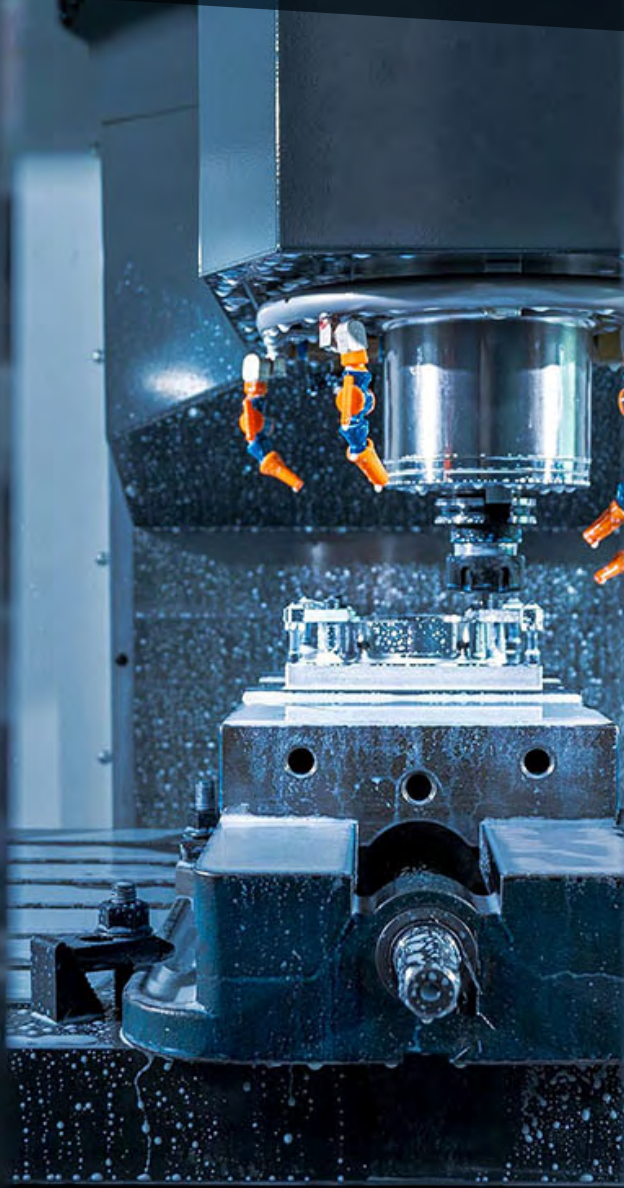




Precision Metal Hybrid Manufacturing

CAPABILITIES & APPLICATIONS



Building the Future

Multiscale Systems

Founded in 2018 by physicist Jesse Silverberg, Ph.D., Multiscale Systems integrates engineering expertise with precision manufacturing to solve complex challenges for demanding environments. Our focus on advanced materials and manufacturing enables innovative solutions across sectors.

Multiscale has delivered solutions under contracts with various federal agencies, including NASA and the U.S. Department of Energy, as well as private-sector partners, with projects ranging from aerospace structures and molten sodium reactor components to specialized industrial tooling.

Hybrid CNC Parts

In 2021, Multiscale acquired and modernized a tooling shop with more than 30 years experience in precision machining. Rebranded as Hybrid CNC Parts, our co-located facility delivers vertically-integrated design, engineering, and manufacturing capabilities under one roof in Worcester, Massachusetts.

Advanced Solutions

At the core of our integrated approach is our focus on advanced materials and methods. Using hybrid manufacturing, we combine metal additive and CNC machining within a single setup. Our system creates precision components with shorter lead times, increased design freedom, and greater material flexibility compared to convention manufacturing.



Quality & Compliance

ISO:9001 & AS9100 certified (NQA)
CMMC Level 2 • DFARS 252.204-7012

Integrated Additive & Subtractive

Hybrid manufacturing combines additive and subtractive processes within a single setup.

