Desktop Metal™

[E-BOOK]

Case Study: **John Zink Hamworthy Combustion**

JOHN ZINK HAMWORTHY COMBUSTION®

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JOHN ZINK HAMWORTHY COMBUSTION®

00 Overview

John Zink Hamworthy Combustion is a global leader in the design and manufacture of emissions-control and clean-air combustion systems. Based in Oklahoma, JZHC serves customers in a wide range of industries, including energy, oil and gas, and petrochemicals, producing everything from burners to gas recovery and vapor control systems.

01 The Challenge

In the decades since the Clean Air Act was passed, emissions limits on everything from power plants to passenger cars have grown more stringent, and for the public, those narrowing standards mean less pollution in the environment, and significant improvements in air quality.

For industry, though, the law has come with a challenge - how to constantly innovate and evolve to meet ever-tightening air quality standards while also keeping costs as low as possible.

To do it, many turn to John Zink Hamworthy Combustion.

One way JZHC helps their customers meet that challenge is by creating emissions-control and combustion systems that are custom engineered and manufactured to meet each customer's specific needs.

To do it, the company is investing in state-of-the-art manufacturing technology, including metal 3D printing.

> *While the limits of traditional manufacturing had locked the company into a relatively static atomizer design for decades, the possibilities of 3D printing opened their eyes to entirely new design options, including irregularly-shaped holes to assembly consolidation and controlled airflow to optimize the fuel-air mixture.*

02 The Power of 3D Printing

With the ability to create complex parts without the need for hard tooling, 3D printing allows JZHC to create parts that are engineered-to-order and optimized for each customer's specific application.

Printing new parts, though, is only one among many benefits.

Given the bespoke nature of the systems they manufacture, and the fact that they could be running for years before replacement parts are needed, JZHC faces a tricky choice - either stock custom tooling for hundreds of custom designs or face the high cost and long lead times of creating custom replacement parts.

With 3D printing, however, they don't have to make that choice - parts that may have been produced decades ago, which may no longer have tooling or design drawings, can be recreated on-demand, reducing costs and downtime for customers.

And because it eliminates many of conventional manufacturing's design limitations, 3D printing can create parts with far more complexity than traditional methods.

*Fule Atomizer

John Zink engineers have taken advantage of that increased complexity to redesign virtually every aspect of the fuel atomizers used in marine burners, all the way down to the holes.

That redesign process didn't just result in a new part - it also resulted in a new way of thinking for JZHC engineers.

While the limits of traditional manufacturing had locked the company into a relatively static atomizer design for decades, the possibilities of 3D printing opened their eyes to entirely new design options, including irregularly-shaped holes to assembly consolidation and controlled airflow to optimize the fuel-air mixture.

Engineers then took advantage of additive manufacturing speed - parts can be printed in just days as opposed to weeks for machining - to significantly speed up the development timeline. Because it is possible to print multiple prototype designs quickly, they were able to simultaneously test several parts and quickly iterate on designs to arrive at a final part.

The end result is a radical new atomizer design that maintains efficiency while using nearly two-thirds less fuel, leading to significant cost savings.

The ability to quickly produce printed parts also eased demand on JZHC's internal machine shop, and empowered operators to explore creative ways to improve their workflows.

In one case, those improvements were as simple as a handle.

Rather than loading heavy tools in and out of a lathe by hand, an operator created handles that attach to the tools, making the process simpler, safer and more efficient.

04 Why Desktop Metal™?

The Studio System™'s ease of use and office-friendly design - because the system uses no loose metal powders or dangerous lasers, operators don't need personal protective equipment - made it an attractive choice for John Zink Hamworthy Combustion.

In addition to being safe and easy-to-use, the Studio System™ represented an affordable entry point into the world of metal 3D printing.

Other additive methods that use lasers to fuse metal powders require massive upfront investments - often $1 million or more for equipment and facilities - and are both slow and produce parts that require extensive post-processing.

The Studio System™, by comparison, came with virtually no set-up costs, JZHC engineers said - they simply plugged it in, and began printing.

And the system's versatility has enabled engineers and designers to find both applications for the technology and design benefits the company hadn't initially anticipated.

“Our primary goal is to eliminate waste from the environment so our customers can operate safely and efficiently... so we’re always looking for ways to better serve our customers, and help them serve their customers.

