
stratasys

# Make Tooling Fixtures Faster and Cheaper With Less Labor

Solution Guide

# The Challenge:

Does the title of this guide sound too good to be true? If it does, you need to keep reading because compared to the conventional way of making fixtures, you can take a more efficient path.

## Don’t Fall Victim to Opportunity Blindness

Fabricating tooling fixtures by machining metal parts and fastening or welding them together undoubtedly works. And for many manufacturers, the familiarity and predictability of this process prompts no need for change. However, if that’s your position, it could ultimately cost you lost time and added expense because better, more efficient methods are available.

The truth is the manufacturing industry doesn’t remain static, and those who stay with the status quo risk becoming stagnant and falling behind the competition. New technologies supplant older, less efficient ones, improving production methods and streamlining supply chains. 3D printing is one of them, but it’s not a new technology. In fact, it’s used every day by small machine shops to large corporations – in other words, your competition.

In short, 3D printing offers a more time and cost-efficient means of making tooling fixtures than machining them. And since change starts with awareness, this solution guide will show you the facts behind the promise and how manufacturers benefit by switching to 3D printed tooling.

# The Solution: 3D Printed Polymer Tooling Fixtures

Let's start with a closer look at the drawbacks of making fixtures with conventional fabrication methods and compare that with how 3D printing offers a better solution.

## Conventional Fabrication Drawbacks

### Dwindling Skilled Resources

In a recent survey, 77% of manufacturers believe that attracting and keeping workers will be a continuing problem.[1] Individuals skilled in disciplines like CNC machining are becoming scarcer while the demand for their services only increases.