Multiscale's hybrid systems use wire-laser DED as the additive method, chosen for its advantages over powder-based methods. Lasers melt wire feedstock, building up layers to create a preform. Subtraction is handled by an integrated 3- or 5-axis CNC for precision shaping and finishing.

Hybrid processes enable near-net preform builds directly in the CNC, replacing the long lead times of forgings and the defect risks of castings. Single-setup machining streamlines quality control while attaining precision parts.

Hybrid Advantages

QUALITY AND PRECISION

- Fully dense, void-free builds.
- Precision finishes with tight tolerances.
- Minimal material waste and post-processing.
- Welding wire feedstock, not metal powder.

VERSATILE

- Multi-alloy printing capabilities.
- Faster procurement cycles with shorter lead times.
- Range of feedstock options, including superalloys.
- Ability to create, repair, refurbish, or modify parts.

INNOVATION

- Build complex geometries and integrated systems.
- Rapid prototyping gets you to first article faster.
- Supports low volumes with pathway to scale.



How Long Does it Take?

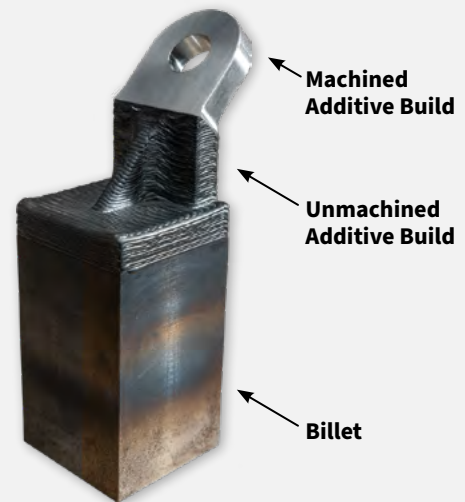
Our hybrid systems print about 1 pound of material per hour.

Faster, Better Parts

Hybrid manufacturing not only cuts lead times compared to traditional methods—it's more efficient overall, providing savings across the supply chain.

Hybrid Efficiencies

- **Improved Dimensional Control:** Predictable geometry eliminates rework/extra machining.
- **Optimized Material Performance:** Cost-efficient wire feedstock is certifiable, homogeneous, and changeable mid-build for tailored multi-material preforms.
- **Material Efficiency:** Leveraging stock/billets as functional portions of parts reduces materials and machining while accelerating production of high-value, complex components.
- **Enhanced Designs:** Readily build parts with complex geometries, targeted durability, and integrated functionality.
- **Traceability:** Every gram of wire and deposition path is logged with a hybrid build, simplifying compliance.

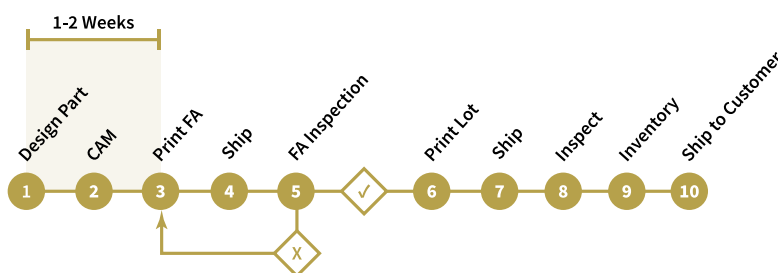


Efficiency in Action: 316 L Bracket

Traditionally, hardened alloys require increased cycle time to achieve quality results. With hybrid manufacturing, we can decrease both time and cost by replacing oversized billets, building off billets with near-net shape printing, and strategic use of machining. This bracket would take 45+ minutes with conventional manufacturing, compared to about 20 minutes using hybrid methods.

