assembly reduction)
- Must be metal due to: Strength, stiffness, and lifetime requirements, requires mild corrosion resistance
- 17-4 PH Stainless Steel
- Part 1: 4.8 x 1.3 x 1.5 in (12.2 x 3.3 x 3.8 cm)

	Studio System™	**SLM**	**CNC**	**Savings**
Cost	$86	$660	$1,914	>95% cheaper
Lead time	4 days	2-3 wks	2 wks	4x faster

Shock absorber piston

Desktop Metal

Shock absorber piston

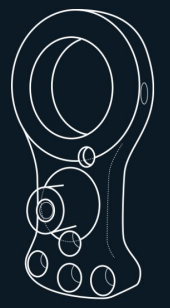
- Shock pistons for vehicle wheel shock absorbers
- Provides damping to reduce uncomfortable bouncing after shock is applied
- Complex internal channels direct the flow of shock fluid to transfer energy away from the shock
- Must be metal due to: Strength, stiffness, corrosion resistance
- 1.9 x 1.9 x 0.6 in (64.7 x 4.74 x 1.5 cm)

	Studio System™	**SLM**	**CNC**	**Savings**
Cost	$73	$524	$402	>80% cheaper
Lead time	4 days	2 wks	2 wks	4x faster

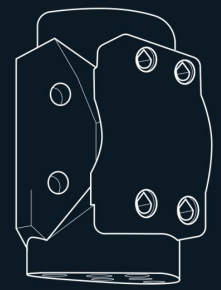
Engine components

Connecting rod

Swing arm

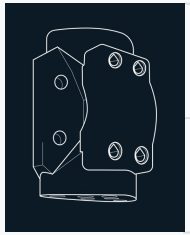


Saddle carrier

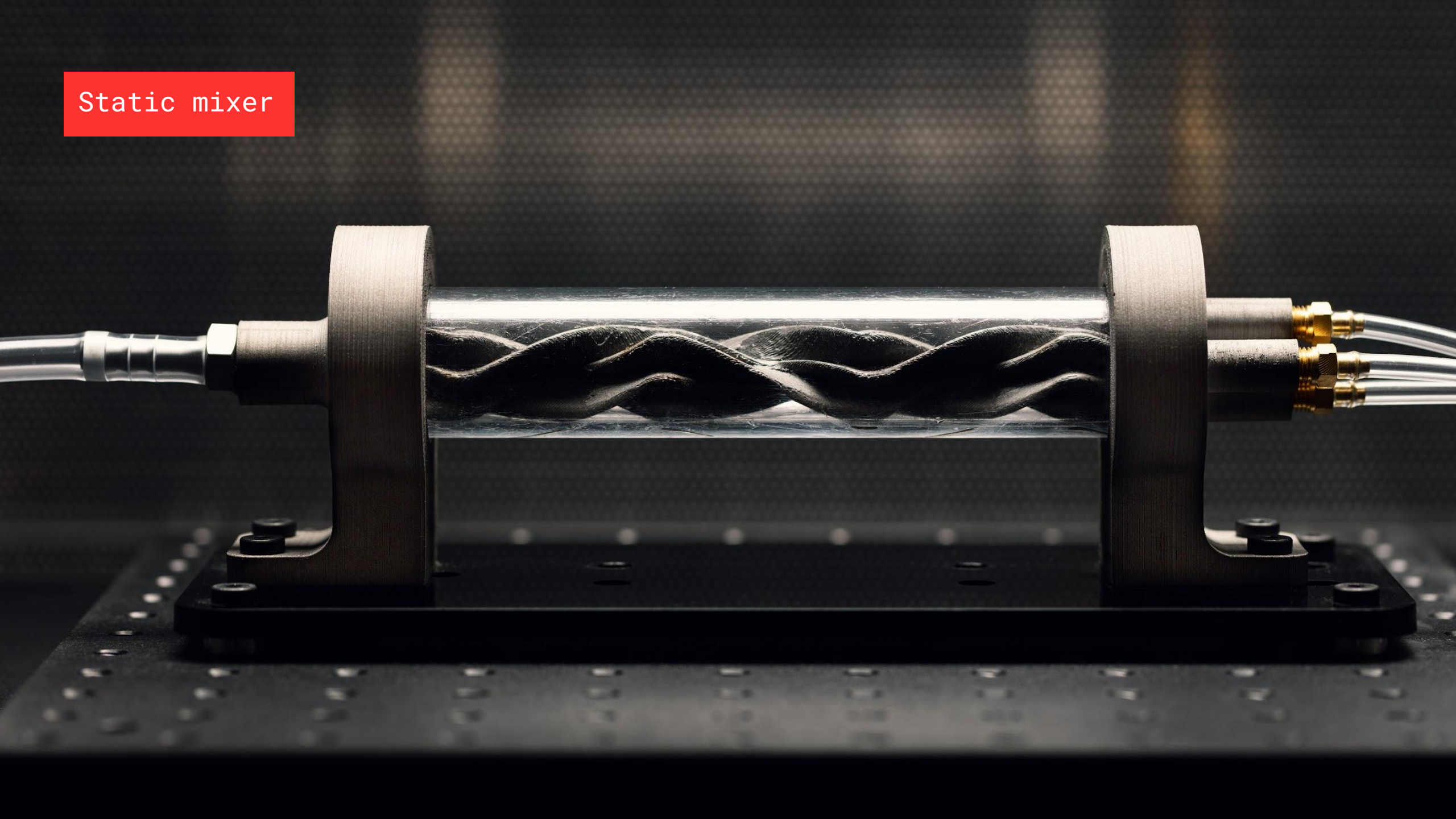


Engine components

- Design of a new internal combustion engine
- Rapid prototyping (20/month) critical to design iteration
- Must be metal (strength, thermal and chemical resistance)
- Printing connecting rods, swing arm, saddle carrier
- 25% shorter product development cycle
- 2.9 x 2.0 x 4.0 in (7.4 x 5.1 x 10.2 cm)



	Studio System™	CNC	Savings
Cost (for saddle carrier)	$148	$606	85% cheaper
Lead time (for saddle carrier)	4 days	2 wks	4x faster


Static mixer

Static mixer

- Precision engineered device for the continuous mixing of fluid materials using baffles (flow-directing vanes)
- Common applications include oil refinery, polymer production, and wastewater treatment
- Must be metal due to chemical resistance and strength
- Prototyping is critical: mixing depends on many variables including the fluids' properties and mixer design.
- 4.0 x 1.0 x 1.0 in (10.2 x 2.5 x 2.5 cm)

	Studio System™	**SLM**	**CNC**	**Savings**
Cost	$41	$896	N/A	>95% cheaper
Lead time	3 days	3 wks	N/A	4x faster

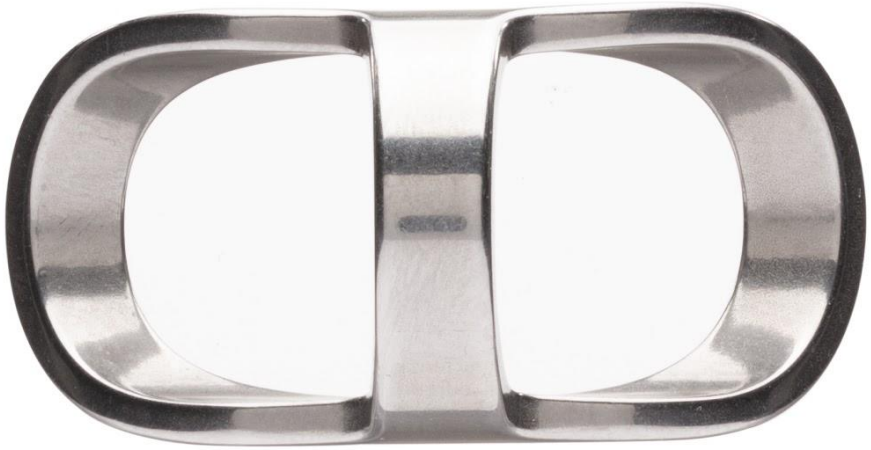
Orthotic finger splint

Desktop Metal

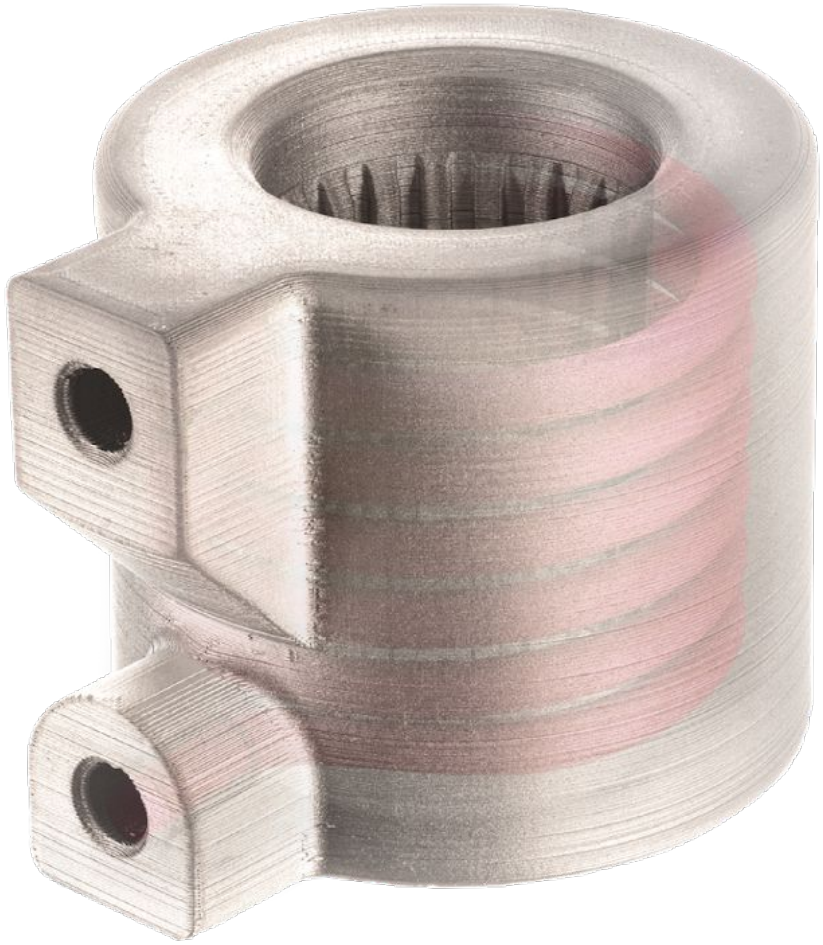
Orthotic finger splint

- Used to immobilize or limit range of motion for injured limbs
- Challenges:
  - Typically Injection-molded plastic in standard sizes, are brittle, often break, cannot be customized to improve fit, and “look medical.”
- Why 3D print:
  - Can be customized to improve fit, and are more durable and aesthetically pleasing.
- 4.0 x 1.0 x 1.0 in (10.2 x 2.5 x 2.5 cm)

	Studio System™	**SLM**	**CNC**	**Savings**
Cost	$xx	$xxx	N/A	>95% cheaper
Lead time	3 days	3 wks	N/A	4x faster



Heat exchanger



Desktop Metal

Heat exchanger

- asdf
- asdf
-
- 4.0 x 1.0 x 1.0 in (10.2 x 2.5 x 2.5 cm)

	Studio System™	SLM	CNC	Savings
Cost	$xx	$xxx	N/A	>95% cheaper
Lead time	3 days	3 wks	N/A	4x faster

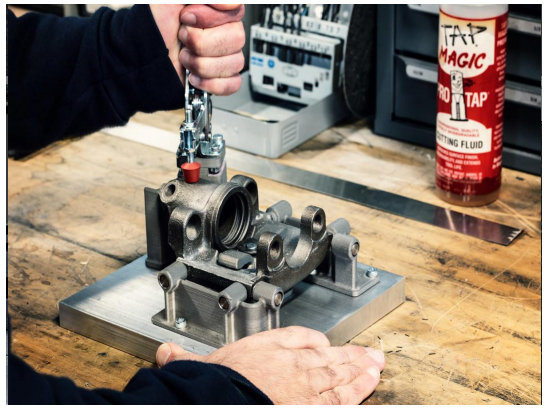
Impeller

- …
- …
- ...
- 4.0 x 1.0 x 1.0 in (10.2 x 2.5 x 2.5 cm)

