



PRODUCTION FLOOR TRENDS

JUSTIFYING ADDITIVE MANUFACTURING THROUGH JIGS & FIXTURES

By Joe Hiemenz, Stratasys

There is an often-overlooked additive manufacturing (AM) application with potentially huge financial returns. Savings can be so large that they can justify the purchase of an AM (or 3D printing) system in far less time than the typical three- to five-year payback period the financial officer will demand.

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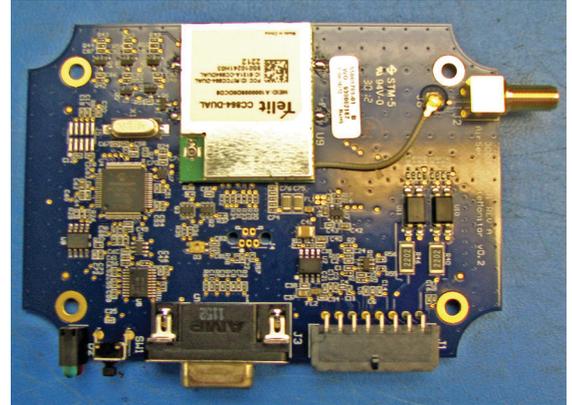
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The application is jig and fixture making — which also includes gauges, organizational aids and other manufacturing devices. AM produces these tools by adding material in an automated, layer-by-layer process rather than removing material with a cutter or forming it in a mold.

Replacing conventionally manufactured jigs and fixtures with additively manufactured ones will reduce the fabrication expense — often by 50 to 90 percent — while reducing labor and speeding delivery. But that financial advantage is tiny when compared to the profit gains that result from production-floor reductions in labor and time to market.

According to three owners of Stratasys Fortus machines, one-year profit gains ranged from \$60,000 to \$230,000 from just a few fixture-related applications.

Although traditionally made manufacturing tools could produce the same financial results, AM's advantage is that it's easier and quicker to implement. The result is a deployment of fixtures where they previously did not exist. Making these items with AM is a simple, efficient and nearly labor-free task that does not require the overhead of highly skilled CAM programmers and machinists.



A typical PCB for Digi.

The bottom line: AM makes jigs and fixtures more available and accessible, which in turn improves manufacturing efficiency, capacity, unit cost and responsiveness.

DIGI INTERNATIONAL INC.

Digi International designs and manufactures wireless networking devices using Wi-Fi, cellular and ZigBee communications standards. Its focus is on industrial, commercial and enterprise applications.

As with many companies, Digi acquired AM with specific applications in mind but found others, such as conformal coating masking. According to Matthew Larsen, lead mechanical engineer, management approved his AM purchase after he showed a 2.6-year payback based on savings in engineering-related functions, with an emphasis on prototyping expenses and engineering productivity.

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The efficiency of the AM process promotes deployment of fixtures where they previously did not exist.

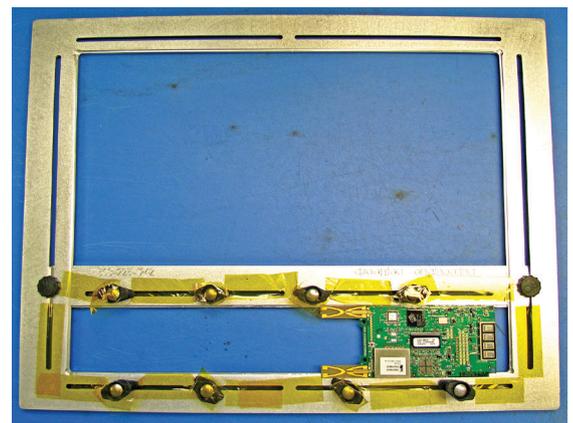
Larsen said, “We didn’t even consider operational labor on the production floor in our initial justification for adding a Fortus additive manufacturing machine.”

Within a year of purchasing the machine, Digi expanded beyond engineering into applications such as fixtures with integrated masks for its conformal coating process, which have big operational savings.

Many of Digi’s electronics require a conformal coating to protect sensitive components from the environment or to maintain sterility. Historically, Digi would purchase machined aluminum carriers for printed circuit boards (PCBs), and prior to

the coating process, technicians would manually apply tape to mask uncoated components.

For a PCB in an outdoor product, each board took 60 seconds for technicians to apply and remove



Machined carrier with manually applied tape for masking.

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the tape. Over its total production runs, the labor cost would be \$135,000.

With hybrid carrier and masking fixtures produced through FDM additive manufacturing, Digi reduced masking labor by 55 seconds per PCB for its outdoor product, which will yield a \$123,750 labor savings. This single fixture has an annual savings greater than that for all engineering-related AM applications combined. Larsen acknowledged that this financial gain would be possible with a machined alternative, but noted that Digi had not considered it. With small-batch production, saving a minute per board appeared to be a small benefit that was countered by the time and effort to have the hybrid masks machined by a supplier. With an ever-present list of higher priority projects, permanent masks for conformal coating were considered “nice to do when we have the time.”



FDM hybrid mask (black) shields PCB components from conformal coating (blue under ultraviolet light).

But that time never came, at least until they had in-house AM capabilities.

“We looked at our masking operation and thought we’d give AM a try,” said Larsen. “The risk was small because the cost was low, the process was simple, and it took very little time on the part of engineering and manufacturing. We had every reason to give additive manufacturing a shot.”

Digi is glad that it tried AM masking. According to Larsen, “When our costing department ran the numbers, everyone was shocked at how much AM had saved us.”