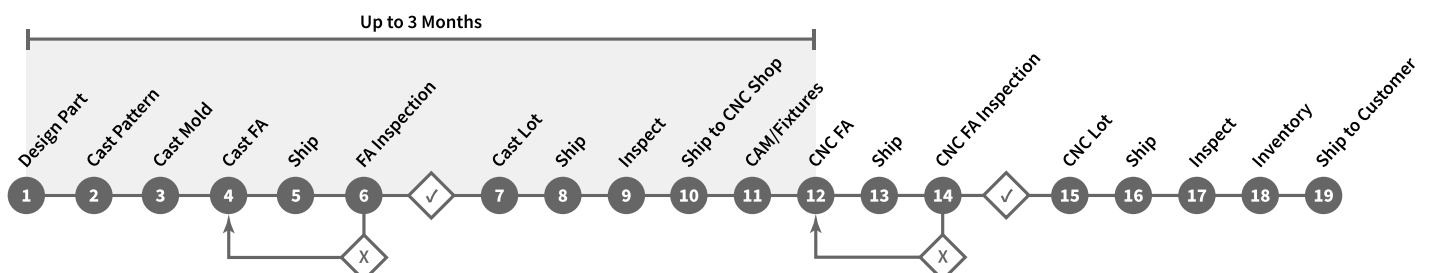
HYBRID VS CASTING: SIMPLIFY YOUR SUPPLY CHAIN

Hybrid Process: 3-6 Weeks



- **No Tooling Costs:** Build near-net preforms from CAD—no molds needed.
- **Rapid Iteration:** Updated designs within hours, not weeks.
- **Faster First Article:** Single setups produce usable preforms within 1-2 weeks.
- **Free Up Capital:** Ready-to-print manufacturing reduces inventory.

Casting Process: 3-6 months



From Steels to Superalloys

Available material ranges from commodity to exotic and we can assist in determining the best fit for your requirements.

Heat-Resistant Superalloys

These specialty alloys are often dismissed due to their expense, supply chain instability, and processing difficulty. However, with wire-laser hybrid manufacturing, superalloys are readily accessible.

Near-net builds, targeted material application, and reliable wire feedstock options—along with our expertise in these hard-to-machine materials—allow us to offer these highly durable alloys to our customers.



Alloy Composite™ Materials

Multiscale’s functionally-graded, multi-alloy technology seamlessly fuses different materials to produce tailored performance properties.

Selected Materials & Relative Properties

ALLOY	LOW DENSITY	HEAT RESISTANCE	CORROSION RESISTANCE	WEAR RESISTANCE	ISO GROUP	EXAMPLE BRAND NAMES & GRADES
Nickel	—	■ ■ ■	■ ■ ■	■ ■	ISO S Heat-Resistant Superalloy	Inconel®, Hastelloy®, Techalloy® Nickel 625, 718, X-750, C-276
Cobalt	—	■ ■ ■	■ ■ ■	■ ■ ■	ISO S Heat-Resistant Superalloys	Stellite®, Haynes®, Ultemet®, Polystel® Cobalt 6, 20
Titanium	■ ■	■ ■	■ ■	—	ISO S Heat-Resistant Superalloys	Grade 2, Grade 5
Stainless Steel	—	■	■ ■	■ ■	ISO M Stainless Steels	304, 316 L, 316 H, 440C, 17-4 PH
Carbon Steel	—	—	—	■	ISO P Steels	1018, 1045, A36
Tool Steel	—	■ ■	■	■ ■ ■	ISO H Hardened Materials	H11, H13, M2, M50, T1, D2
Aluminum	■ ■ ■	—	■	■	ISO N Non-Ferrous Metals	6061, 7075

In-House Design and Manufacturing

Multiscale Systems provides full-stack engineering solutions, incorporating design, materials expertise, and manufacturing capabilities for a streamlined path from concept to delivery.

Through our vertically-integrated model, we reduce handoffs, shorten lead times, and maintain tighter quality control.

Beyond production, we support our customers' supply chain needs, from prototyping and process validation through manufacturing and a pathway to scale.