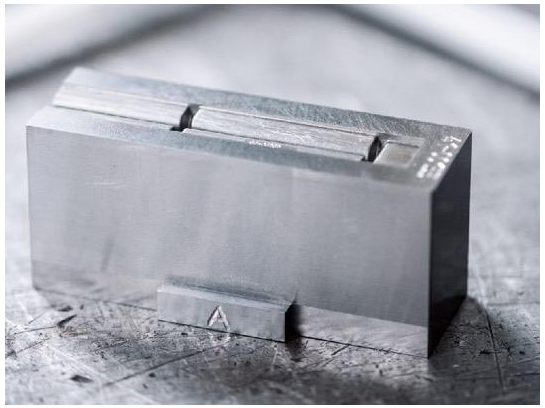
Studio System™

Four key use cases

Functional prototyping



Jigs & fixtures

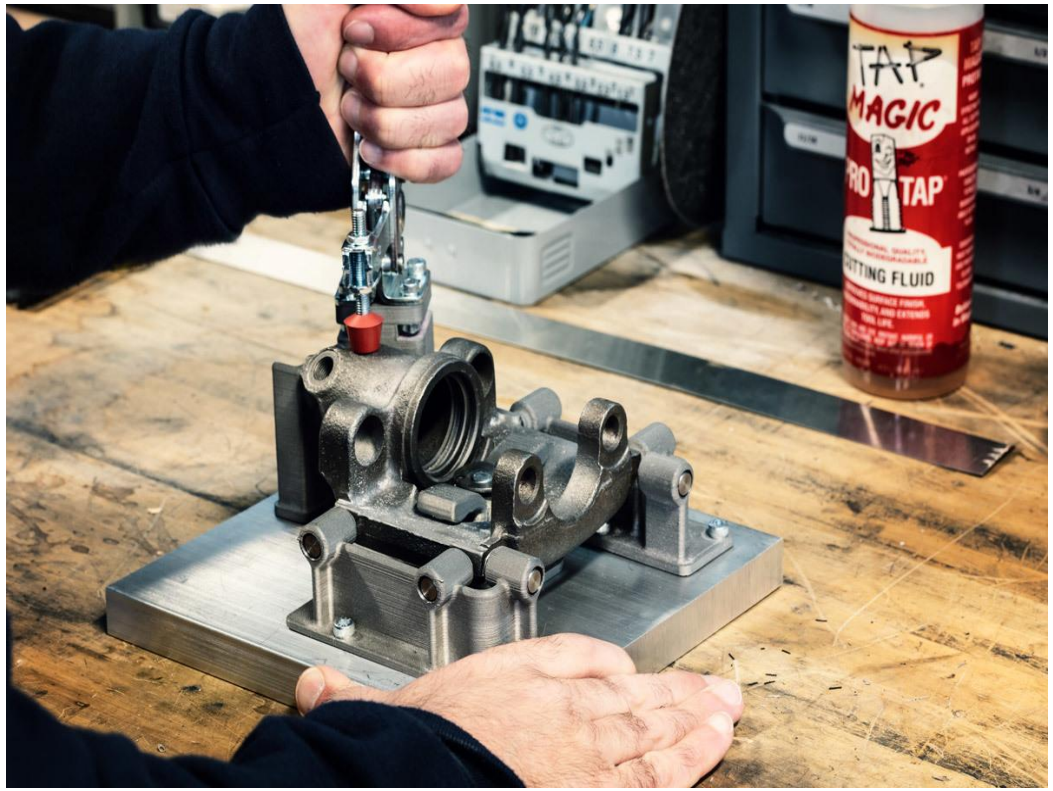


Manufacturing tooling

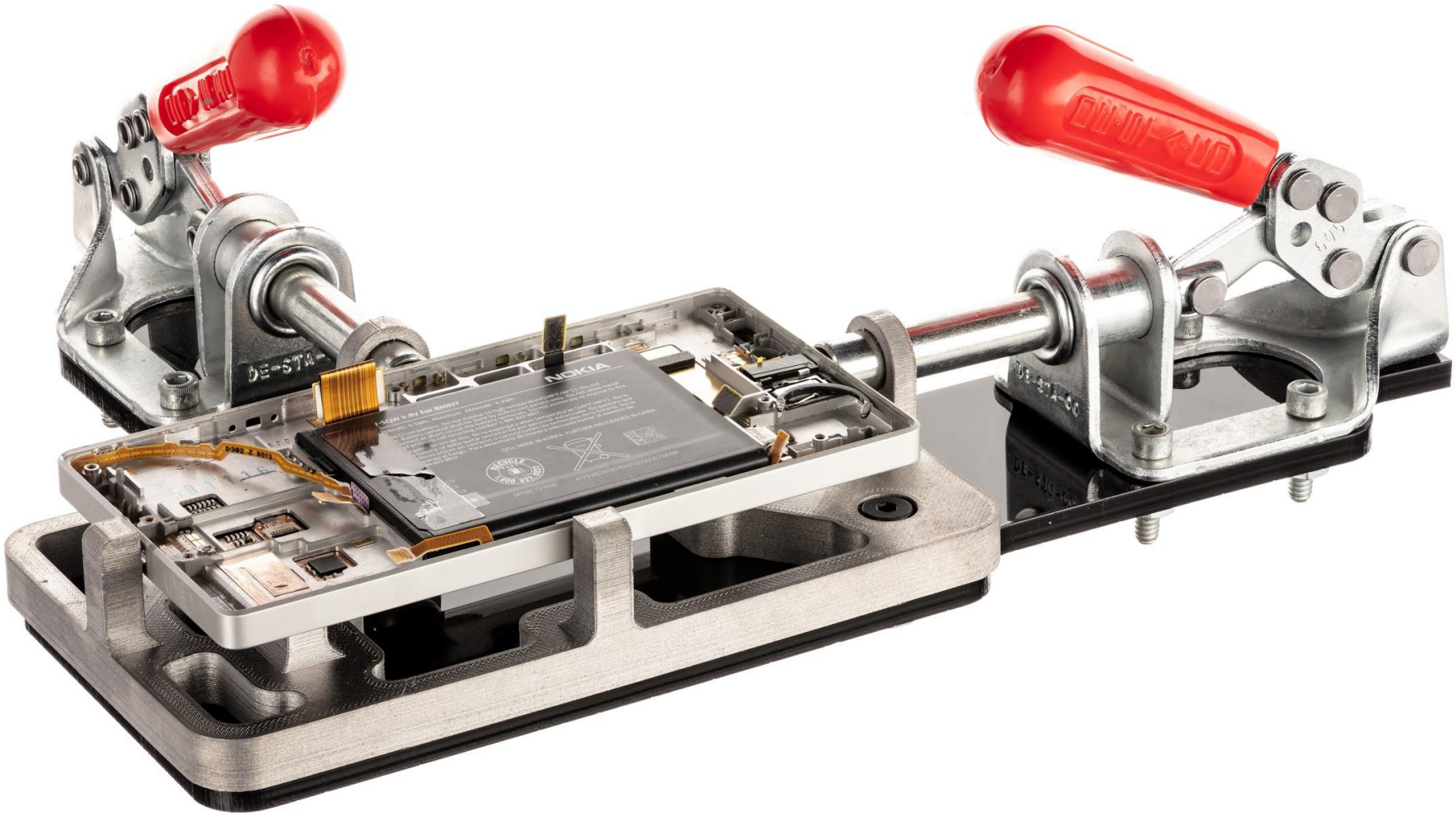
Low volume production

Jigs & fixtures

- Custom workholding fixtures provide manufacturing operation consistency, and minimize the need for highly skilled operators
- The fixtures' complex geometry can mean long lead times and high expenses
- Because many manufacturing operations include high forces, high heat, and abrasive chemicals, they require the use of metal jigs and fixtures
- Periodically wears out - must be quickly replaced to keep production line up
- Typically produced with labor-intensive machining operations due to the relatively low volume



Smartphone fixture

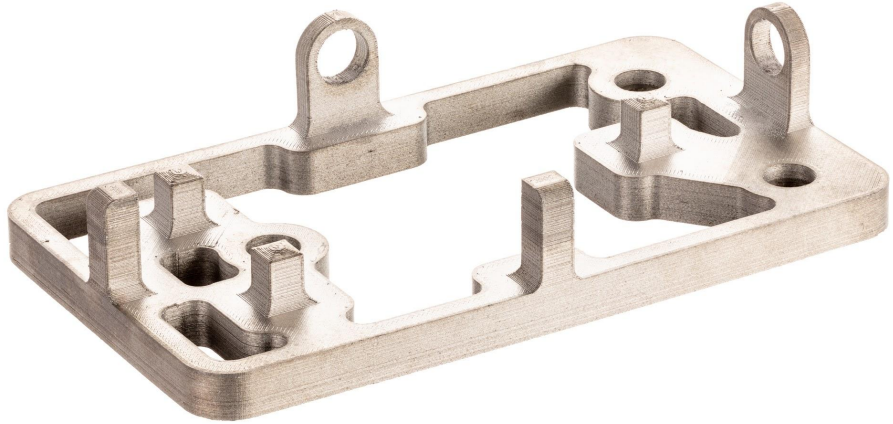


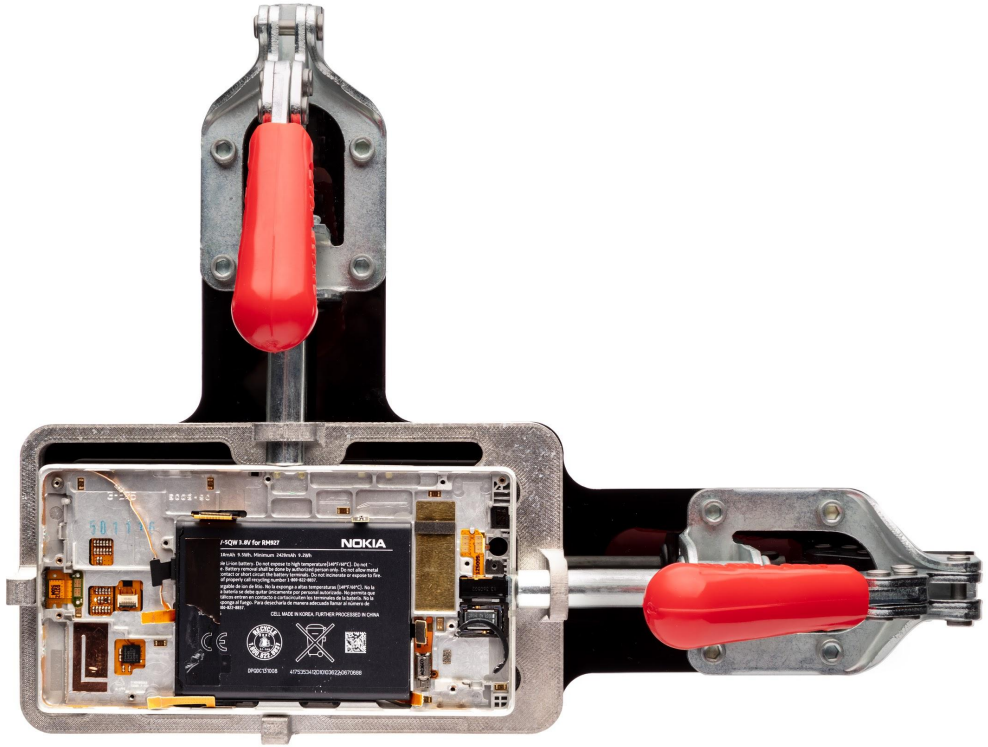
Desktop Metal

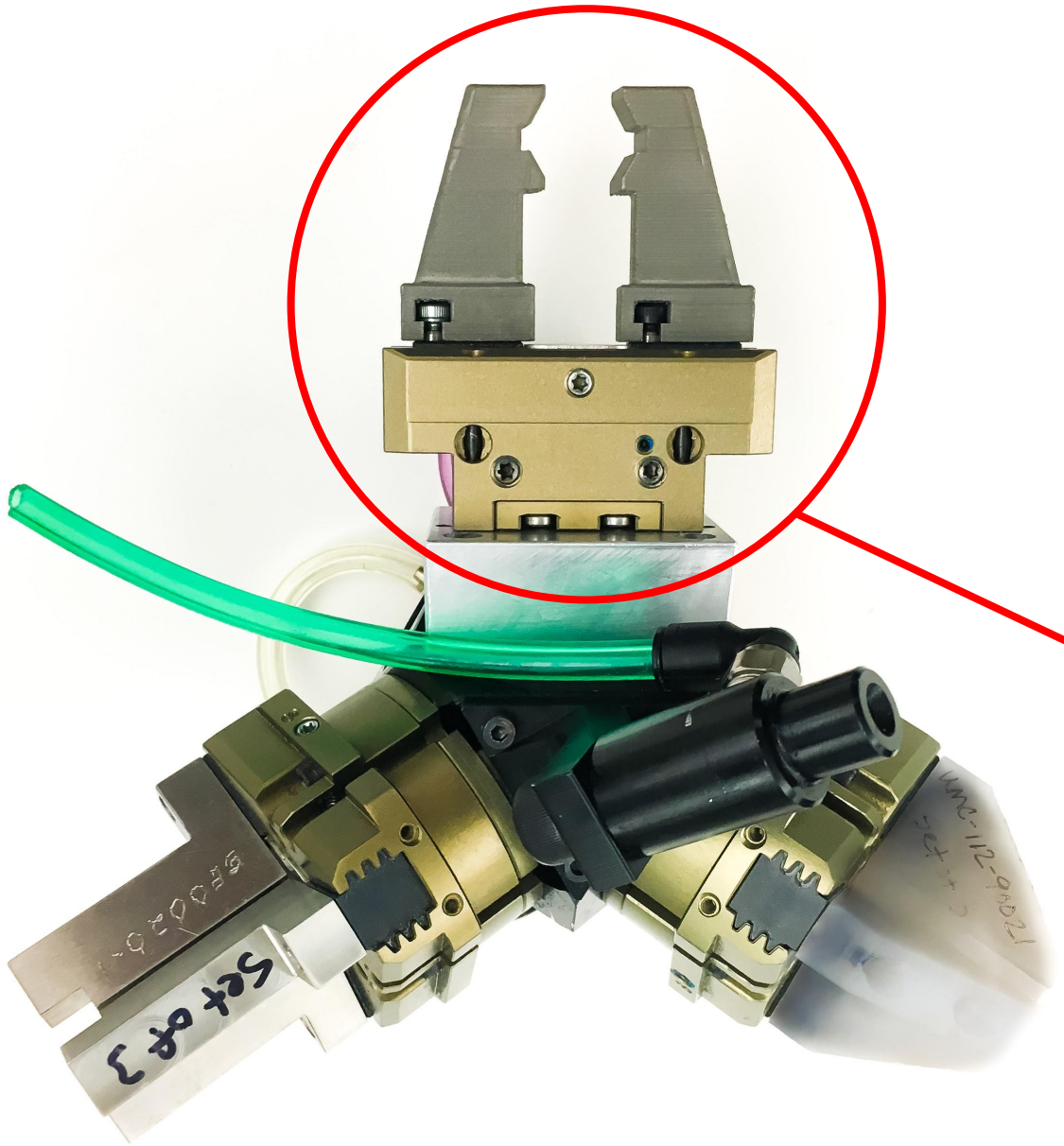
Smartphone fixture

- Used in many manufacturing operations, workholding fixtures are used for accurately locating subassemblies
- Because many manufacturing operations include high forces (e.g., during automated machining and assembly operations), and/or heat (e.g., during soldering), fixtures must be metal
- Fixtures commonly contain complex custom geometry and are produced in low volume, typically requiring CNC machining
- CNC capacity (machines and operators) can be a bottleneck ⇒ 3D printing eliminates much of the lead time and labor
- When they periodically wears out, fixtures must be quickly replaced to keep production line up
- 7.5 x 4.3 x 1.6 in (19.1 x 10.9 x 4.0 cm)