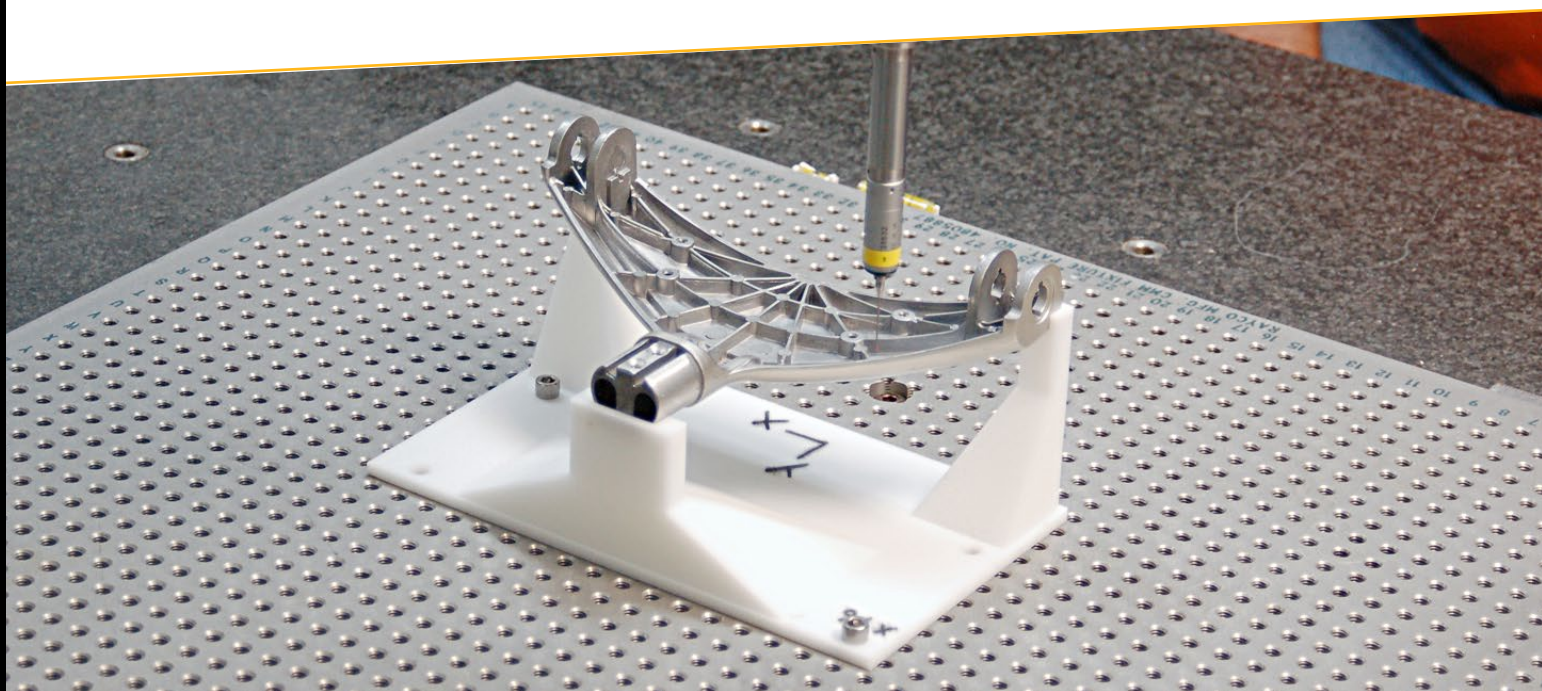
### Slow/Long Lead Time

When was the last time your request to replace a tool or fixture was fulfilled the same day or the next? If you rely on conventional fabrication methods, you're at the mercy of your internal machine shop or an outside vendor. There's typically a backlog in both cases, and your order may take a week or more. How do scenarios like this impact your operation's productivity?

### Higher Cost

The cost of machining, welding, and assembling tooling fixtures is typically higher than 3D printing. The reasons are related to greater material use (subtractive vs. additive), higher labor requirements (CNC programming, process monitoring, assembly), longer lead time (production impacts), and manufacturing volume (higher for lower-volume, custom production).

1. Deloitte article, **"Creating pathways for tomorrow's workforce today - beyond reskilling in manufacturing"**



# Conventional Fabrication Drawbacks

## Design and Manufacturability Constraints

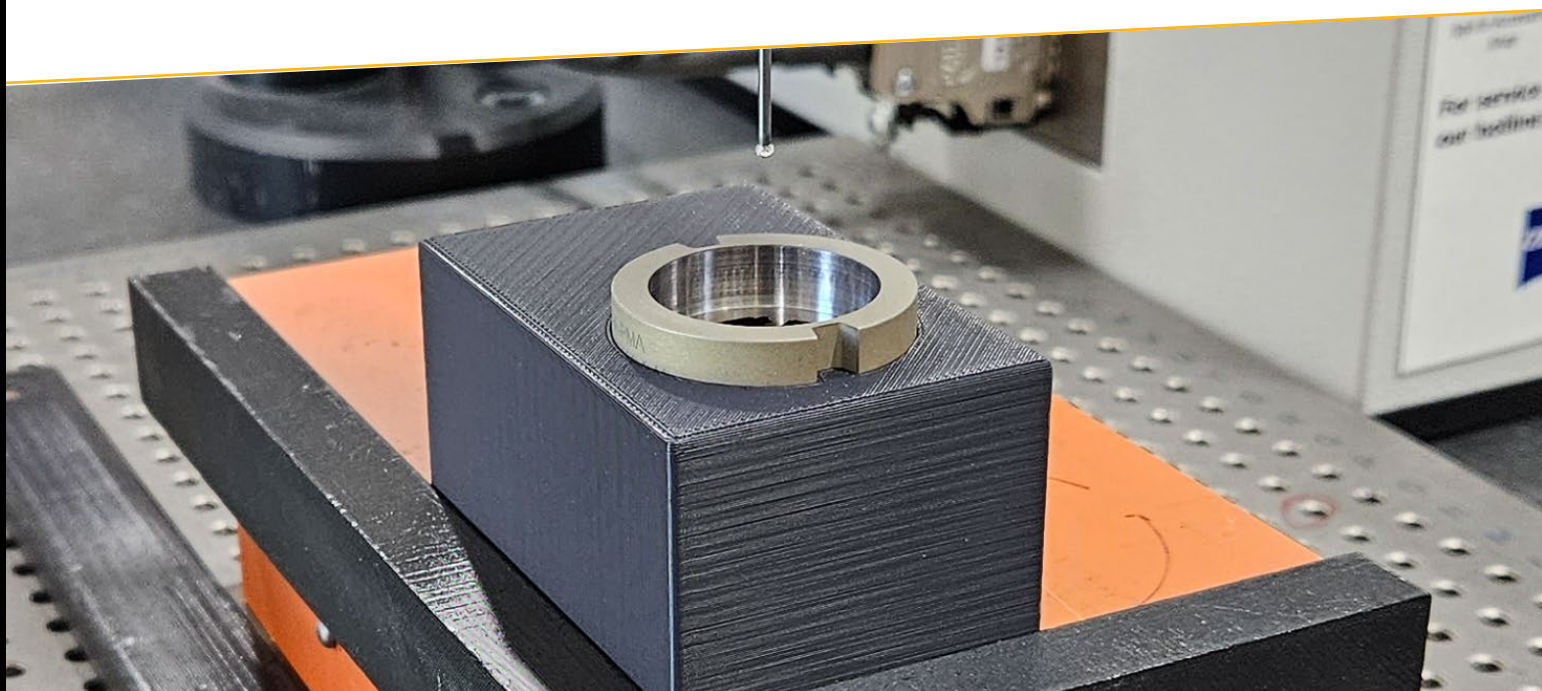
There are physical limitations on the complexity of the parts that can be made by machining. That limits your ability to create a fixture optimized for the task or the operator using it. Designing a fixture free from manufacturability constraints might allow you to make it lighter, fit better, work more efficiently, consume less material, and all of the above.