Key Resources

- Haas UMC-750 CNC with Meltio Wire-Laser DED
- Haas VF-5SS CNC with Meltio Wire-Laser DED (x2)
- Haas VF-2 CNC
- Multiscale Compression Forming System
- Glowforge Plus Laser Cutter & Engraver
- 3DGence Industry F350 FFF High-Temp Printer
- MakerGear M3-ID FFF 3D Printer (x6)
- Lase-X Laser Marking Tool
- Hexagon GLOBAL Scan+ CMM
- Instron 5985 Universal Tester
- Polariscope™ QC System



Our Process

DISCOVERY

- Requirements
- Concept development
- Reverse engineering

DESIGN

- CAD
- FEA
- Material selection
- Process development
- Value-added engineering

PROTOTYPING

- Iteration
- Proof of concept

MANUFACTURING

- First article
- Process validation
- Production
- Testing & Inspection
- Delivery



Specialty Components

In aerospace, nuclear, and other demanding applications, components must withstand excessive temperatures, corrosive conditions, and varying levels of activation without compromise. Hybrid manufacturing enables the use of materials and designs that can survive these extreme environments.

USE CASE

Needle Roller Bearings for Nuclear

Required to survive within highly corrosive fueling systems reaching 1,000°F, these bearings were engineered using Design for Additive Manufacturing (DFAM) principles to optimize geometry, material selection, and performance.

Wire-laser DED hybrid manufacturing was an efficient method for validating concepts and producing the required low volume testing quantities, while providing a pathway to full-scale production.

Project Notes

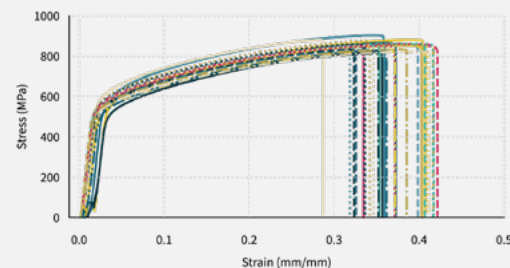
- Materials selected for heat- and corrosion-resistance: Nickel alloy 718, AWS 5.21 ERCoCr-A, H11.
- Witness coupons made and tested with every build for process control and material property validation.
- *In situ* fully-hardened state of H11 achieved without post processing—reducing lead times, production costs, and increasing performance.
- Consultive approach to design, DFAM, and supply chain risk management.



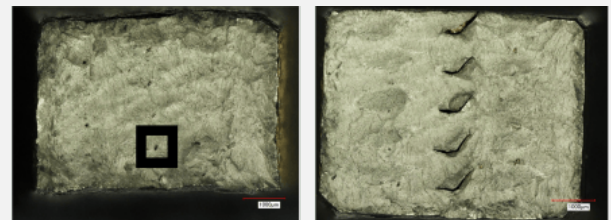
Assembled bearing with nickel rings and cobalt rollers.



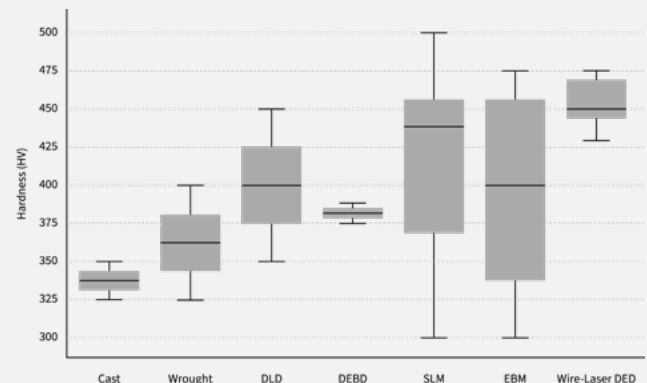
Nickel Alloy 718: Testing & Analysis



Witness coupon tensile testing data with example coupon (right).



Post-testing metallurgical analysis of fracture surfaces.



Hardness distribution across manufacturing methods of heat-treated nickel alloy 718.

Multi-Material Preforms

Wire-laser hybrid manufacturing enables the use of functionally-graded materials (FGMs), allowing composition and material properties to change seamlessly across a part. Dissimilar alloys are knitted together with smooth transitions instead of sharp interfaces.

Equipped with dual-wire print heads, Multiscale Systems' hybrid systems can produce and finish FGM components within the same setup, providing an efficient and cost-effective solution to tailored performance requirements.