Additive manufacturing opens up a whole new door for new designs - you can have internal pathways in certain parts and you can get more efficient mixing of fuel and steam, as in an atomizer.

Desktop Metal has a system that has a very low-cost entry point into the technology - there’s no real cost to preparing the facility, you basically just plug it in and you can go.

Companies that feel like metal 3D printing is too far in the future...if additive manufacturing adds value to them whatsoever, and they’re not already investing in it, they’re already behind.”

Jason Harjo
Design Manager, John Zink Hamworthy Combustion

3D Printing vs. Traditional Manufacturing

[Part Example]

Fuel Atomizer

[Material]

17-4 PH Stainless Steel

[Cost Saving]

75%

Studio System™	DMLS
$300	$1,200

[Time Saving]

37%

Studio System™	DMLS
5 Days	8 Days

*Not available to manufacture with traditional methond, only 3D printing.

[Description]

John Zink Hamworthy Combustion has been a leader in developing innovative solutions to reduce emissions, and has long understood that using atomizers to improve the fuel-air mix inside burners is one easy way to help customers minimize their environmental footprint.

For conventional atomizers, design options are limited - the part is machined to shape from round bar stock, with holes to deliver fuel and steam drilled in different sizes or different angles, depending on the application.

Using the Studio System™, however, JZHC designers and engineers were able to prototype and test a variety of options before ultimately creating a radical new design featuring sweeping, airfoil-like fins. The geometric freedom of 3D printing even allowed them to reconsider the shape of the holes - instead of drilling round holes, the part is built with flat openings to improve atomization and increase burner efficiency.

The results of the newly designed nozzle were impressive - where the previous design was able to reduce fuel use to 120 kg/hr, the new design cut fuel use to just 38 kg/hr. With three burners per ship, the environmental impact across an entire fleet can be huge.

The savings can be equally significant - per ship, the new atomizer could save companies between $90,000 and $160,000 in fuel costs annually, and costs just $300 and less than one week to manufacture. Using laser-based systems, the part costs $1,200 and takes 8 days to produce.

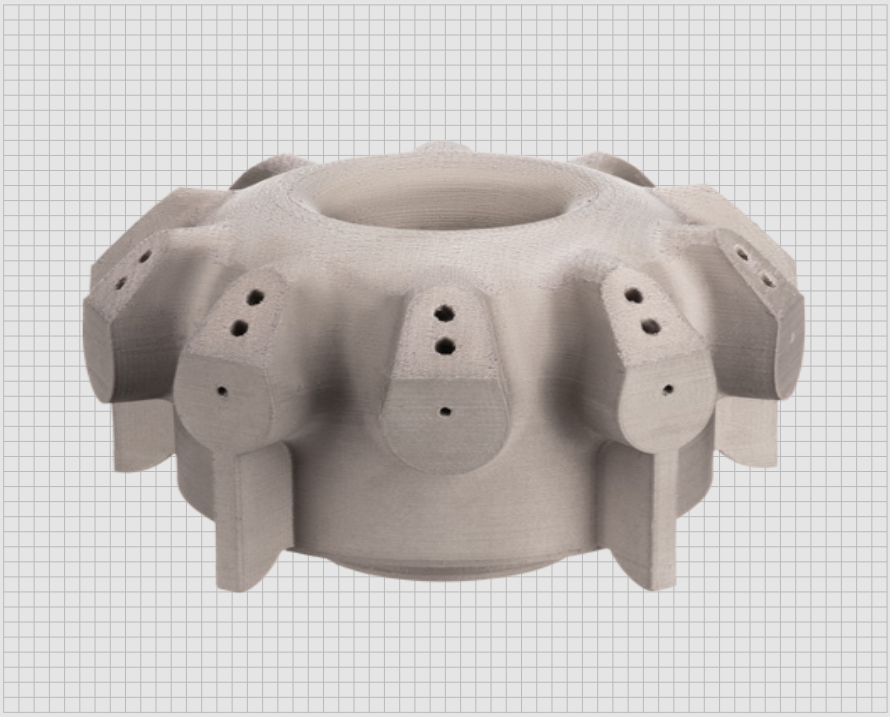
3D Printing vs. Traditional Manufacturing

[Part Example]

YE-6 Burner Tip

[Material]

17-4 PH Stainless Steel



[Cost Saving]

72%

Studio System™	Traditional
$193	$693

[Description]

A key component in the efficient operation of industrial burners, burner tips are used to control the injection of fuel into the combustion chamber, or as atomizers, mixing fuel with an atomizing medium like steam to increase burner efficiency.