	Studio System™	**SLM**	**CNC**	**Savings**
Cost	$150	$1500	$450	65-90% cheaper
Lead time	5 days	3 wks	2 wks	4x faster





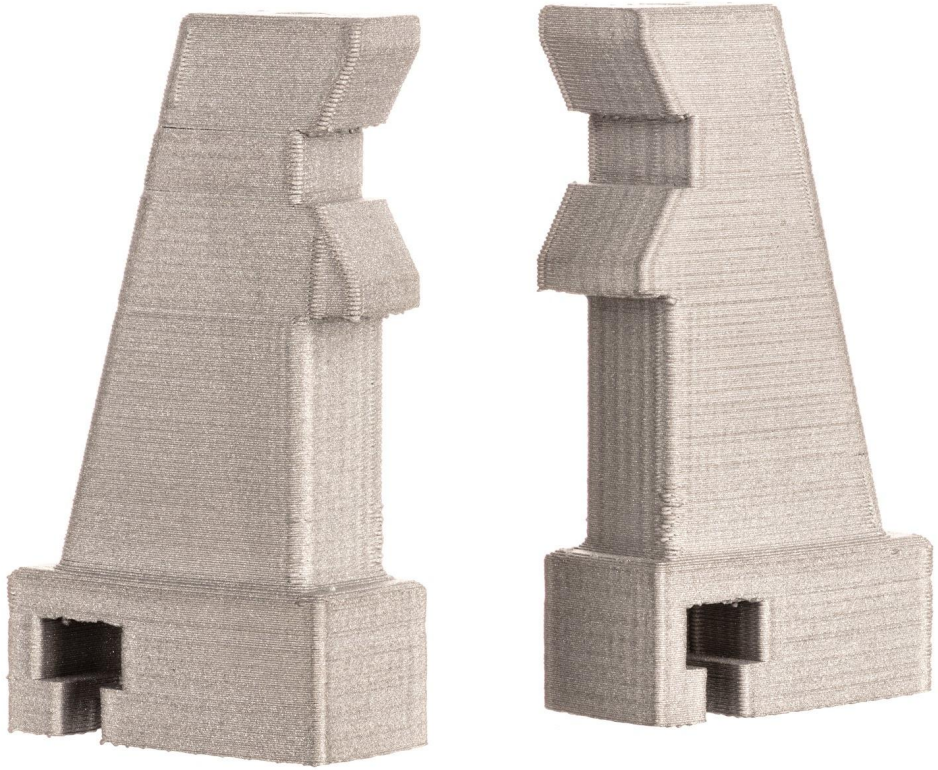


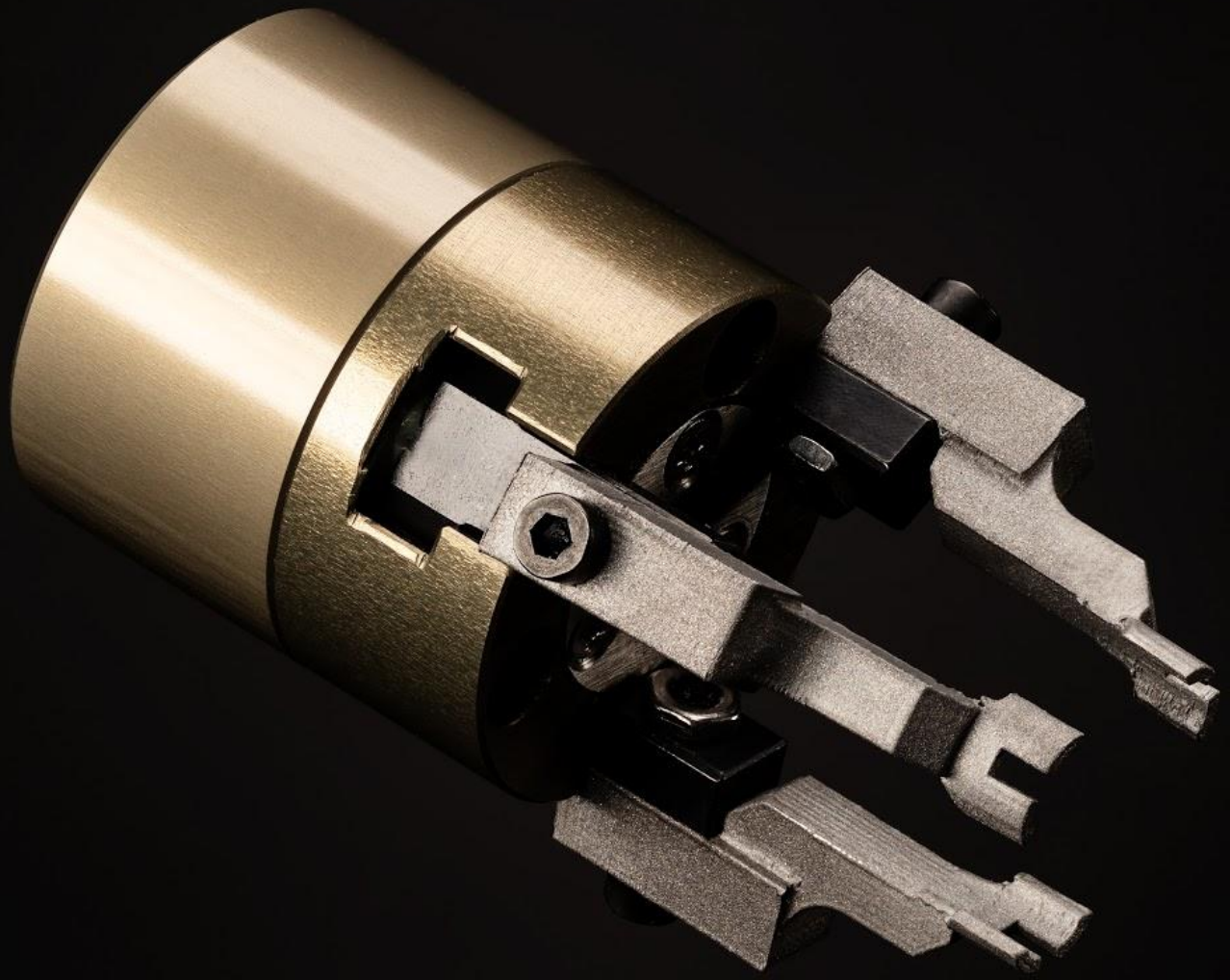
Robotic end effectors

Robotic end effectors

- Used in many manufacturing operations, end effectors are used for fixturing and moving components (aerospace forgings in this case)
- Commonly contain complex custom geometry and are produced in low volume
- Custom geometry and low volume is associated with long lead times and high manufacturing costs
- CNC capacity (machines and operators) can be a bottleneck ⇒ 3D printing eliminates much of the lead time and labor
- If an end effector is to break, the manufacturing line is shut down until it is replaced
- Saves >12 hrs of CNC time, uses 1.5 hrs of post processing with a Bridgeport instead
- 1.9 x 1.3 x 0.5 in (4.9 x 3.2 x 1.2 cm)

	Studio System™	**SLM**	**CNC**	**Savings**
Cost	$28	$181	$165	>80% cheaper
Lead time	4 days	2 wks	2 wks	4x faster





Robotic end effectors

Robotic end effectors

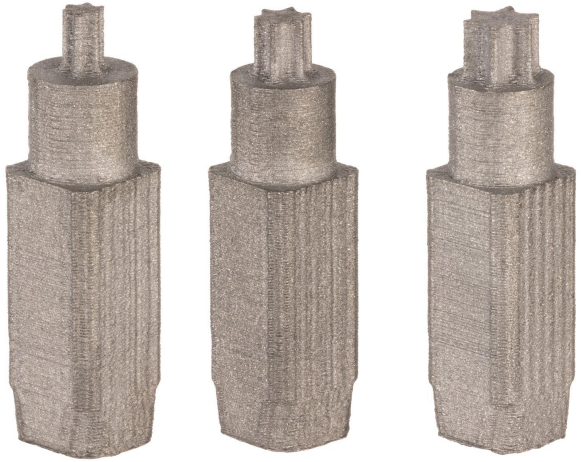
- Used in many manufacturing operations, end effectors are used for fixturing and moving components (installing a precision-engineered O-ring in this case)
- Commonly contain complex custom geometry and are produced in low volume
- Custom geometry and low volume is associated with long lead times and high manufacturing costs
- CNC capacity (machines and operators) can be a bottleneck ⇒ 3D printing eliminates much of the lead time and labor
- If an end effector is to break, the manufacturing line is shut down until it is replaced
- Swappable high resolution printhead allows for smaller parts with finer features (with sintered voxels as tiny as 240 microns in XY by 45 microns in Z)
- 1.4 x 0.3 x 0.5 in (3.6 x 0.8 x 1.2 cm)

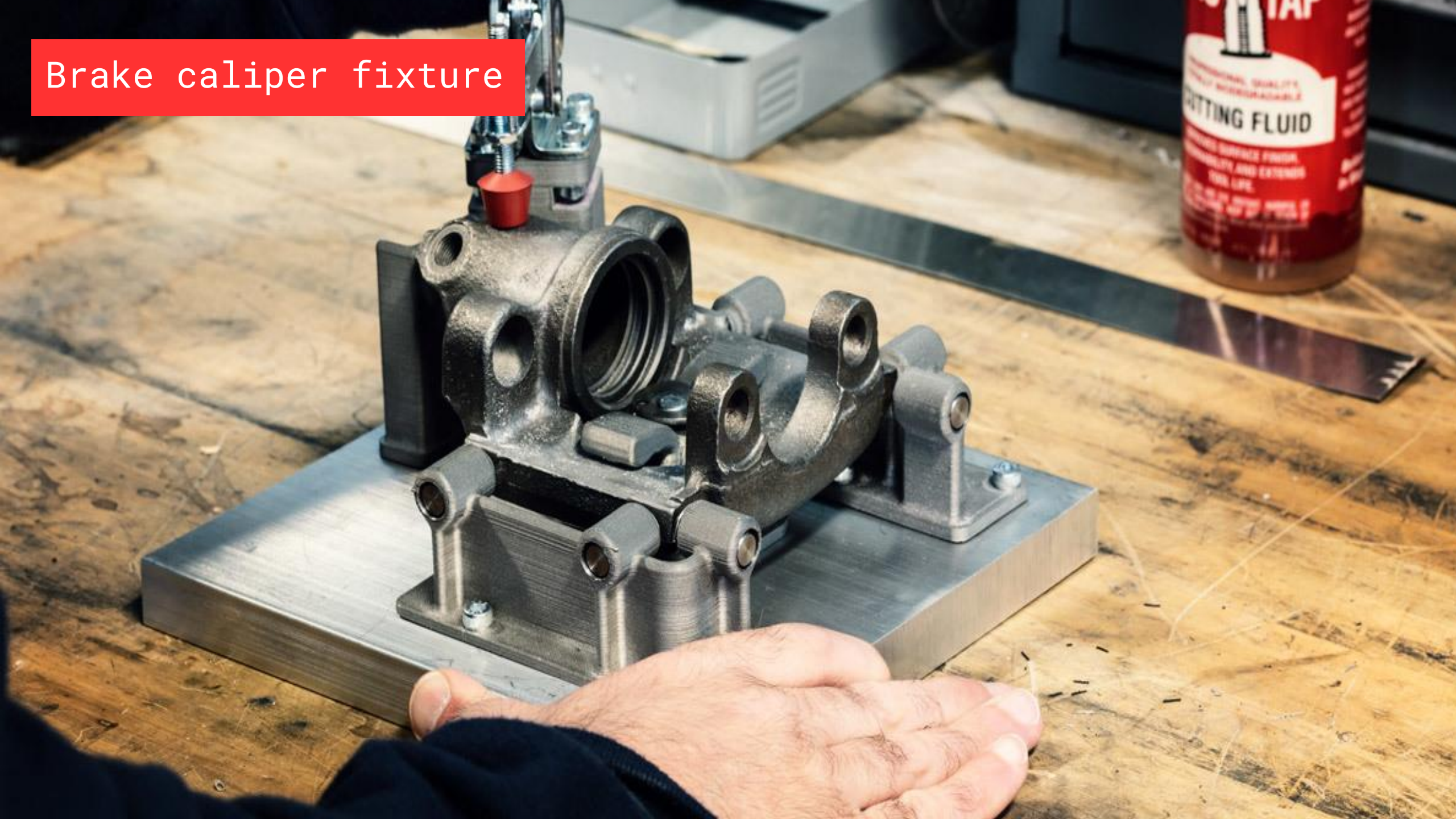
	Studio System™	**CNC**	**Savings**
Cost	$6	$150	>95% cheaper
Lead time	3 days	2 wks	>5x faster