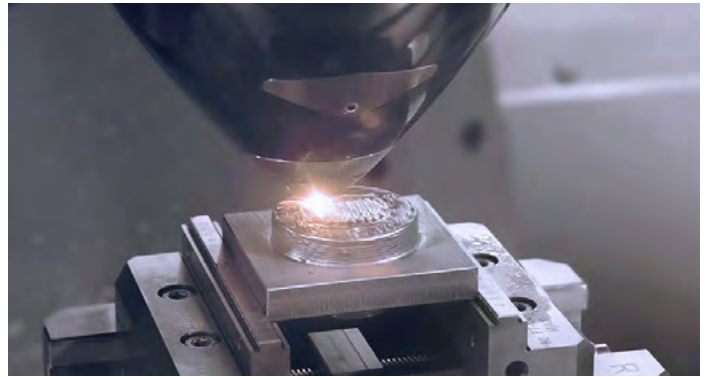
USE CASE

Sprue Bushing with Inconel® Core

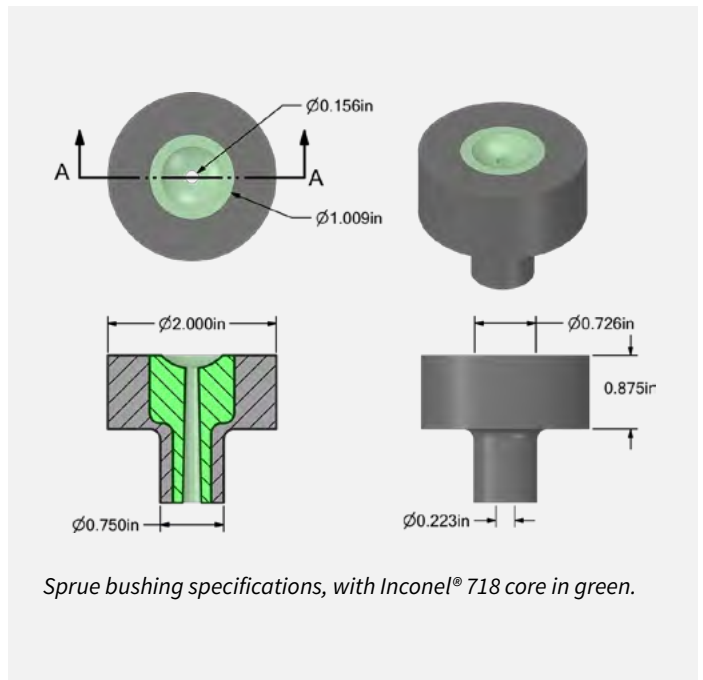
Sprue bushing are used in injection molding to guide and control the flow of molten plastic into the mold. Due to the nature of their use, sprue bushings are subjected to severe wear and thermal instability. To extend service life, reduce down time, and maintain consistent performance, we engineered this bushing with a superalloy core.

Project Notes

- Inconel® 718 core for performance where needed.
- Mild steel casing for easy finishing of near-net preform.
- Printed and finished within a single setup and built as a solid body.
- FGMs create a void-free bond that reduces defects, resulting in lower scrap rates compared to casted components.
- Near-net shape printing removes the need for casting molds, making it a fast and cost-effective production method.
- Wire-laser DED enables the efficient use of high-performance superalloys.



Cross section of a multi-material sprue bushing preform with a fully-printed bushing (right).



Rapid Reverse Engineering

Valves are used to control the flow of fluids or gases in critical systems, typically forged or cast to provide the strength and integrity needed under high pressures and temperatures.

Off-the-shelf options are often limited to less durable materials, making them unsuitable for demanding applications where they are exposed to thermal cycling, corrosion, wear, and other harsh environmental conditions.