## Heavy and Non-Ergonomic

Due to the manufacturing limitations noted above, fixtures made from machined metal are usually bulky and heavy. This also limits the capability for ergonomic design. When workers repeatedly move heavy tools, they run the risk of overuse injuries or strain induced by heavy loads.

## Minimum-Viable Utilization

Because of the challenges associated with traditionally fabricated tools and fixtures, their penetration on the shop floor is usually limited to critical or must-have applications. The result is another status-quo situation that overlooks the potential benefits more tools might achieve, leaving opportunity gaps where efficiency and productivity could be improved.



# 3D Printing's Answer

## Minimal Labor and Skill Requirements

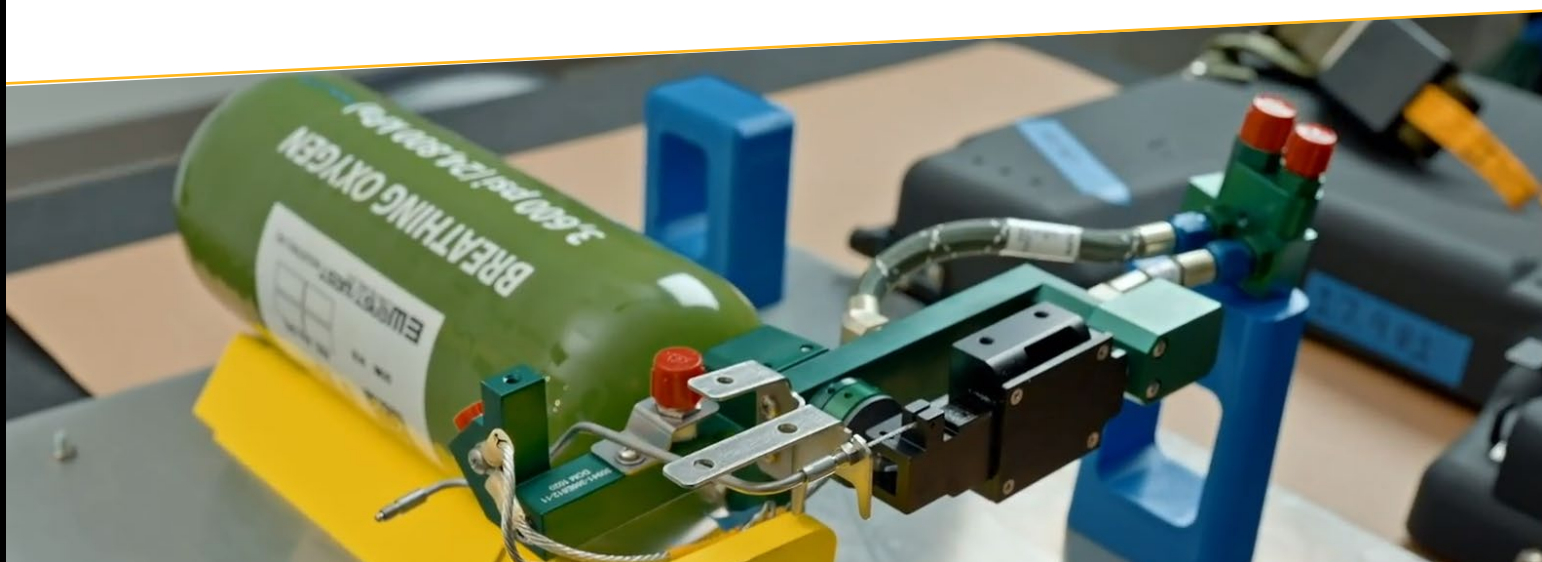
The effort to learn and operate an FDM® extrusion 3D printer is minimal compared to the skill requirements for machinists and CNC operators. Additionally, the printer's operation doesn't need oversight during the print operation. The only labor entails loading a build sheet or build tray before printing starts and removing the part when it's done. Post-processing is typically limited to removing support material from the part. And if water-soluble support material is used, the process is hands-free.