Custom nut drivers

- Used in many manufacturing operations, custom nut drivers typically feature a standard interface on one end, and a custom robot-specific interface on the other end
- Commonly contain complex custom geometry and are produced in low volume
- 3D printing eliminates much of the lead time and labor associated with precision CNC work
- If the driver is to break, the manufacturing line is shut down until it is replaced
- Swappable high resolution printhead allows for smaller parts with finer features (with sintered voxels as tiny as 240 microns in XY by 45 microns in Z)
- 1.2 x 0.3 x 0.3 in (3.0 x 0.8 x 0.8 cm)

	Studio System™	**SLM**	**CNC**	**Savings**
Cost	$6	$292	$122	>80% cheaper
Lead time	3 days	2 wks	2 wks	4x faster




Brake caliper fixture
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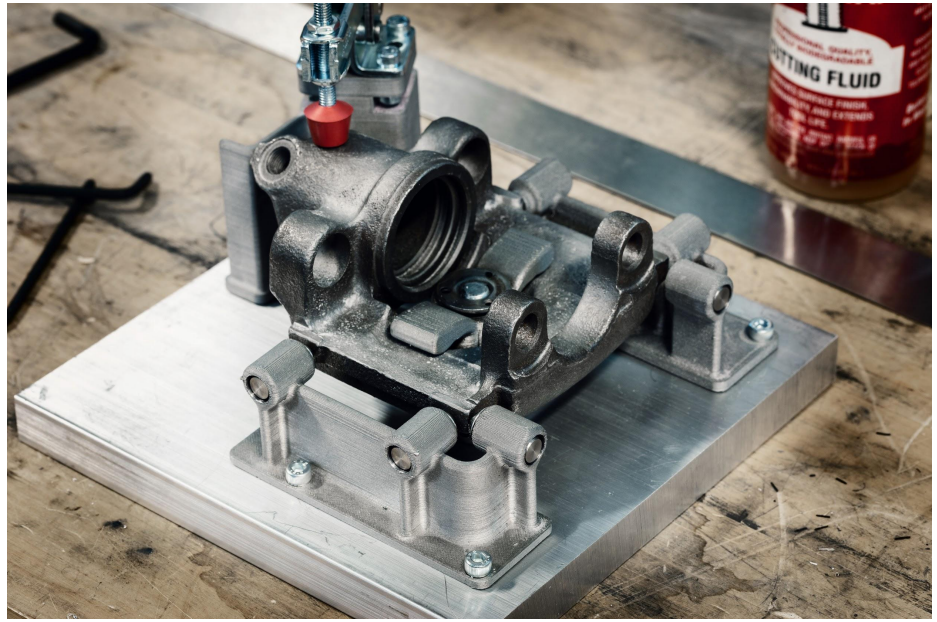
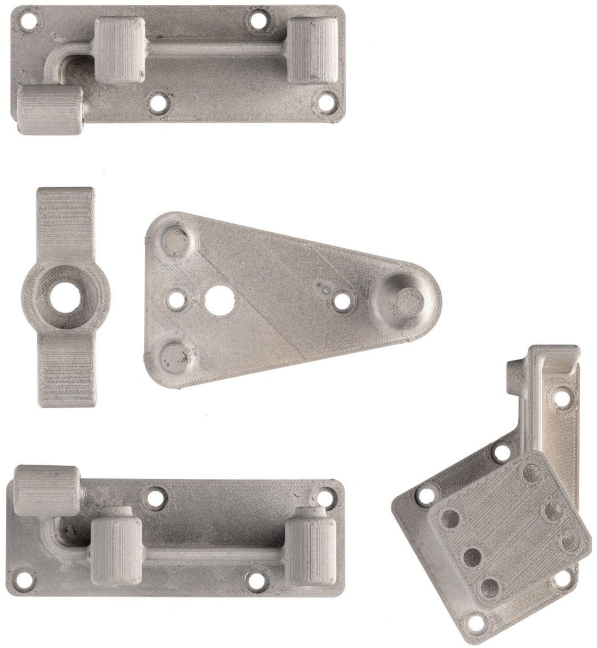
Brake caliper fixture

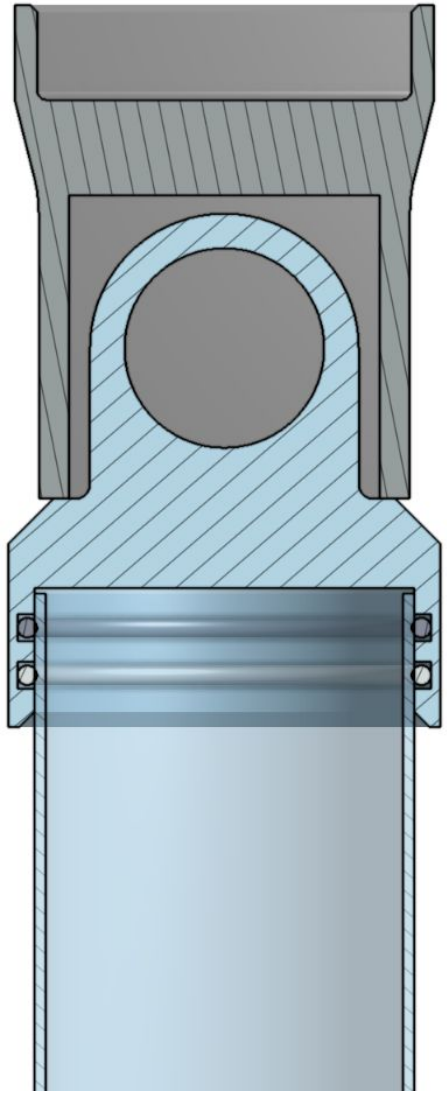
- Fixture holds brake caliper in place for machining
- Must be steel due to strength and stiffness requirements
- With the freedom of geometry that is provided with the Studio System designers can design for the fixtures' application, rather than constrained by how it's going to be manufactured
- With the Studio System the lead time and costs of custom fixturing is greatly reduced

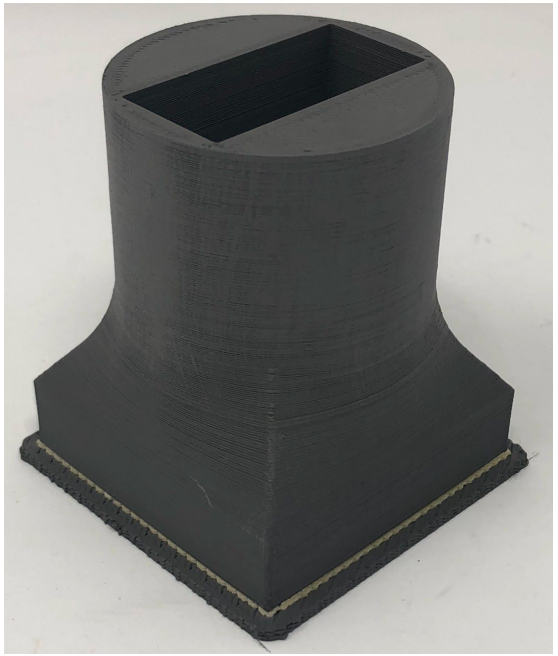




Arbor press fixture

- Complex geometry sometimes needs to be used in conjunction with an arbor press which has only a generic ram
- Must be steel due to strength and stiffness requirements
- With the freedom of geometry that is provided with the Studio System designers can design for the fixtures' application, rather than constrained by how it's going to be manufactured
    - Deep pockets on this part would make it difficult to machine
- With the Studio System the lead time and costs of custom fixturing is greatly reduced