USE CASE

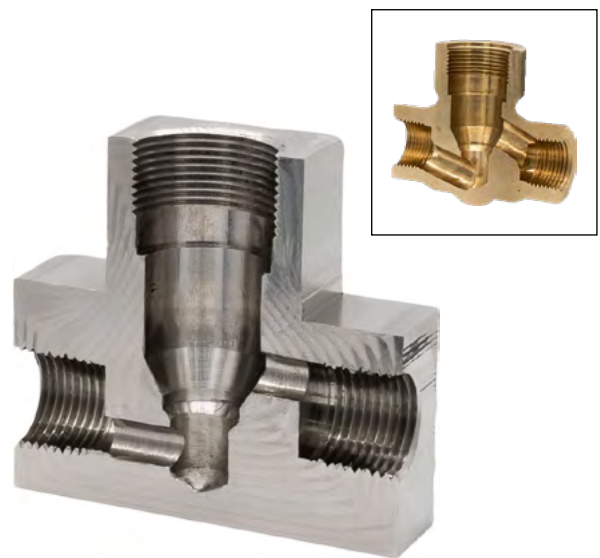
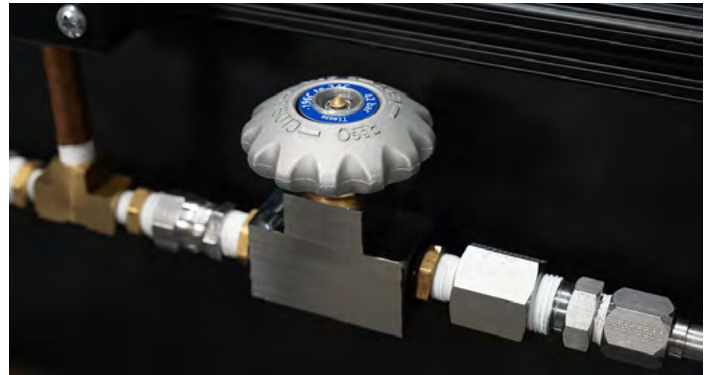
Cryogenic Valves

This valve was designed for liquid hydrogen transportation. An off-the-shelf brass valve was reverse engineered and optimized, with Multiscale's version produced with wire-laser hybrid manufacturing using 316H stainless steel.

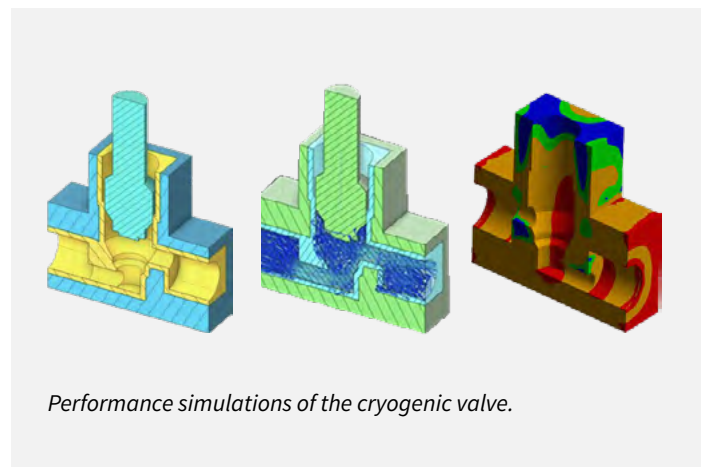
To add additional durability, a suitable superalloy could be built into the seat. Compared to a conventional process involving 1) forging, 2) machining, 3) cladding, and 4) more machining, laser-wire DED hybrid manufacturing reduces this process to a fast, efficient, multi-material, single-setup build.

Project Notes

- Quick turnaround from reverse engineering to prototyping to first article.
- Mold-free manufacturing.
- Preforms completed within one setup.
- Exotic alloys selectively added to provide targeted durability.
- Increased supply chain resilience for critical components.
- Reduced customer costs by eliminating downtime.



Hybrid-manufactured cryogenic valve with original reverse-engineered valve (inset).



Performance simulations of the cryogenic valve.

Systems Integration

Wire-laser hybrid manufacturing enables system-level integration that goes beyond standard part fabrication. Components that once required multiple assemblies can be built as unified structures, streamlining production processes.