## Faster Turn Time

FDM technology can produce 3D printed fixtures in hours instead of days, weeks, or longer with conventional machining. If you use in-house printing, the only lead time is waiting for the printer to finish the job.

## Lower Cost

Since tooling fixtures are usually a low-volume production item, their unit cost is driven by the infrastructure needed to make them. Low-volume production is cheaper with 3D printing because there is no ancillary tooling beyond the printer needed to produce the parts. If a fixture can be built overnight and deployed the next day, that quick turn can have a significant favorable influence by minimizing any production impact. And because 3D printing is an additive process, material is used only where necessary to make the part, avoiding waste.

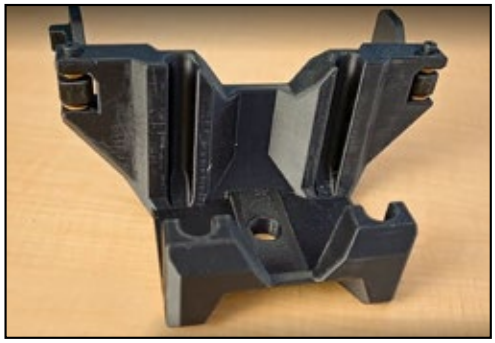


# 3D Printing's Answer

## Design Freedom

3D printing isn't limited by the physical and geometric constraints of machining. Organic and complex shapes are easily produced on a 3D printer due to the additive, layer-by-layer nature of the process. This means you can optimize fixture design to best fit the task, the operator, or both.

The assembly fixture on the left is made up of multiple parts that are welded and pinned together.



In contrast, the 3D printed fixture on the right serves the same purpose but is made up of fewer parts and can be printed in a single print operation.

## Increased Task Efficiency

3D printed polymer fixtures can increase task efficiency for several reasons. They're lighter than metal, which makes them easier to handle and maneuver. They can also be made as a single piece, avoiding assembly or reducing setup time. Although the time difference per individual task may be small, the total time saved on repetitive tasks adds up.

## Improved Health and Safety

Ergonomic fixtures – lighter and designed to accommodate a human operator – can lessen the frequency of MSDs (musculoskeletal disorders). According to the U.S. Bureau of Labor Statistics, MSDs are the largest category of workplace injuries and account for a third of worker compensation costs.[2] And polymer 3D printed fixtures check both boxes on ergonomic capability due to design freedom and lighter weight.

## Improved Fixture Availability

If you can make tooling fixtures faster and cheaper with 3D printing compared to machining, you have an opportunity to increase their proliferation on the manufacturing floor. That increases workforce productivity, reduces downtime, and improves overall production efficiency.