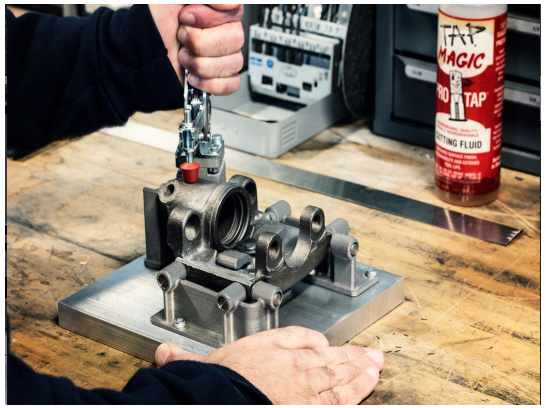




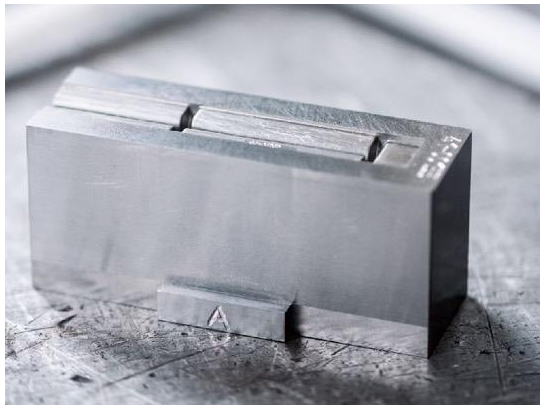
Studio System™

Four key use cases

Functional prototyping



Jigs & fixtures

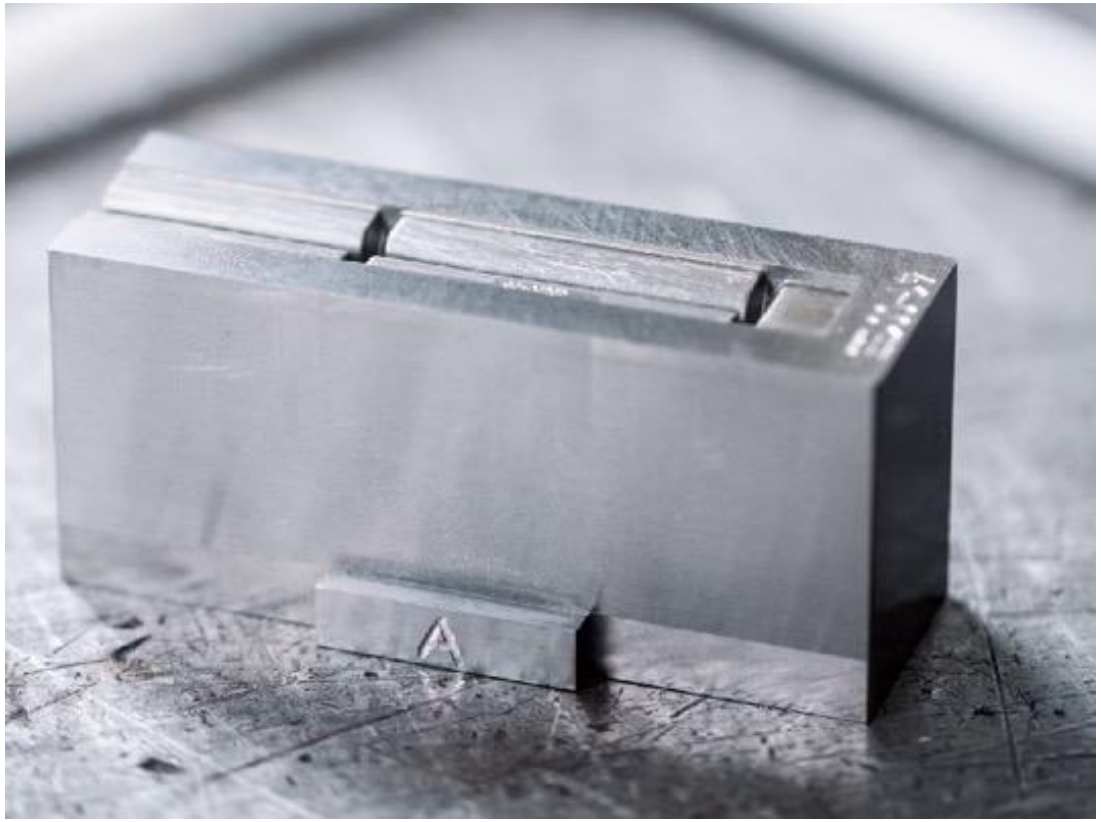


Manufacturing tooling

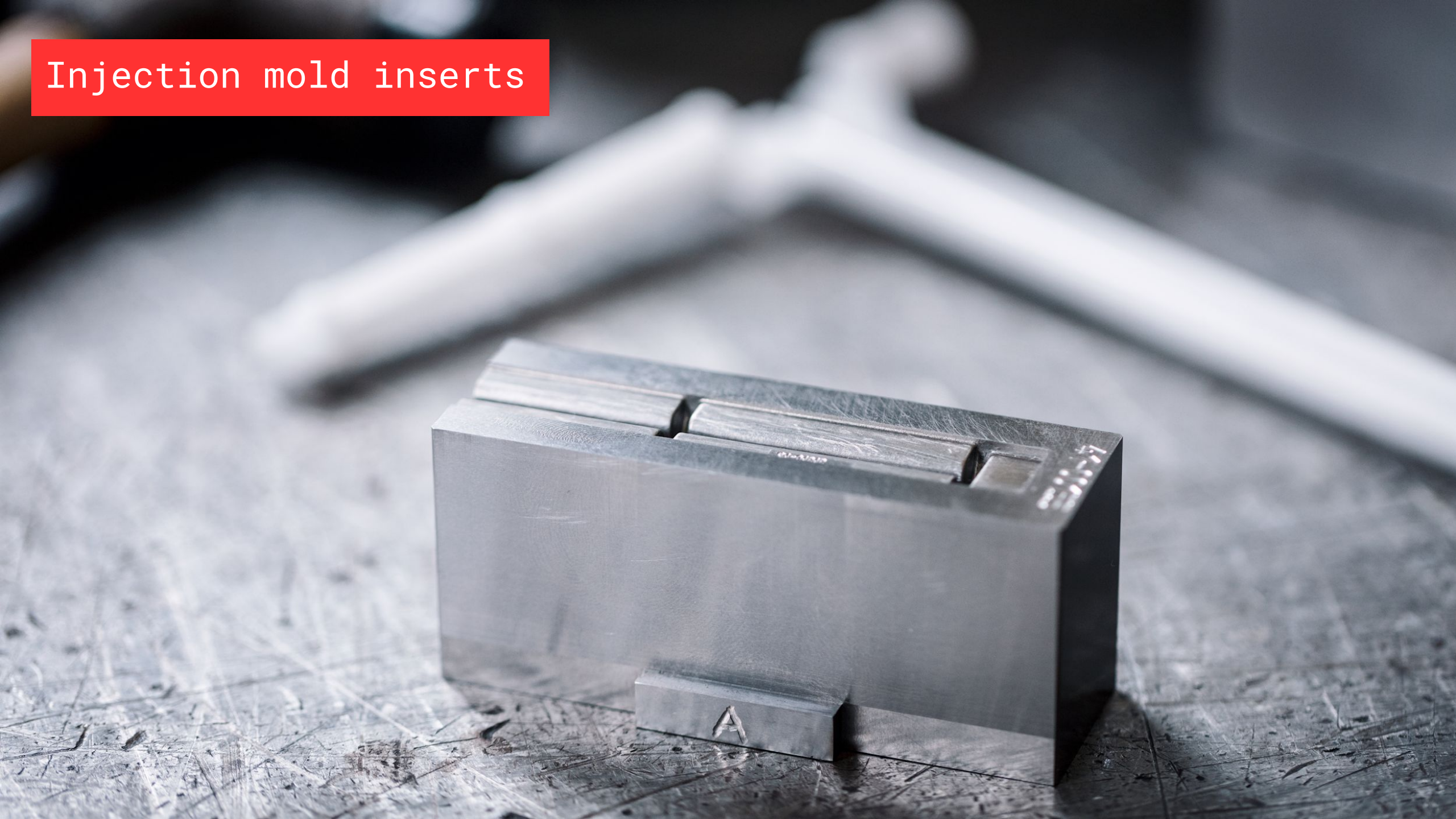
Low volume production

Manufacturing tooling

- Parts with complex geometries difficult (or impossible) to produce with conventional mfg methods
- Reduced tooling costs for short production runs
- Shorten tooling lead times
- Quicker tooling iteration
- Quickly replace defective tooling



Injection mold inserts



Injection mold inserts

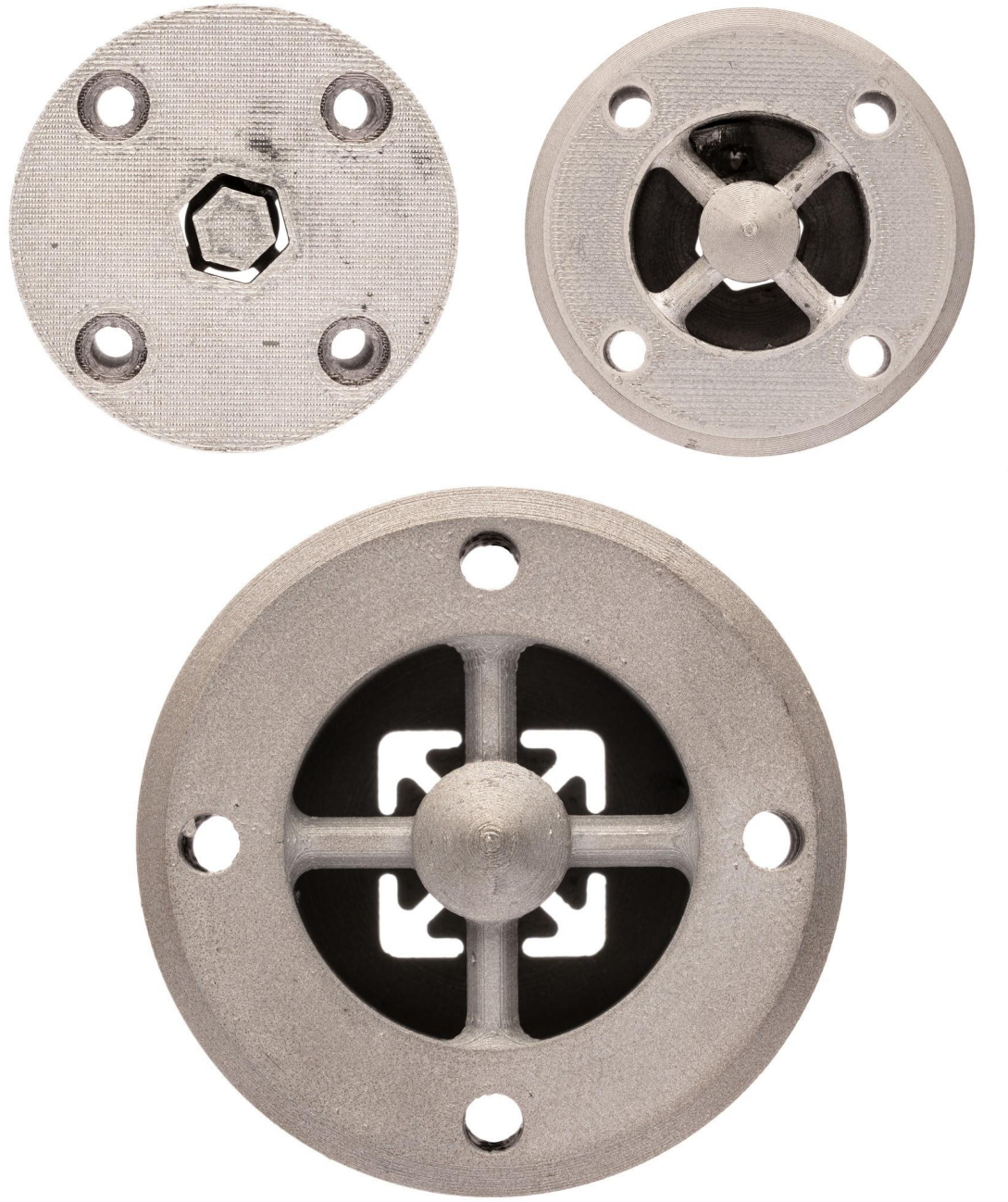
- Mold shops are under increasing cost and lead time pressures
- Design changes can have a significant impact on time and cost, so the ability to iterate quickly is critical
- Studio System allows mold makers to iterate on mold insert designs faster and at a lower cost
- Printing conformal cooling channels improves throughput
- 1.0 x 1.4 x 3.1 in (2.5 x 3.6 x 7.9 cm)

	Studio System™	SLM	CNC	Savings
Cost	$47	N/A	$493	>90% cheaper
Lead time	3 days	N/A	2 wks	4x faster

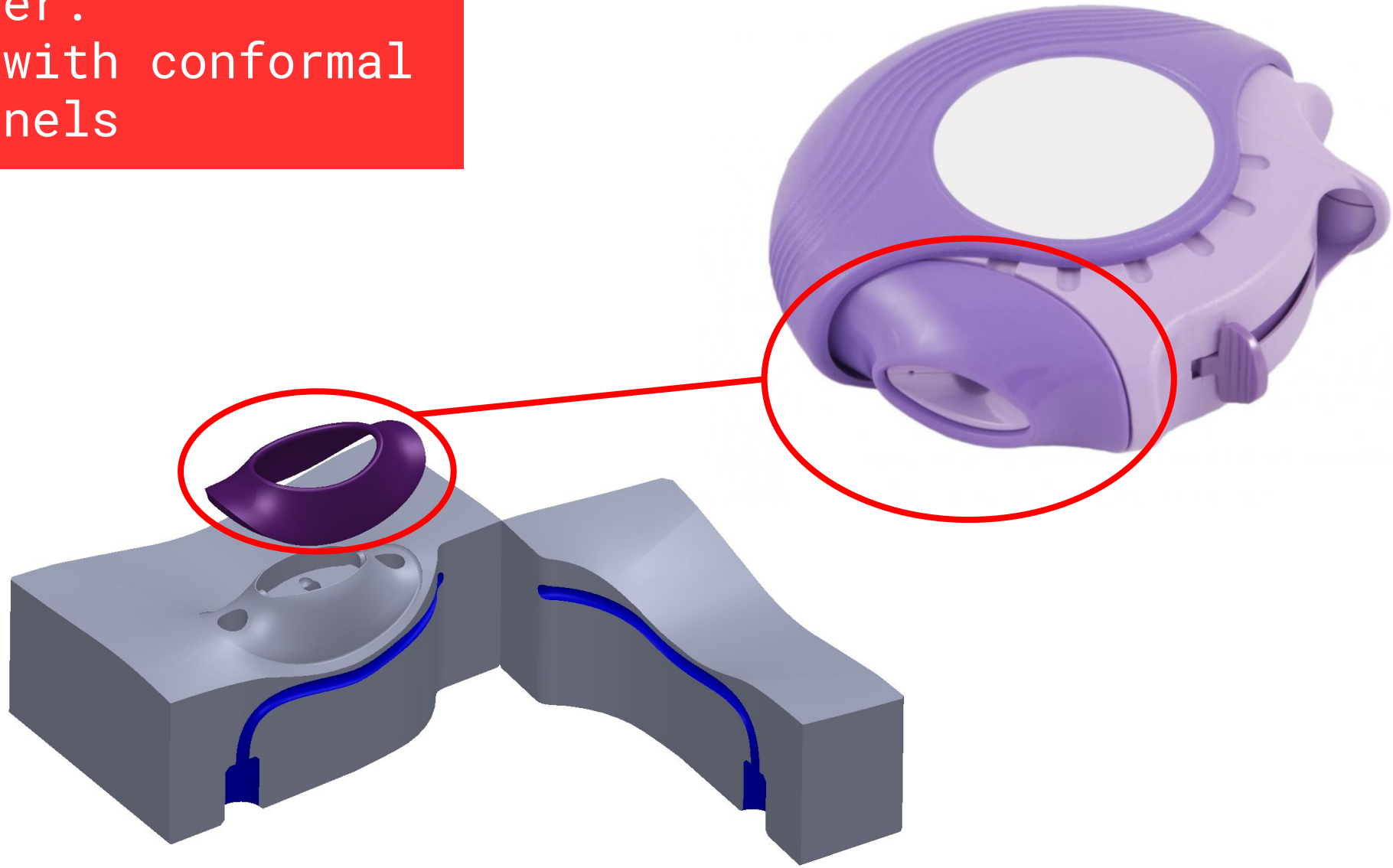
Extrusion dies

- Extrusion is typically used for high volume production due to high tooling cost
  - With metal 3D printing, the cost of tooling is dramatically reduced - allowing for low volume extrusion runs
- Metal is a necessity due to the high heat and pressure necessary for extrusion
- Iterating on a die design is challenging due to the high costs and leads times
  - With the Studio System, lead times and costs are dramatically reduced - allowing rapid iteration and refinement of the die design
- 2.2 x 2.2 x 1.7 in (5.7 x 5.7 x 4.4 cm)

	Studio System™	SLM	CNC	Savings
Cost	$58	$1,692	N/A	>96% cheaper
Lead time	4 days	2 wks	N/A	4x faster