The burner tip shown here - originally cast and post-processed via CNC machining - was first manufactured 30 years ago, and the tooling used to produce it is no longer available. Because the part is too complex to machine as a single component, manufacturing spare parts using traditional techniques would require large investments in both time and money. Instead, JZHC engineers looked to 3D printing to produce a cost-effective replacement burner tip. Using the original engineering drawings, JZHC engineers modeled the burner tip and printed the part on the Studio System™.

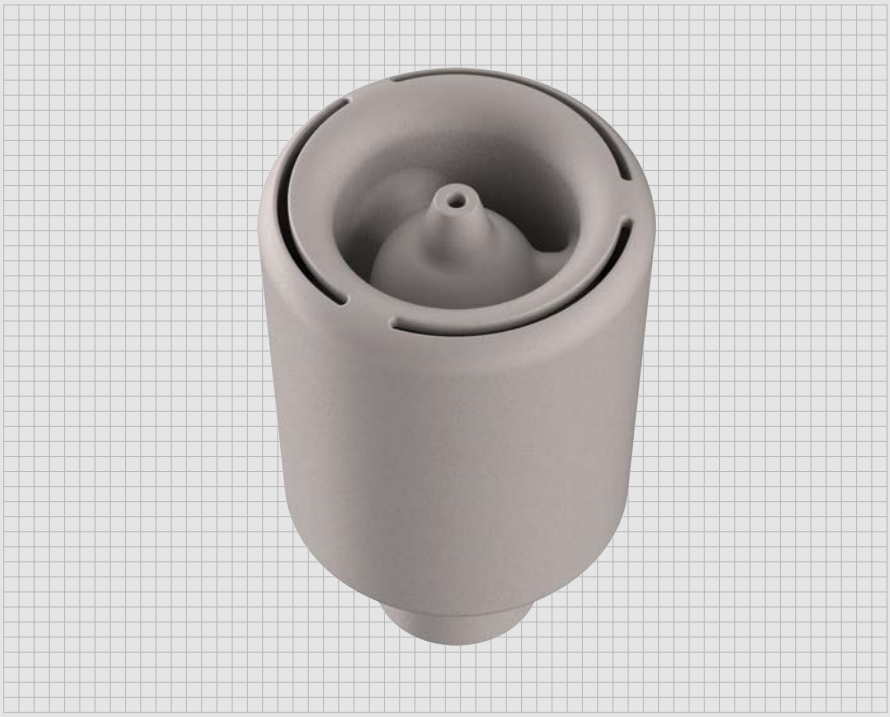
The finished part was produced in just weeks - as opposed to months - and cost significantly less than a cast part - just a few hundred dollars versus a few thousand dollars.

[Part Example]

Laser Gas Nozzle

[Material]

17-4 PH Stainless Steel



[Description]

A useful tool found in many machine shops, laser cutters can make precise cuts in a variety of materials.

The problem for JZHC engineers was the cutter's nozzle could become clogged or slag could build up on the edges of cut parts, requiring labor-intensive post-processing.

The solution they found was to use the Studio System™ to design and print an entirely new nozzle, one that incorporates a series of internal channels to direct high-pressure nitrogen gas across the cuts and blow away slag, preventing clogs and ensuring cleaner cuts.

The complex geometry of the new nozzle could only be made using additive technology, and was printed in metal after an earlier version - printed from PLA plastic - melted at higher temperatures.