2. OH&S article, **"The Relationship Between MSDs and the Workplace"**

# But Can Plastic Do the Job?

Anyone new to 3D printing – particularly polymer 3D printing – usually has legitimate misgivings about its effectiveness in making things like manufacturing tools historically made from metal. However, a closer look at the facts is usually sufficient to demonstrate that 3D printing can do the job for the right applications.

## Let's look at the common concerns:

### 1 Concern: Plastic tooling isn't strong enough to replace metal.

While it's true that plastic isn't metal, it doesn't mean it lacks suitable material properties to handle a particular task. The specific application is the key consideration, and FDM technology is well suited to address many unique tooling applications because of its wide range of versatile thermoplastics.

**3D Printed Solution**

To start with, many metal fixtures used in manufacturing are simply over designed. 3D printing them with durable engineering-grade thermoplastics is often a very suitable alternative to machined metal fixtures. When additional strength and stiffness are needed, carbon-filled materials like ABS-CF10, FDM® Nylon-CF10, and FDM® Nylon 12CF provide several options to fit these requirements. Some thermoplastics like ASA also offer an advantage over metal for CMM fixtures since they are more temperature stable.

### 2 Concern: I can't justify the capital expenditure for a 3D printer right now.

Substantiating the purchase of new equipment is rarely easy. However, plenty of case studies corroborate how the cost of a 3D printer has been recouped based on the savings it provides. But before you even start down that path, an alternative option lets you "test drive" 3D printing to determine its value.

**3D Printed Solution**

Using a service bureau like Stratasys Direct Manufacturing lets you quickly get 3D printed parts like tooling fixtures in hand to use and assess. If they provide benefits, it's easier to quantify and demonstrate them to your organization's decision-makers to ultimately justify a 3D printer purchase.

## 3 Concern: We don't have the labor resources to operate a 3D printer.

Unlike CNC machining, which requires skilled operators, 3D printing does not demand the same skill or oversight labor. In fact, FDM technology is one of the simplest forms of 3D printing available. When combined with GrabCAD Print™ software that simplifies the design-to-part workflow, FDM printers are as close as possible to a push-button 3D printing operation.

### 3D Printed Solution

The most significant aspect of this attribute is that you can quickly train existing personnel – engineers, designers, and machine operators – to work with an FDM printer. And once the system has started printing, no oversight is needed. Those individuals can tend to other responsibilities while parts are printed.

## 4 Concern: I can't afford the risk of bringing in new technology.

Introducing new equipment, let alone new technology, poses understandable risks to already-tight production schedules where any disruption could result in missed deliveries and customer dissatisfaction. However, 3D printing with FDM technology minimizes these risks because you can start small and take a phased approach to achieve small wins and grow from there. Or, you can rely on a 3D printing service provider to gain familiarity with the technology and learn from their expertise.

### 3D Printed Solution

Numerous businesses have succeeded by starting with smaller yet powerful printers like the F123 Series™ and F123CR composite-ready printers. They've afforded an easier path for these companies to integrate 3D printing into their operations. They offer a low-risk/high-reward scenario that lets companies keep pace with technology and not lose ground to competitors who have already embraced additive technology.

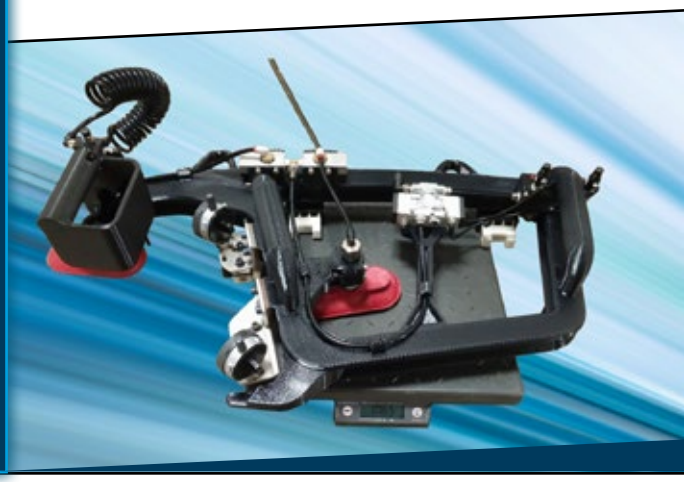
**Simply put, you can't afford not to adopt 3D printing. At some point, conventional manufacturing may not be adaptable to address future production challenges or opportunities for new business. And that's when 3D printing offers a beneficial alternative.**