Asthma inhaler:
Mold insert with conformal cooling channels



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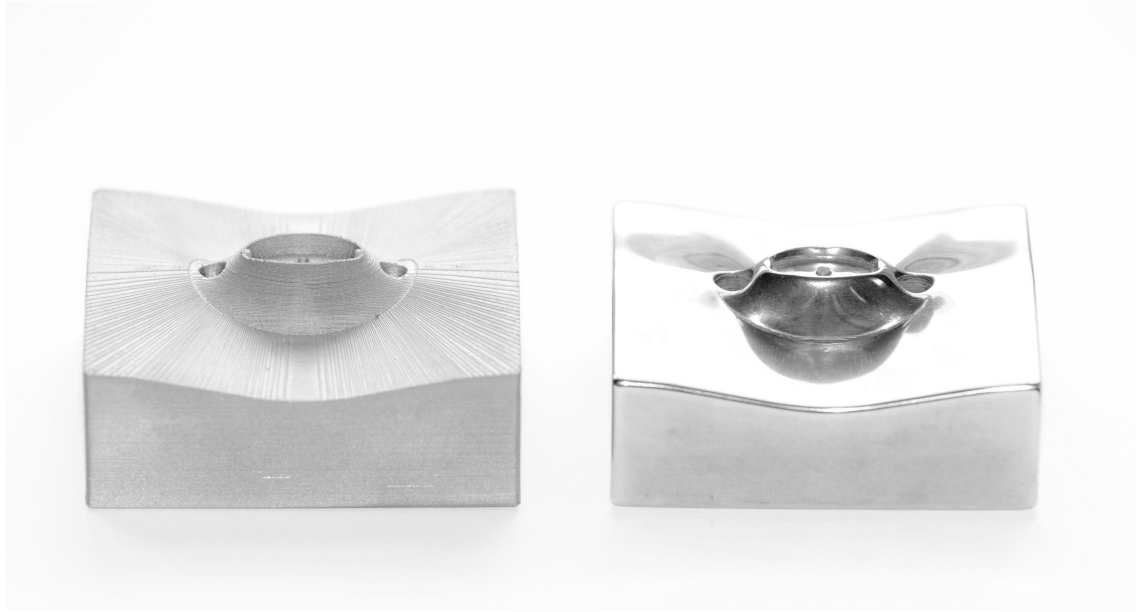
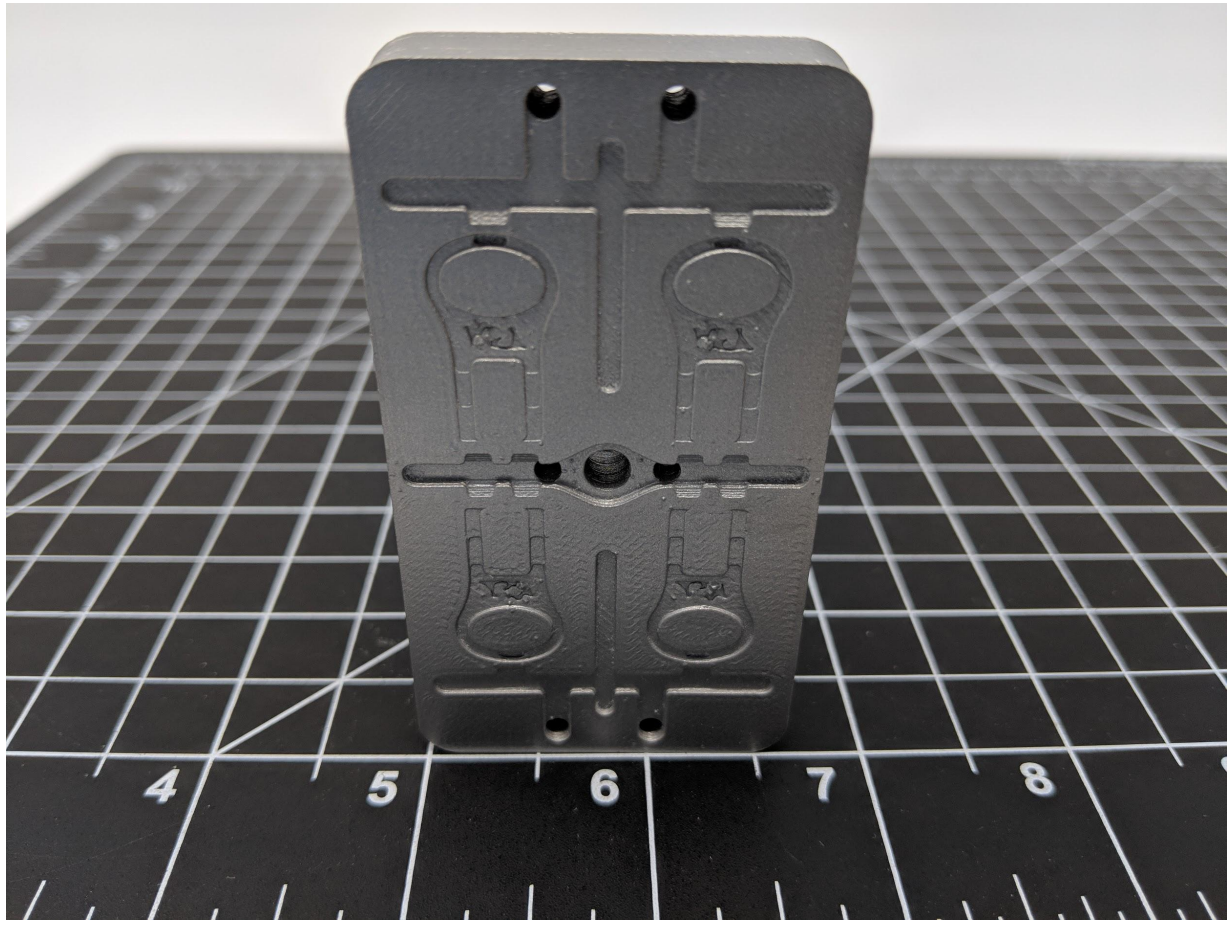
Mold insert with conformal cooling channels

- Printing near net shape reduces 95% of CNC machining
- Mold insert with internal conformal cooling channels for injection molding
- During the injection molding process cooling can account for up to 95% of the cycle time
- Using internal conformal cooling channel results in an increase in part quality and a reduction of cycle time allowing up to 40% more throughput
- The high temperatures and pressures of injection molding make metal mold inserts a necessity
- 3D printing the inserts shortens production run lead time
- 4.0 x 3.5 x 1.8 in (10.2 x 9.0 x 4.5 cm)



	Studio System™	SLM	CNC	Savings
Cost	$160	$3,184	$933 (w/o internal cooling channel)	83-95% cheaper

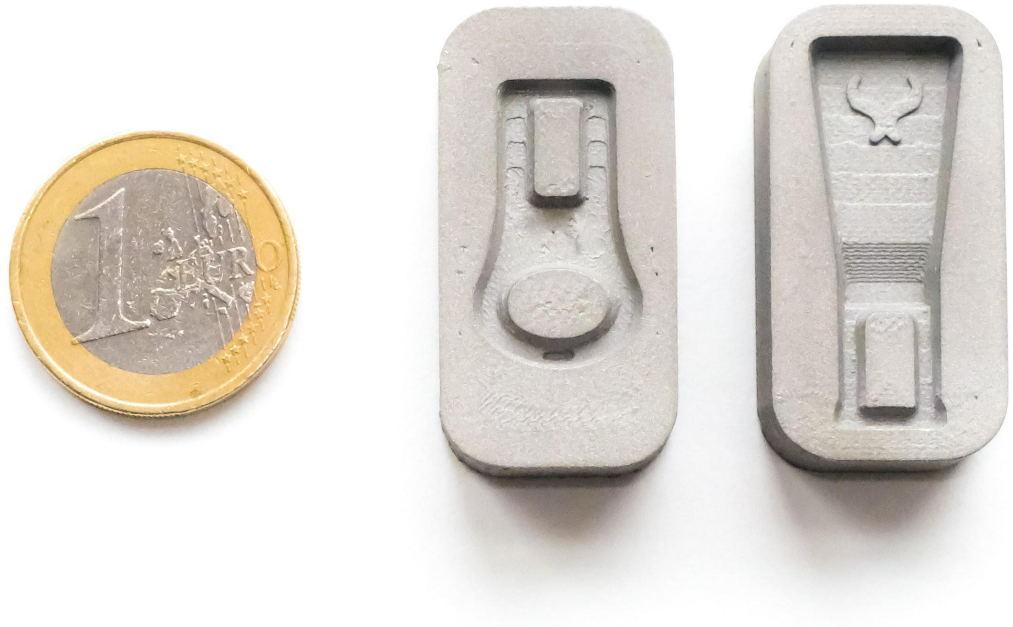
Zipper mold inserts



Desktop Metal

Zipper mold inserts

- 3D printing the mold inserts shortens production run lead time and allows rapid iteration and refinement
- Zippers are a fashion element ⇒ Ability to market test is key
- Swappable high resolution printhead allows for smaller parts with finer features (with sintered voxels as tiny as 240 microns in XY by 45 microns in Z)
- Required precision not achievable via SLM
- 1.7 x 0.8 x 0.6 in (4.2 x 2.1 x 1.4 cm)

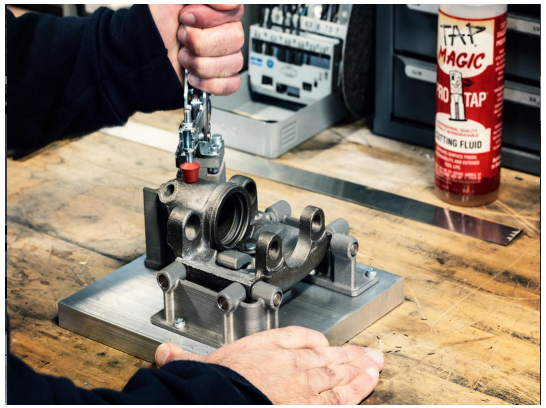


	Studio System™	SLM	CNC	Savings
Cost	$15	N/A	$119	8X cheaper
Lead time	4 days	N/A	2 wks	3x faster

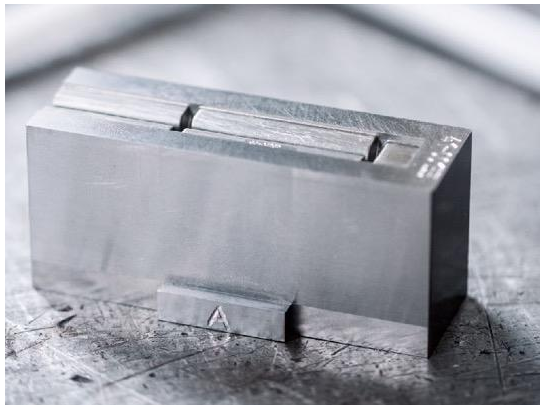
Studio System™

Four key use cases

Functional prototyping



Jigs & fixtures



Manufacturing tooling

Low volume production

Desktop Metal

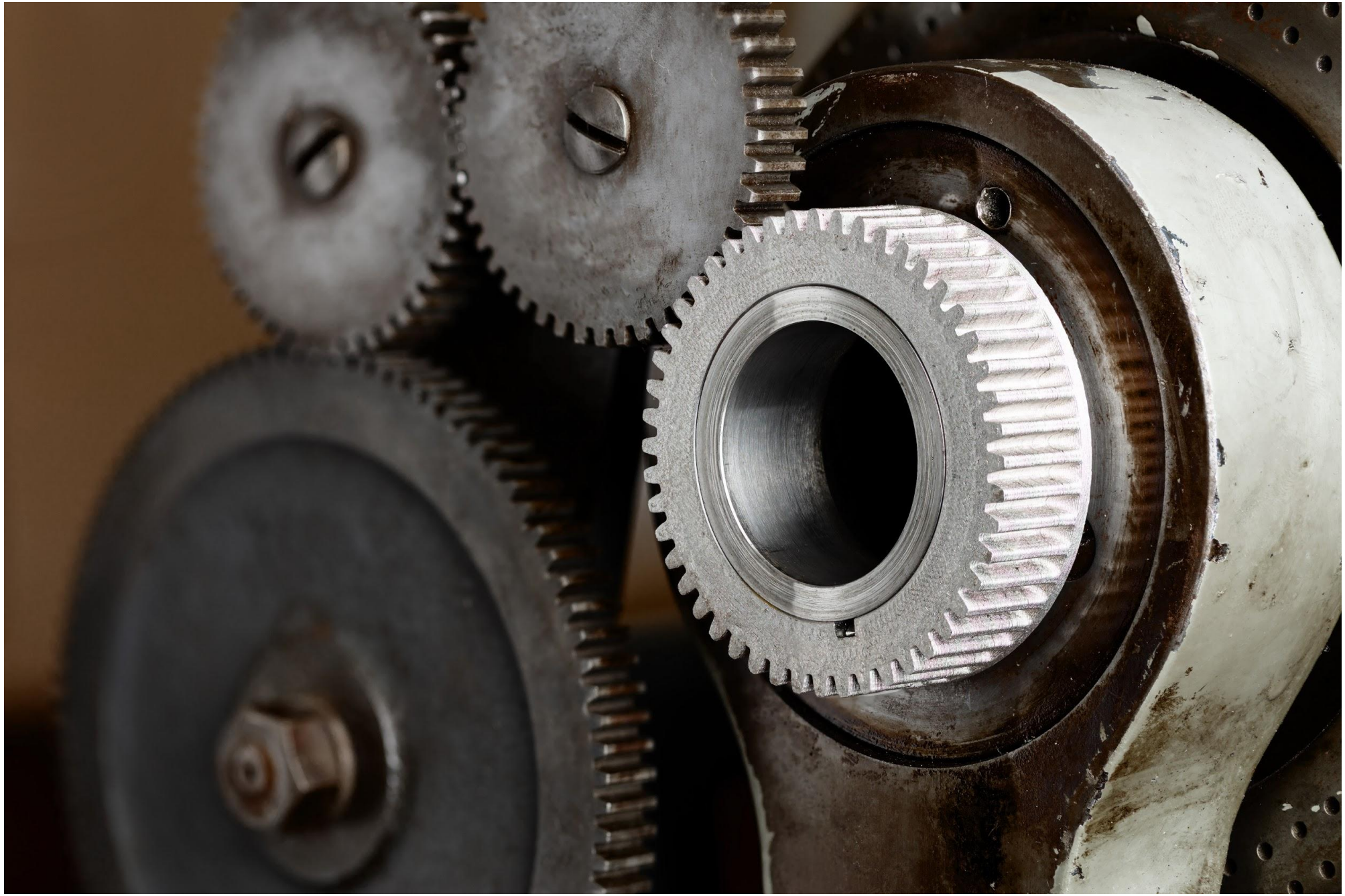
Low volume production

- No tooling required
- Short lead times
- Customization
- On-demand production
- Replacement parts
- Design flexibility for new/innovative products

