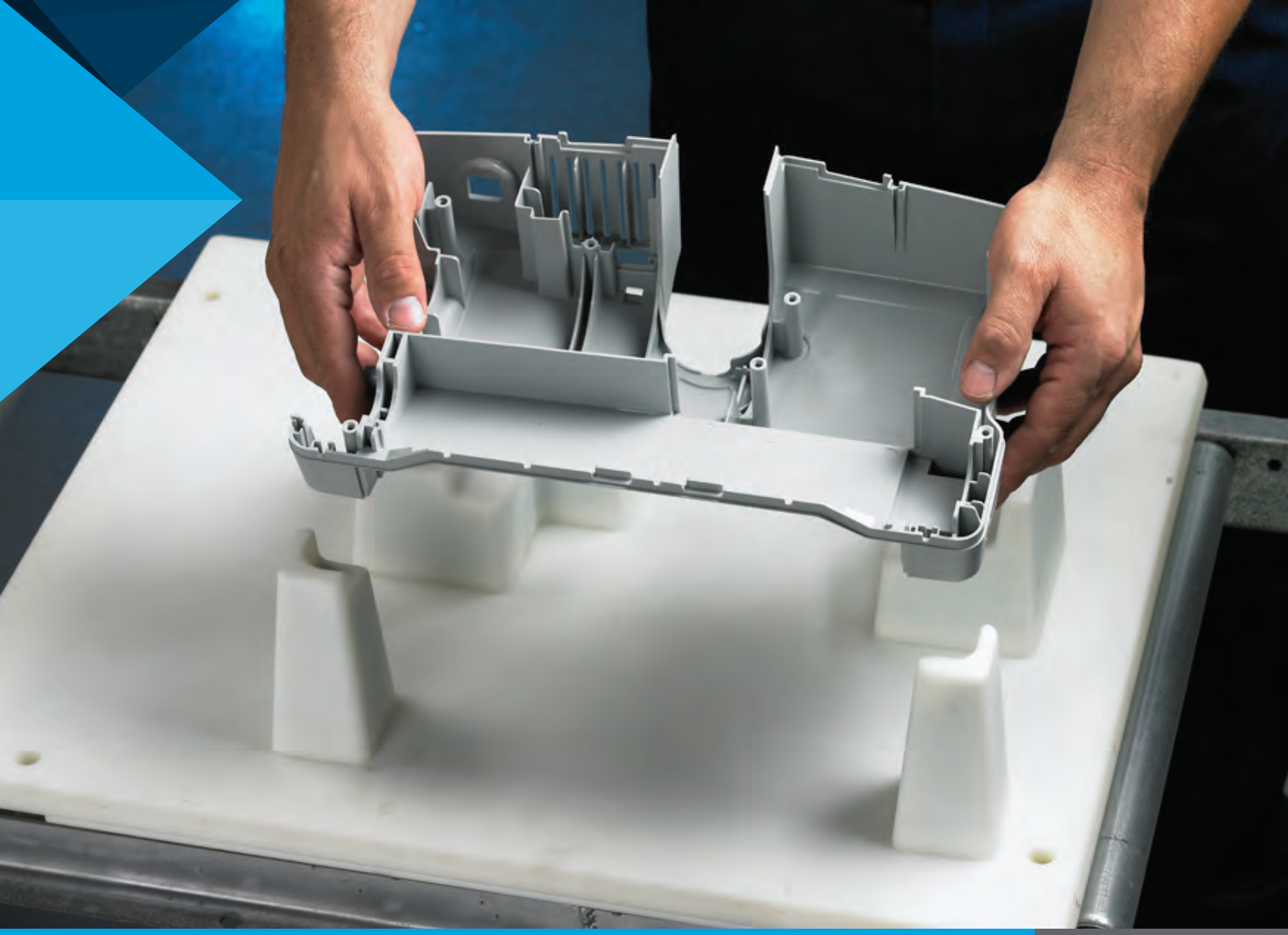

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DIRECT MANUFACTURING

3D PRINTING & ADVANCED MANUFACTURING

3D PRINTING JIGS & FIXTURES FOR THE PRODUCTION FLOOR

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3D PRINTING JIGS & FIXTURES FOR THE PRODUCTION FLOOR

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INTRODUCTION

Often overlooked, jigs and fixtures are types of manufacturing aids used to produce products and are essential for delivering those products reliably, repeatedly and with high quality.