# 3D Printed Fixture Success Stories

Rather than just telling, we want to show you the benefits 3D printed fixtures offer manufacturers through the experience of several Stratasys customers. They range from large, well-known corporations to small production shops.

## Ford Motor Company - Assembly Fixture

The desire for a lighter, more ergonomic window glass installation fixture prompted Ford engineers to pursue a 3D printed solution. To achieve precise and repeatable assembly, engineers chose FDM Nylon 12CF carbon fiber material to make the tool lighter yet strong and rigid. 3D printing also allowed the fixture to be internally reinforced with a higher density of material where strength was needed and lower density in non-critical areas, something that's not possible with a machined tool. The result was a new fixture that was 15% lighter and 70% cheaper than its metal predecessor, and easier to use.



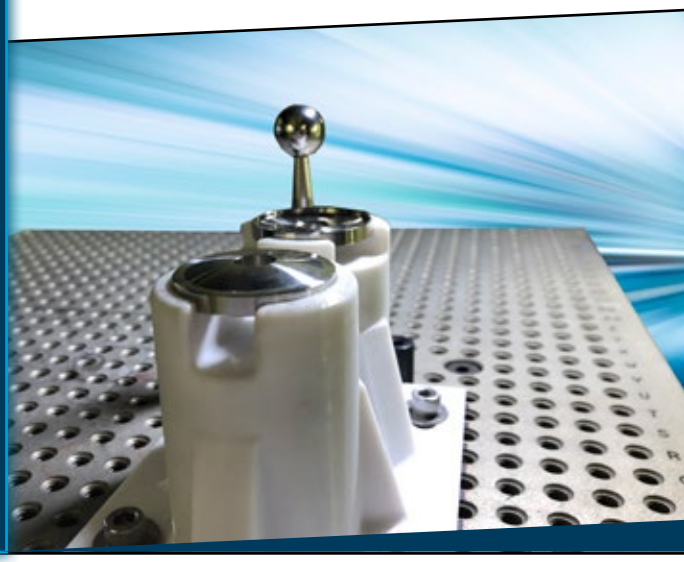
## Mercury Marine - Label Application Fixture

Affixing brand and product labels is an integral part of the production process for many manufactured goods. The fixtures used to apply these labels need to provide consistent results without marring the product's surface. Mercury Marine has used custom fixtures to apply decals to the marine engines it manufactures. However, these outsourced, traditionally fabricated fixtures were expensive, cumbersome, and usually replaced annually. To avoid these handicaps, Mercury Marine tooling engineers switched to 3D printing the fixtures using a combination of FDM materials that provide a conformal, non-marring surface with sufficient rigidity. The 3D printed decal fixture reduced lead time by 96%, getting the tool into production much faster while cutting its cost by 68%.