Low volume production: Three common scenarios

- Specialized / custom applications
  - Small production runs (<500 assemblies)
  - Capital equipment (e.g., packaging machinery)
- Aftermarket parts
  - Original part production is shut down, or cost-prohibitive to reactivate (including tool maintenance)
  - Example: 40+ year SLA to guarantee spare part availability of thousands of SKUs with worldwide demand of ~10/month
- Pilot runs prior to mass production
  - Development, testing, certification, market testing, localization
  - Prior to sign-off on expensive tooling
  - Example: automotive and consumer pilot runs are often in quantities of 100’s to 1000’s

Lathe gear



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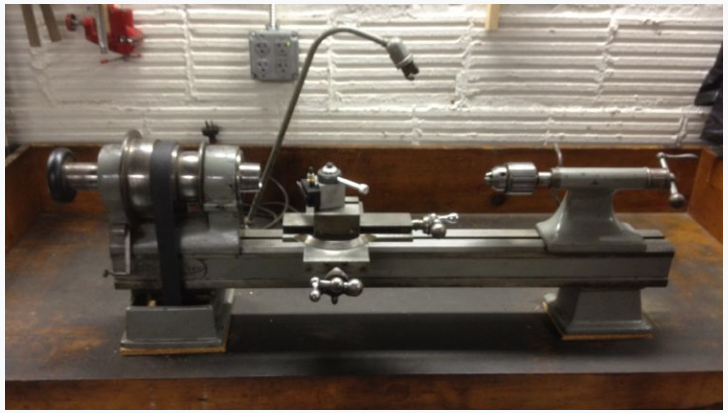
Lathe gear

- Replacement gear for vintage lathe
- Must be metal due to strength and hardness
- Often, no obvious source of replacement parts
- Prohibitively expensive to have a gear maker cut the gear
- Maintenance Repair and Operations (MRO) parts can be great candidates for 3D printing
- 2.5 x 2.5 x 0.8 in (6.4 x 6.4 x 1.9 cm)



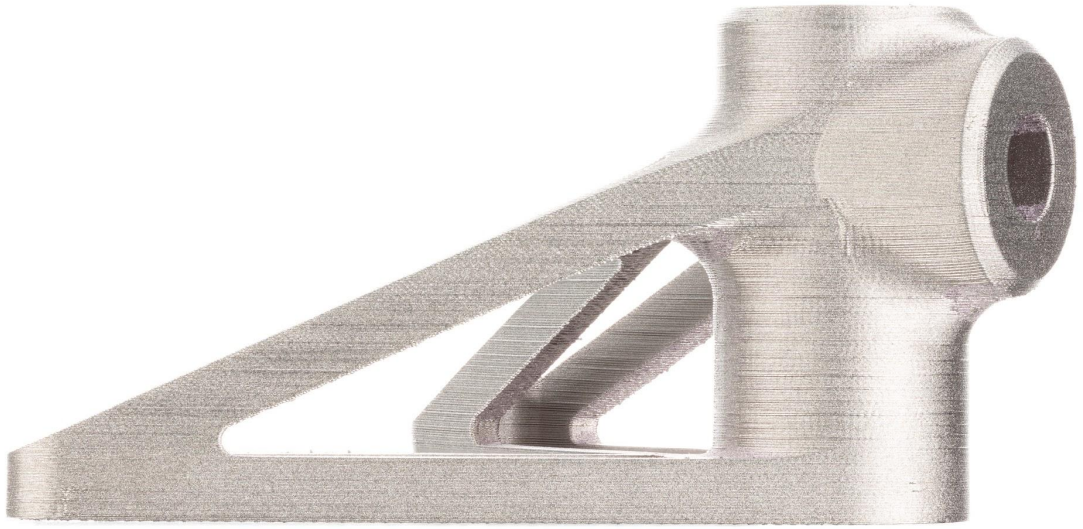
	Studio System™	SLM	CNC	Savings
Cost	$56	$585	$340*	80-90% cheaper
Lead time	4 days	2 wks	2 wks	5x faster

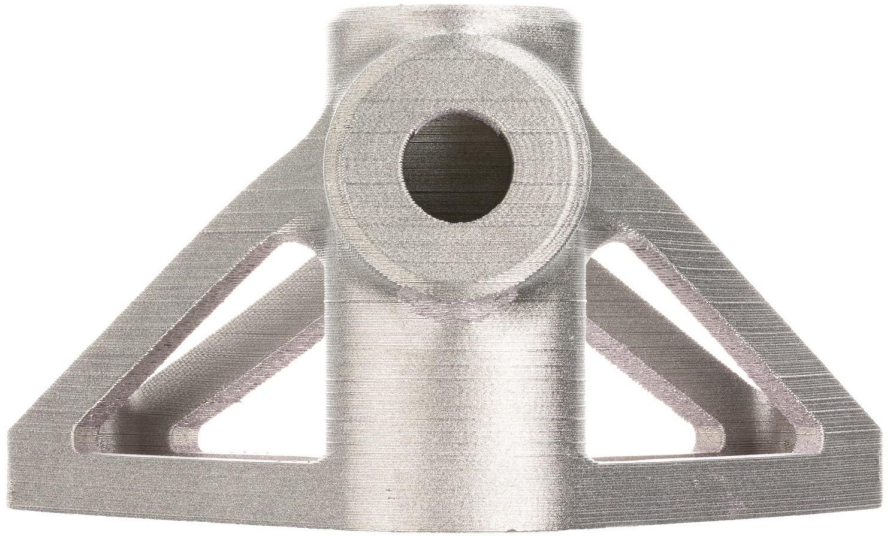
Battlebots SawBlaze backstop

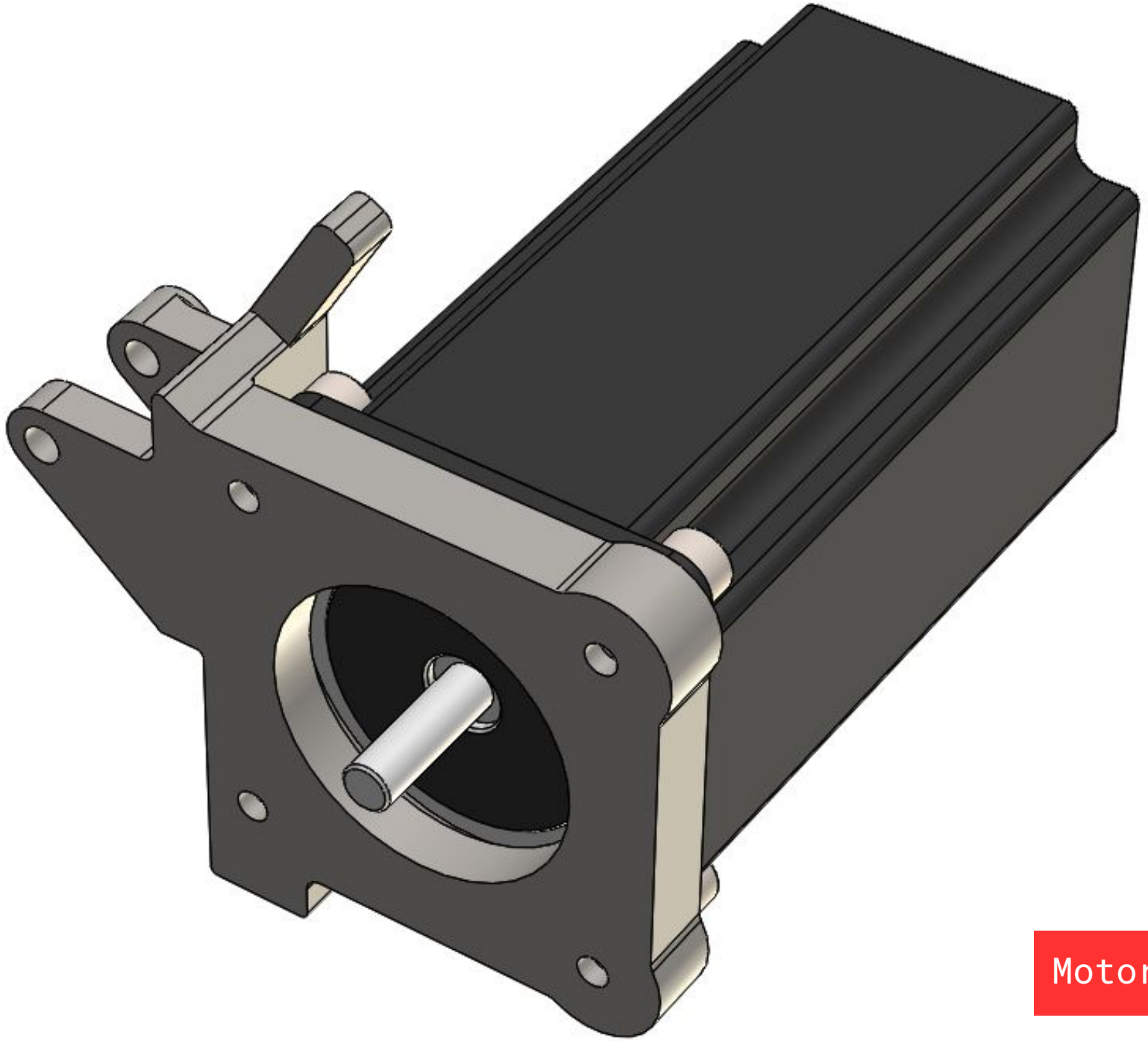
Battlebots SawBlaze backstop

- Support for BattleBot fighting robot's saw arm
- Structural member - must resist bending and lateral motion
- Must be metal due to: Stiffness, strength, hardness, weldability, fire resistance
- Complex geometry due to strength/weight constraints
- Lead time was critical (1 month to build entire robot)
- Part functioned flawlessly: Performed as intended, withstood extensive stresses without failure and was key to robot's success
- 3.6 x 3.6 x 2.0 in (9.1 x 9.1 x 5.1 cm)

	Studio System™	**SLM**	**CNC**	**Savings**
Cost	$56	$1,285	$606	>90% cheaper
Lead time	4 days	2 wks	2-3 wks	4x faster