While the terms are often used together, there are distinct differences between jigs and fixtures (J&F). Jigs are custom-made tools used to guide and control the location and motion of another work piece during an operation. Jigs provide repeatability, accuracy and interchangeability, as well as maximize efficiency in the manufacturing of products. Fixtures are devices used to locate and hold a work piece in a fixed location during a machining operation or another industrial process. Fixtures maintain consistent quality, reduce cost of production and enable a variety of parts to be made to correct specifications. Commonly used “off the shelf” fixtures include vises, chucks, clamps and collets. However, custom fixtures, designed and produced for a specific operation on a specific machine, are commonly used on the production floor.

3D printed jigs and fixtures open up new possibilities on manufacturing-floor productivity.

3D printing, also known as additive manufacturing (AM), not only dramatically reduces lead times, but can also provide significant cost savings through reduced material consumption, improved performance and added efficiencies. 3D printing processes are easy to implement and offer a wide variety of materials to support a part’s requirements. With fast and nearly labor-free production that doesn’t require the overhead of highly skilled CAM programmers and machinists, 3D printing provides a simple yet powerful solution for manufacturing tools.

A production floor worker uses a jig to aid with drilling.

3D printing eliminates cost, lead time and design barriers to adopt manufacturing aids on the shop floor.

While conventionally manufactured jigs and fixtures require high investment with uncertain returns, the return on investment (ROI) from a 3D printed jig or fixture continues to be high. Additive manufacturing can deploy jigs and fixtures where they previously could not exist due to several key advantages:

DESIGN FREEDOM

The more complex the design of the manufacturing aid, the better fit for 3D printing. Using 3D printing instead of conventional processes, like CNC machining, removes traditional manufacturing constraints and opens up nearly endless opportunities for tool configuration. Common conventional design considerations, like irregular profiles, contours or number of machine set ups, are no longer relevant when designing parts for 3D printing. These additional design complexities, which can eliminate multiple processes using conventional methods, save manufacturing time and costs.

COMPONENT CONSOLIDATION

Because of the technology's ability to handle design complexity, additively manufacturing jigs and fixtures eliminates or significantly reduces assembly time. Tools previously envisioned with multiple-components, requiring assembly via traditional manufacturing processes, can be redesigned as one contiguous component, saving time and post-build labor.

BETTER ERGONOMICS

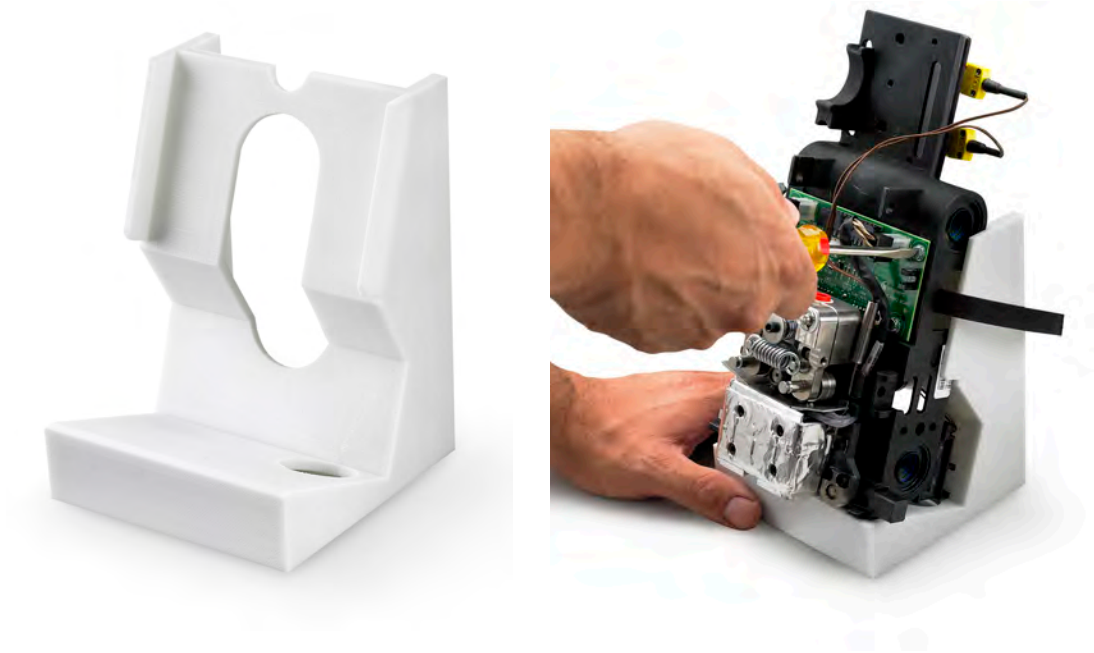
With AM's design freedoms, manufacturing aids can be created with improved handling and ease of use in mind. Through the elimination of conventional constraints, additively manufactured tools can produce contours and organic shapes that help increase worker comfort. With no added cost, the aids can increase safety, efficacy and comfort of production floor employees.