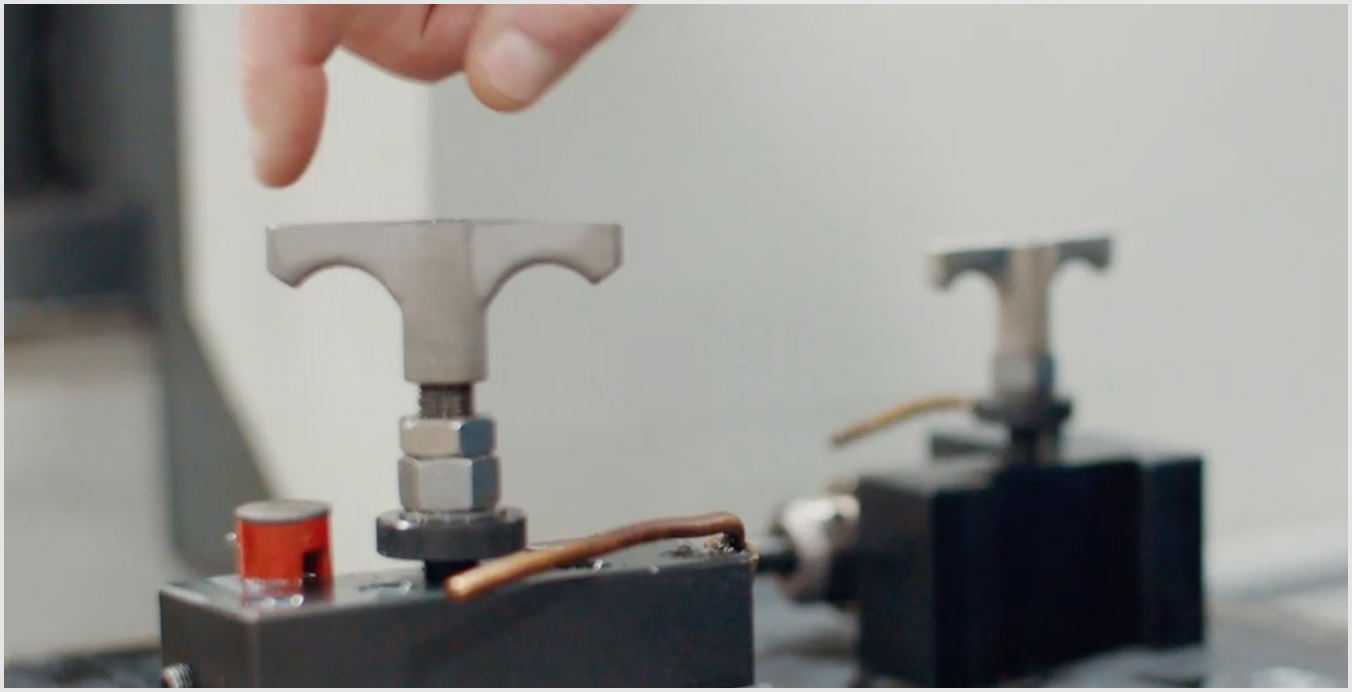
3D Printing vs. Traditional Manufacturing

[Part Example]

Machine Tool Handles

[Material]

17-4 PH Stainless Steel



[Description]

Additive technology has helped JZHC engineers to recreate legacy parts and redesign existing parts, but it's also helped them find creative solutions that improve how they manufacture those parts.

Designed by a machinist with three decades of experience at JZHC, these handles were created to make it easier to lift and place heavy tools in a lathe, and were printed using the Studio System™ after the initial parts - printed in plastic - broke.

The handles were printed rather than machined to minimize waste - each handle would have to be made from a relatively large piece of metal - and to leave machine shop capacity free for customer jobs.

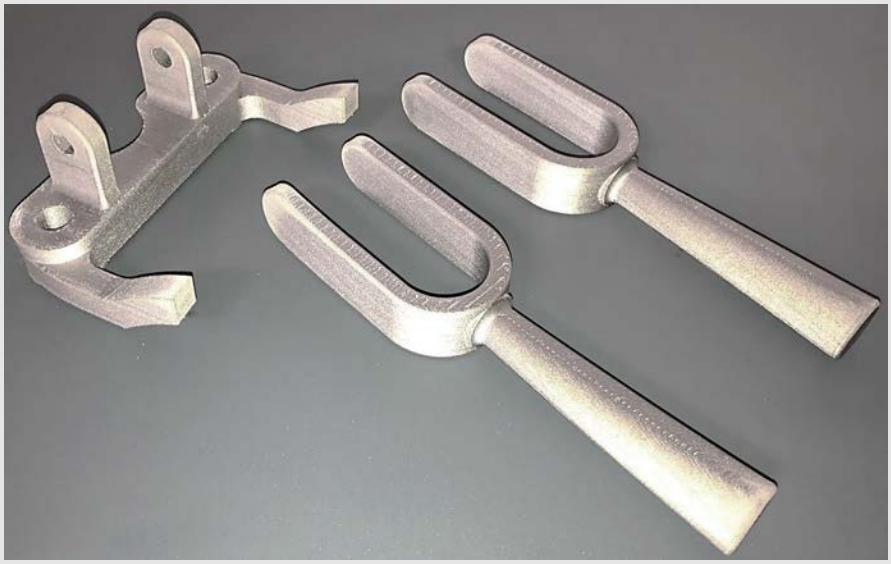
3D Printing vs. Traditional Manufacturing