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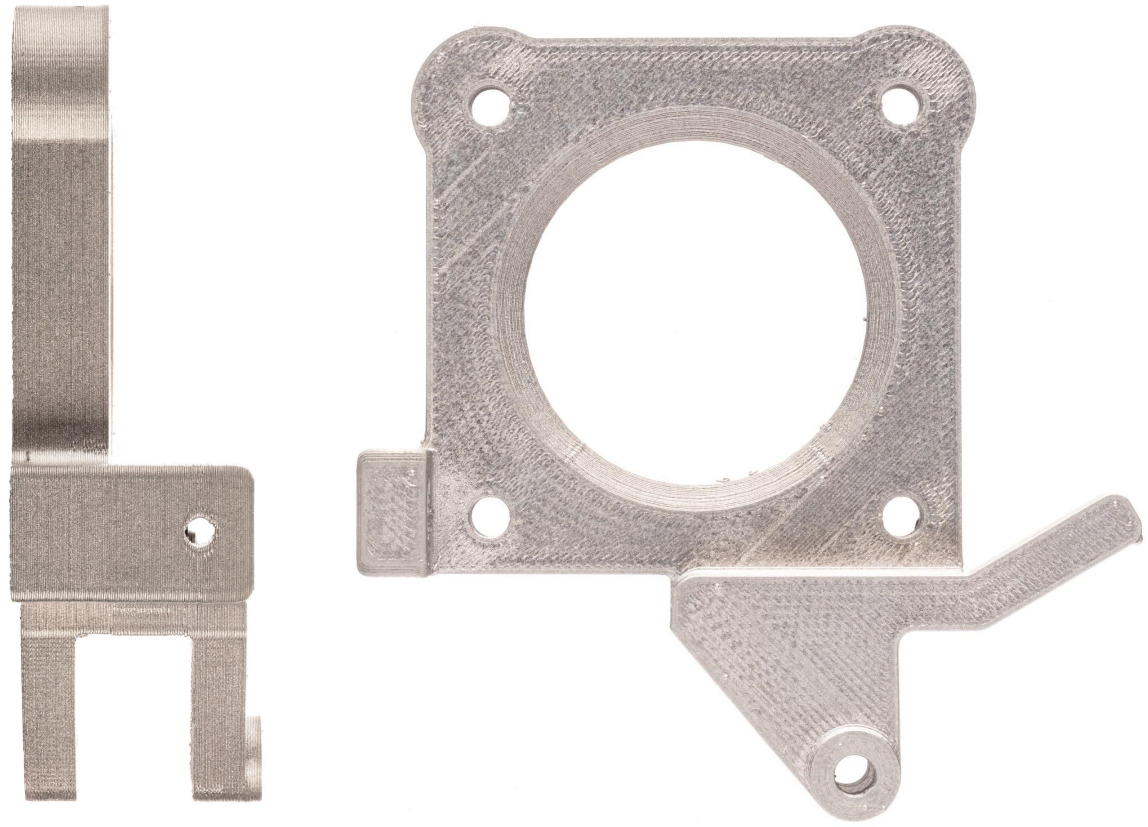
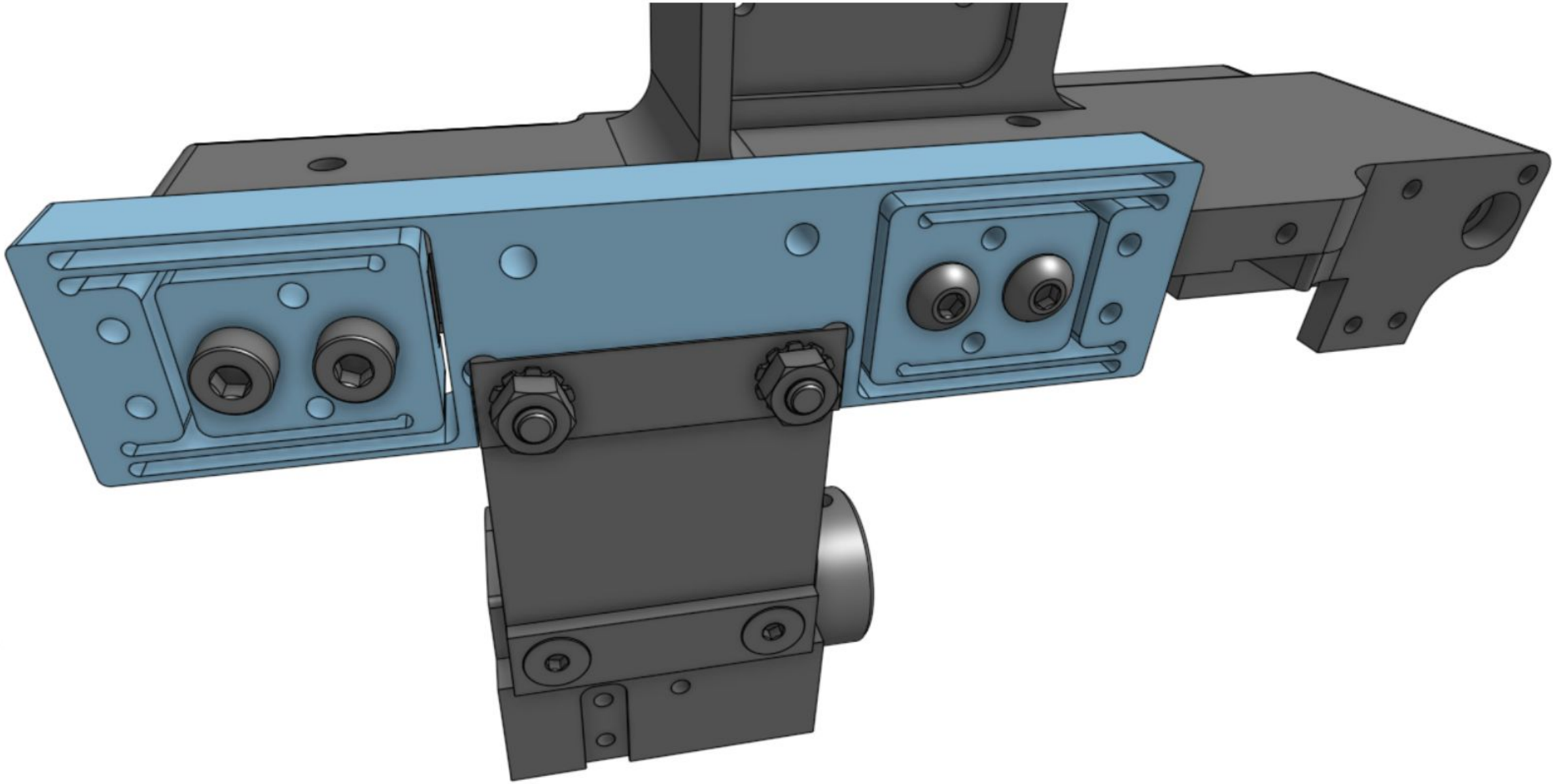
Motor mount

Motor mount

- Mount for NEMA motor
- Geometry requires several CNC set-ups
- During development, prototyping helps size motor
- For low volume manufacturing (<50/year), on-demand printing eliminates CNC costs and inventory
- 3.5 x 3.4 x 1.1 in (8.9 x 8.6 x 2.8 cm)

	Studio System™	**SLM**	**CNC**	**Savings**
Cost	$56	$685	$245	>90% cheaper
Lead time	4 days	2 wks	2-3 wks	4x faster





Motion stage flexure

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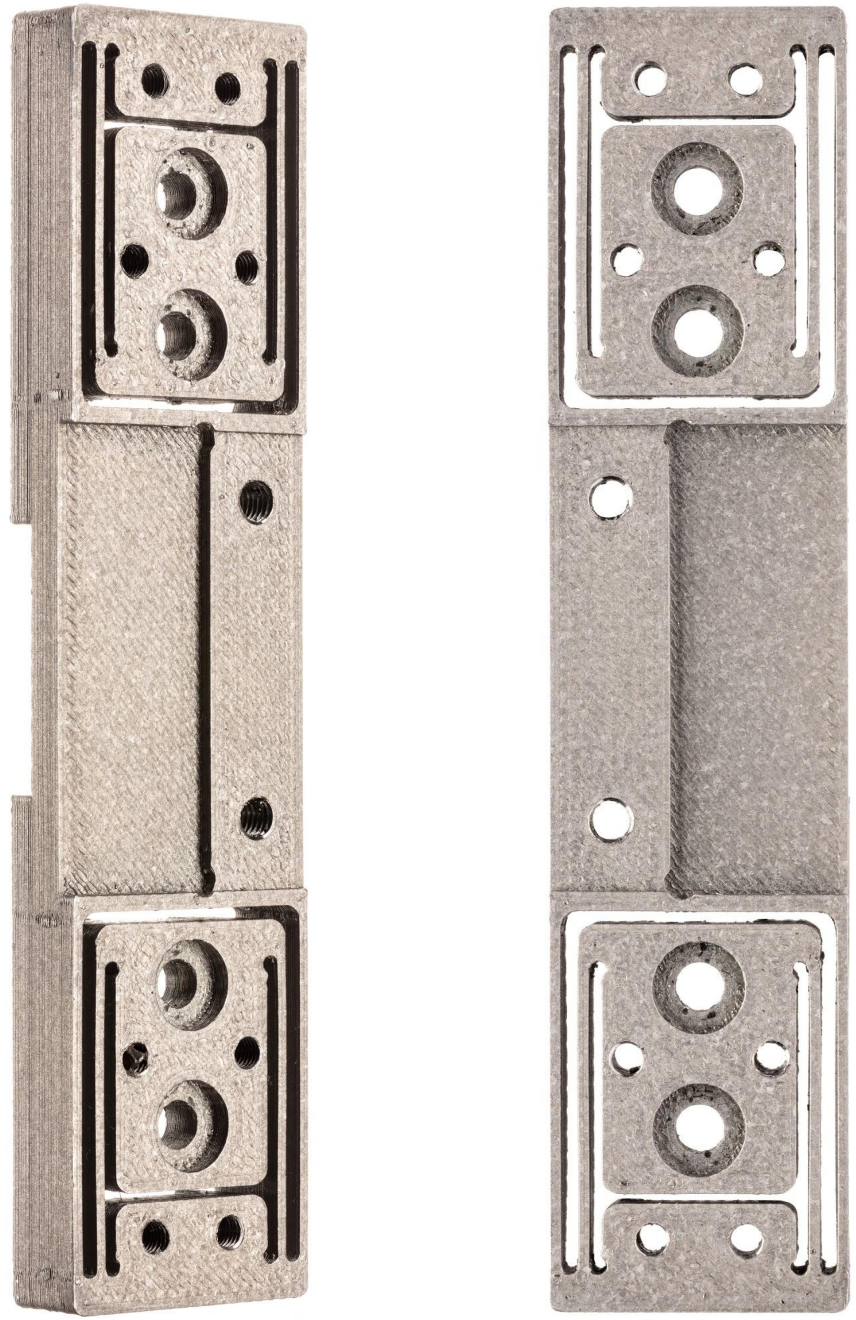
Motion stage flexure

- A flexure is an engineering component designed to be compliant over a small range in a predictable manner
- The flexure is used to allow the ball screw and motion stage to be slightly askew without binding or causing excessive wear
- Complex geometry makes machining and waterjet cutting particularly tricky and expensive
- With 3D printing, the complexity is free (in fact, can be simplified by avoiding fixturing holes)
- 4.3 x 1.0 x 0.4 in (10.9 x 2.5 x 1.0 cm)

	Studio System™	**SLM**	**CNC**	**Savings**
Cost	$41	$437	$210	>90% cheaper
Lead time	4 days	2 wks	2-3 wks	4x faster



Key business benefits

Reduced product development timeline

- In-house, rapid design iteration
- Avoid lengthy machining operations
- No tooling required

Lower costs and increase revenue

- Minimize waste
- Increase manufacturing bandwidth
- No highly-skilled, dedicated operator required

Optimize part performance for the application

- Achieve complex, intricate geometries
- Produce parts that are not possible using traditional fabrication methods

Thank you.

Visit desktopmetal.com/get-started to connect with sales and reserve your system.

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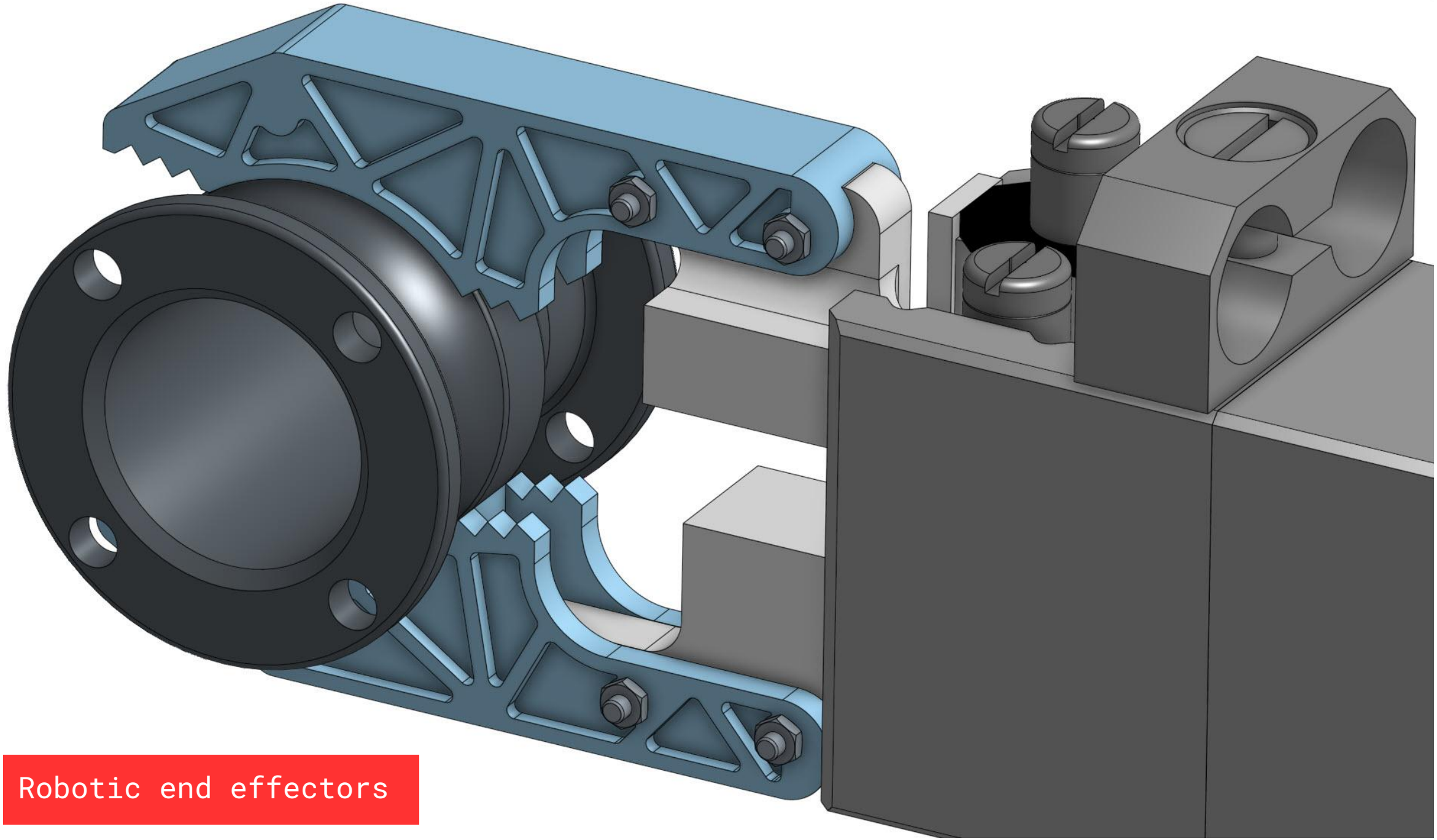

Robotic end effectors

End effectors

- Used in many manufacturing operations, end effectors are used for fixturing and moving components
- Commonly contain complex custom geometry and are produced in low volume
- This custom geometry and low volume is associated with long lead times and high manufacturing costs
- If an end effector is to break, the manufacturing line will shut down until it is replaced
- 3.9 x 1.1 x 0.6 in (9.9 x 2.8 x 1.5 cm)

	Studio System™	**SLM**	**CNC**	**Savings**
Cost	$23	$335	$175	>90% cheaper
Lead time	4 days	2 wks	2-3 wks	4x faster