WEIGHT REDUCTION

Another comfort and safety advantage found in using 3D printed jigs and fixtures is weight reduction. Strong plastics are an excellent alternative to conventional metal cutting processes, and 3D printing has delivered over 70% lighter tools to production workers involved in assembly and fixture work. Tools that are lighter in weight increase flexibility for the workers who need to move them around the production floor; cumbersome and heavy metal tools are less likely to be used. Therefore, light-weight aids can produce the same functionality while improving the adoption of J&F and providing greater ease of use.

CUSTOMIZATION

CAD files can be easily modified before each build, allowing designers to painlessly customize tools or aids. Fixtures can be cost-effectively produced for each individual user and project need. The customization opportunities open up greater control over tasks and further enable ergonomic support for workers, resulting in higher accuracy when performing tasks.



Manufacturing aids can be designed with improved handling and ease of use in mind.

AS-NEEDED QUANTITY

3D printing jigs and fixtures is best suited for 1-100 quantities. The easy accessibility of a digital file allows you to produce aids as needed. This “digital inventory” is always available to you, and allows you to update and redesign tools quickly and effortlessly.

NO MACHINING

If a part is designed for a tolerance +/- 0.005” or +/-0.0015 inch over inch, whichever is greater, additive manufacturing can deliver the part straight off the machine. While machining isn’t universally required, if your geometries require tighter tolerances, post-machining is available for additively manufactured parts. The complementary partnership of additive and conventional manufacturing can enhance the benefits that can be achieved with either process on its own. However, there are many instances in which no machining is required for AM jigs and fixtures, which saves valuable time and money.

Tools with multiple-components requiring assembly can be redesigned as one contiguous component, saving time and post-build labor.

JIGS & FIXTURES ON THE PRODUCTION FLOOR

Jigs and fixtures can be used to streamline a variety of production floor operations.

The production floor offers a broad range of opportunities to implement additively manufactured jigs and fixtures.

From assembly to quality control to logistics, jigs and fixtures are used to streamline integral operations to manufacture parts for a range of products and industries.

PRODUCTION & ASSEMBLY

Fixtures and tools used within initial production and assembly include alignment and holding devices, as well as guides for milling or drilling a component. 3D printed tools are most commonly implemented at this stage to solve cost, accuracy, and design challenges. 3D printing with thermoplastics can be a 1:1 replacement for most traditional tools used within early assembly and production when the heat and environment of the tool do not exceed 180°F - 400°F or 82°C-204°C (on the higher end). If a product is expected to change frequently or a tool is expected to have a shorter shelf life, 3D printing is a good solution, as it can produce cost-effective, one-off parts with customized designs.

HEALTH & SAFETY

Health and safety is integral for every production floor. Investing in processes and manufacturing aids that improve safety and reduce liability is a no-brainer for every bottom line. However, the costs associated with conventional manufacturing can result in the production of jigs and fixtures that are not optimized for their intended function. For instance, the jig or fixture may be heavy or fail to meet basic ergonomic functionality when used by the worker. These seemingly trivial issues can have a huge impact on the bottom line, including flawed units, significant down time on the production floor, and worker discomfort. 3D printed J&F are an effective method for incorporating lightweight, ergonomic aids that can improve productivity and reduce worker fatigue and injury.

QC & INSPECTION

Checking a part or unit for accuracies is critical, but an inaccurate holding or inspection device can result in good parts failing to meet inspection or worse, failed parts passing without detection. 3D printing delivers highly accurate, customized tools that meet stringent specifications. They are more lightweight and therefore easier to utilize for inspection than any traditional method. Complex cradles and nests to hold parts are key to final inspection of an assembled product. Using the design freedom that additive manufacturing enables for building custom fixtures can allow for significant savings and performance advantages over traditional holding fixtures. The durable thermoplastics used in additive manufacturing also provide a non-marring surface, which is critical in final inspection

PACKAGING & LOGISTICS

3D printing is used in a number of ancillary roles for packaging and logistics, including tool guards, dunnage trays, surrogate parts, and kit boxes. But perhaps its most common use is as a customized holding fixture for the transportation of products.