# 3D Printed Fixture Success Stories (cont.)

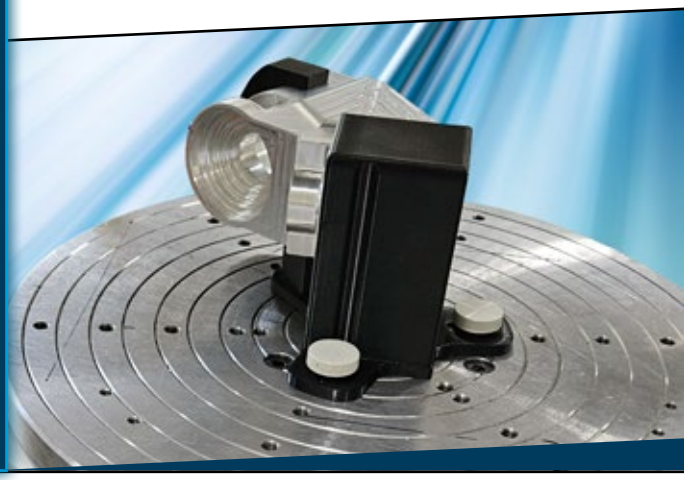
## Senga Engineering - CMM Fixture

Each of the over 1700 parts Senga Engineering makes in a year has to be inspected multiple times on the coordinate measure machine (CMM). Traditional CMM tools like V-blocks and clamps required multiple fixturing arrangements to thoroughly inspect a part. To alleviate the high cycle time and cost for these custom setups, Senga engineers switched to 3D printed fixtures to hold the parts. A key benefit is the design freedom to easily customize fixtures that accommodate numerous part configurations while enabling multiple measurements using a single fixture. Savings vary from part to part, but in one example, Senga achieved an 80% time savings and lowered cost by 93%.



## Christopher Tool - CMM Fixture

In another CMM fixture example, technicians at Christopher Tool leveraged 3D printing to realize similar benefits as Senga Engineering. Using vices, magnets, and other ad-hoc fixturing methods risked the introduction of measurement error. The process wasted time, incurred non-value-added costs, and wasn't repeatable. Changing to customized 3D printed fixtures allowed engineers to design the fixtures to optimally position the parts for inspection. Switching to 3D printed CMM fixtures increased inspection accuracy and reduced reload times (putting additional parts in a particular setup) by 90%.



# 3D Printed Fixture Success Stories (cont.)

## Moog Aircraft Group - CMM Fixture

Moog Aircraft Group designs flight control systems for virtually every commercial and military aircraft flying today. To improve its internal CMM inspection capabilities, the company turned to FDM 3D printing. It had previously used tool-steel fixtures manufactured by a third party, which represented a significant expense and resulted in weeks of lead time. Moog now 3D prints a dedicated CMM fixture for every machined component, reaping the benefits of faster production and lower cost. In some cases, the cost reduction has been over 80% compared to traditional fixture production.

## Turn an Opportunity Cost Into Profit

Opportunity cost is simply the value of the option you do not choose in any decision you make. If you fabricate tooling fixtures from metal with traditional methods, the opportunity cost is the time and money you could save if you chose 3D printing instead. Here's a simple example to demonstrate the point:

Let's say you need to fabricate 10 holding fixtures, and for simplicity, assume each fixture costs $500 in material and labor. In contrast, 3D printing these fixtures cost $250, driven primarily by material cost since labor is minimal. And although this is a fictional example, remember that the previous customer success stories demonstrated that 3D printing was the lower-cost option.

**Traditional fabrication:**

10 fixtures at $500 each = $5000

**3D printing:**

10 fixtures at $250 each = $2500

The difference between the two fabrication methods is $2500, representing the financial opportunity cost of staying with traditional fabrication. But there's also a time opportunity cost. Whether it's a vendor's delivery lead time or the time it takes your technicians to machine and assemble them, that opportunity cost is what you could do with the time if you chose to 3D print them instead (remembering that 3D printing can provide much faster production capability with minimal labor).

The point of this message is to reinforce the opportunity 3D printed tooling fixtures offer as an alternative to machined metal fixtures. That opportunity has the potential to provide profit – financial and time-related. In today's modern manufacturing world, the speed, efficiency and adaptability of your production process greatly influence your overall output and profitability. And 3D printing with FDM technology is one of the tools that can provide those benefits.

# Time to Take Action

The information in this solution guide is intended to show the benefits of 3D printed tooling fixtures compared to machined metal fixtures. But all those words can only do so much; the rest is up to you.

Use the knowledge gained from this guide and take the next step to implement 3D printing in your operation. **Contact the Stratasys team** to learn more, whether it's to talk about specific applications or find answers to any other 3D printing questions you may have.

**Some of your competitors are already benefiting from this technology. Can you afford to stay with the status quo?**

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