Mechanical systems including shafts, housings, and fluid-carrying structures can be incorporated within a single component.

Thermal management using embedded cooling channels and graded conductivity zones can improve performance and durability.

Example integrations:

- Bearing housing with shaft-integrated race.
- Additively-built support webs.
- Internal coolant routing.

USE CASE

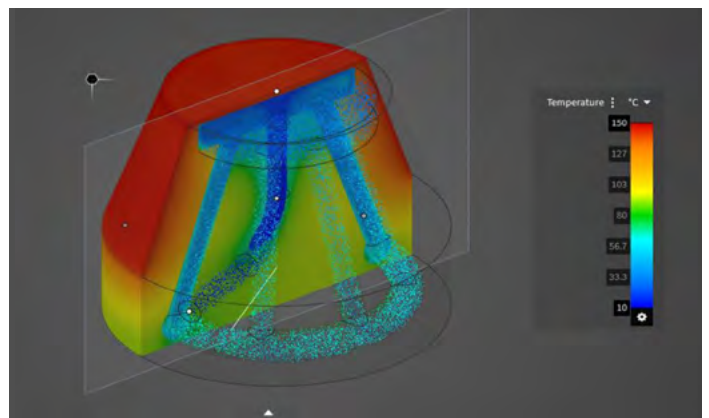
Conformal-Cooled Injection Molds

Conformal cooling channels are optimized to follow the contours of a mold cavity, improving heat transfer, shortening cycle times, and extending tool life.

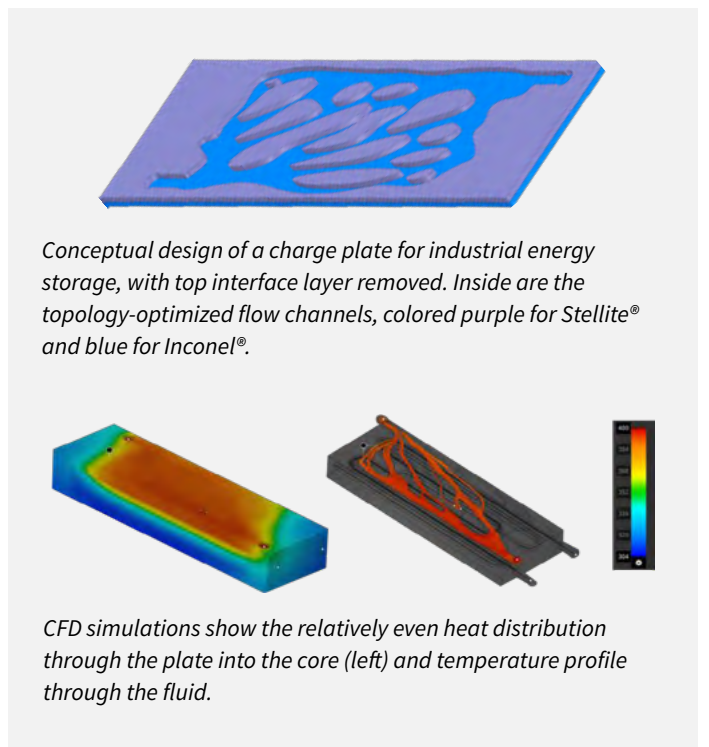
But many conformal designs fail in practice because their complex, organic geometries are difficult to clean, maintain, or refurbish—driving up the true cost of ownership.

In contrast, through decades of experience acquired with Hybrid CNC Parts, we understand the commercial barriers to these otherwise high-performing designs.

Combining practical knowledge with hybrid manufacturing, we engineer cooling solutions that capture the benefits of conformal designs without the hidden costs, complexities, and maintenance challenges associated with molds made conventionally.



Simulation of a 2-piece conformal cooling system, engineered for performance and easy maintenance.



Conceptual design of a charge plate for industrial energy storage, with top interface layer removed. Inside are the topology-optimized flow channels, colored purple for Stellite® and blue for Inconel®.

CFD simulations show the relatively even heat distribution through the plate into the core (left) and temperature profile through the fluid.



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