[Part Example]

Safety Shutoff Yoke and Handles

[Material]

17-4 PH Stainless Steel

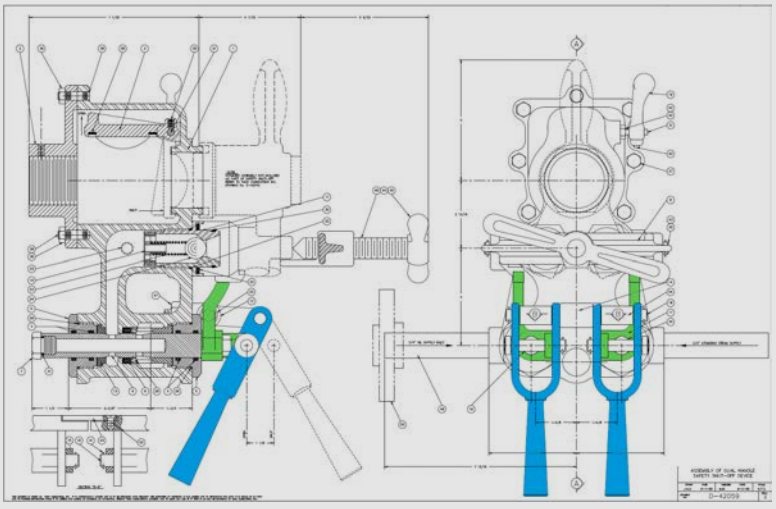


USS Blue Ridge (LCC-19)

[Description]

A key piece of safety equipment, this shutoff yoke and handles are installed on the USS Blue Ridge (LCC-19), which provides command, control, communications, computers, and intelligence support to the commander and staff of the United States Seventh Fleet.

Because no tooling exists for this part, they could only be created via 3D printing.



Blue print

06 Evaluation

For JZHC, the Studio System™ has been a success - using 3D printing, the company has been able to produce custom parts that are tailored to their customers' applications faster than ever before.

For customers, the payoff has come in less down time - printed parts can be in their hands and installed in days rather than weeks or months - and significant savings, both in part costs, and in fuel, thanks to innovative new designs that can only be manufactured via 3D printing.

The benefits of printing metal parts weren't only felt by JZHC customers.

Parts like the laser gas nozzle and tool handles - both of which were designed and printed to improve internal workflows - have functioned exactly as engineers needed them to.

And while the designs of both parts were initially tested in ABS, they were ultimately fabricated from metal to ensure they could stand up to high heat (in the case of the laser nozzle) and resist vibration (in the case of the tool handles.)

08 Summary

The Studio System™ has proven to be a useful tool for JZHC designers and engineers, enabling innovative new designs for existing parts, the recreation of legacy components and the production of manufacturing aids that improve efficiency.

For JZHC customers, the benefits are clear - the innovative new atomizer design, made possible only through the use of additive technology, significantly reduces fuel use, from 120 kg/hour to just 38 kg/hour, resulting in both cost savings and reduced emissions.

And as JZHC designers and engineers continue to explore the possibilities of metal 3D printing, they expect to continue to find new applications for the system, whether to prototype new parts or develop new manufacturing aids.

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About John Zink Hamworthy Combustion

Part of the Koch Industries family of companies, John Zink Hamworthy Combustion develops industry-leading innovations and offers proven emissions control and clean-air solutions to customers around the world. Based in Oklahoma, JZHC serves customers in a wide range of industries, including energy, oil and gas, and petrochemicals, producing everything from burners to gas recovery and vapor control systems.

About Desktop Metal

Desktop Metal, Inc. is accelerating the transformation of manufacturing with end-to-end metal 3D printing solutions.

Founded in 2015 by leaders in advanced manufacturing, metallurgy, and robotics, the company is addressing the unmet challenges of speed, cost, and quality to make metal 3D printing an essential tool for engineers and manufacturers around the world.

In 2017, the company was selected as one of the world's 30 most promising Technology Pioneers by the World Economic Forum, and was recently named to MIT Technology Review's list of 50 Smartest Companies. For more information, visit www.desktopmetal.com.