An economical option when transporting small parts with delicate features, especially when accuracy is crucial, is to produce a customized 3D printed holding fixture. Holding fixtures used in packaging are commonly 3D printed with sturdy, heat resistant thermoplastic materials engineered to withstand the stresses of transportation – such as vibration, pressure, and humidity.

ORECK

The Oreck Corporation, widely known for its commercial and consumer vacuums, was an early adopter of AM-made jigs and fixtures. Before transitioning to the additive process, Oreck relied on modular aluminum clamps as fixtures during inspection of first articles for their vacuum cleaners. It took Oreck thirty days to complete its first article inspections of twenty to thirty components for a new product. After receiving the first samples from production tooling, the QA department would start making fixtures and programming the coordinate measuring machine (CMM). On the thirtieth day, it would complete the CMM inspection and release the program to the production floor.

Oreck saw 78% in cost savings through 3D printing when compared to conventional manufacturing.

With AM, the QA team completes these tasks well before the first articles arrive in the inspection lab. Thanks to 3D printing, what previously took a month to complete is done in a single day! Additionally, AM saved Oreck 78% on the costs of each customized fixture when compared to conventional manufacturing. Over the past few years, Oreck has used AM to make hundreds of inspection fixtures for its CMMs. On average, it saves $200 and 6.5 days versus having them machined.

METHOD	COST	PRODUCTION TIME	TOTAL INSPECTION TIME
CNC	$250	7 hours	30 days
AM	$55	3.5 hours	1 day
SAVINGS	$195 (78%)	3.5 hours (50%)	28 days

BMW used Fused Deposition Modeling to design lighter fixtures with design complexities.

BMW

BMW, a giant in the transportation world, used conventionally machined aluminum fixtures when assembling and testing bumper supports. The metal fixtures were uncomfortable and heavy for workers, who manually held the fixtures for each test and when applying the bumper supports. BMW recognized an opportunity to test out a more optimized fixture using 3D printing. Switching to 3D print technology Fused Deposition Modeling (FDM) with ABS thermoplastic material for their fixture, BMW was able to create more customized fixtures that had previously been too costly to produce. The new 3D printed fixtures are 72% lighter than the previous fixtures. The lightweight fixtures have improved productivity and accuracy thanks to improved ergonomics that are far less taxing on the assembler. By switching to 3D printing, BMW has realized a 58% saving in cost per fixture and a 92% increase in faster lead time.

METHOD	COST	LEAD TIME
CNC	$420	18 days
AM	$176	1.5 day
SAVINGS	$244 (58%)	16.5 days (92%)

LIMITATIONS OF ADDITIVE MANUFACTURING

Despite the many opportunities and advantages of jigs and fixtures with additive manufacturing, there are limitations that need to be considered when choosing additive or conventional manufacturing methods. Some manufacturing environments and processes require a high heat deflection temperature, or HDT. HDT is the temperature at which a polymer part deforms under a specific load. There may also be mechanical stress requirements that exceed the capabilities of the additive process and/or materials available. Material properties are important considerations to apply to design and manufacturing of thermoplastic components. There are instances where the polymers used for AM J&F will not meet the application's requirements. It is also important to note which chemicals the tools will be exposed to on the manufacturing floor, as the chemical resistance does vary for each material. Additionally, there may be high quantities or very simple geometries that could be easier and more cost-effective to produce using conventional manufacturing methods, like CNC machining.

ADDING EFFICIENCIES WITH JIGS & FIXTURES

Pinpointing areas to streamline processes on the production floor is not always intuitive, but these efficiencies and improvements can add up to a major financial advantage for your company. Many manufacturers are discovering how additively manufactured jigs and fixtures are key elements to improving worker productivity, eliminating manual error, or increasing lead time for inspection and delivery of parts. There are many benefits to partnering with a company that is familiar with jig and fixture manufacturing, including choosing the right 3D printing process to utilize for your application on the manufacturing floor. Stratasys Direct Manufacturing builds 3D printed jigs and fixtures for nearly every stage in manufacturing. Its Professional Services team can help with your design or identify opportunities to implement 3D printed jigs and fixtures that will streamline operations, improve quality and reduce cost.

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