ORECK MANUFACTURING COMPANY

Oreck, which is well known for its commercial and consumer vacuums, was an early adopter of AM-made jigs and fixtures. In one case, it saved \$65,000 by lowering the fabrication costs reduction in time- to-market.

Before its work with AM, Oreck took 30 days to complete its first article inspections of 20 to 30 components for a new product. After receiving the first samples from production tooling, the QA department would start making fixtures and programming the CMM. On the thirtieth day, it

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Assembly line pallet saved Oreck \$65,000.

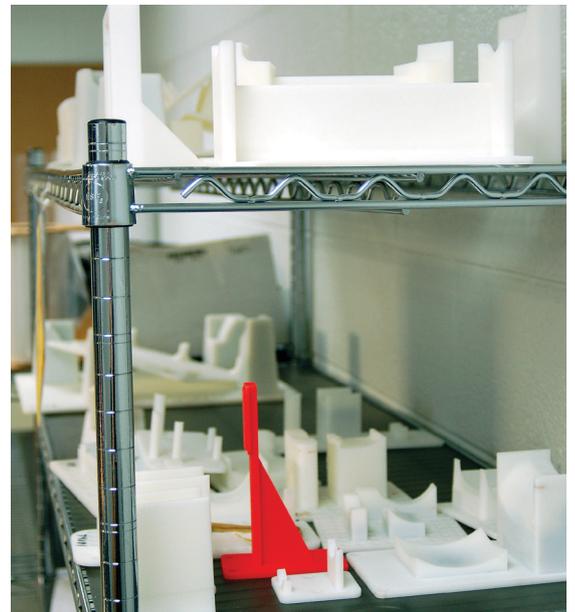
would complete the CMM inspection and release the program to the production floor.

With AM, it has taken fixture making and CMM programming off the critical path. The QA team completes these tasks well before the first articles arrive in the inspection lab. Using AM to make part replicas and CMM fixtures, Oreck creates its of assembly line pallets. But that amount is tiny when compared to the return on investment that resulted from efficiency gains in the quality assurance department.

Over the past few years, Oreck has used AM to make hundreds of inspection fixtures for its coordinate measuring machines (CMMs). On

average, it saves \$200 and 6.5 days versus having them machined. However, the most significant financial gain is a conservatively estimated \$100,000 to \$500,000 increase in gross profit that could result from a 29-day inspection plan and starts its CMM programming when a tooling order is released, not after samples are received. So, the QA department is ready and waiting for arrival of the first samples.

“I can now easily inspect all of the first articles for a new product in one day as opposed to one month in the past,” said Craig Ulmer, senior quality assurance labs technician. “This means we can give the go-ahead to start production one month earlier.”



Additive Manufacturing made fixtures are prevalent in Oreck's QA lab.

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What's the financial gain from 29 days? Let's run the numbers for a generic consumer product that sells for \$250. Gross profit margin usually runs about 50 percent, so each unit sold contributes \$125 to gross profit. With annual sales of 10,000 units (28 per day), the daily gross profit for this product is \$3,500. So, a 29-day decrease in time to market increases gross profit by \$101,500. If you increase sales to 50,000 units per year, the additional gross profit increases to \$507,500.

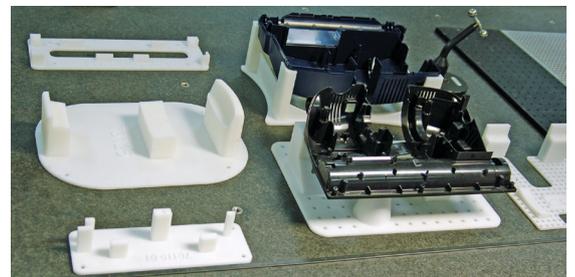
With either estimate, the average AM system would have less than a two-year payback period if it were used for only one first-article-inspection project.



Using AM fixtures, Oreck completes CMM programming before first articles arrive.

RAPID PROTOTYPE + MANUFACTURING LLC (RP+M)

Rp+m is a strategic partner of Thogus, a custom plastic injection molder. Located within Thogus' plant, rp+m's impact on production is obvious — brightly colored 3D-printed production aids are everywhere.



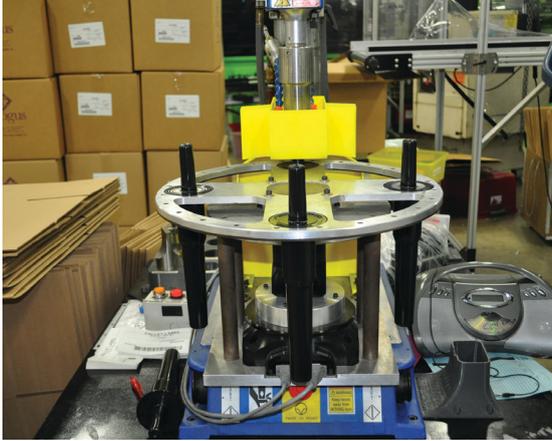
Even simple CMM fixtures can save hours in the inspection process.

According to Patrick Gannon, engineering manager for rp+m, "Our additive manufacturing processes are the path of least resistance." Like Digi, he noted the efficiency of designing, printing and putting an aid in service. The entire process usually takes only 2 to 24 hours.

That path of least resistance has yielded a proliferation of manufacturing aids that are crucial in Thogus' push for operational efficiency. Gannon cites the tools that support Thogus' 5S efforts, a workplace organization and efficiency discipline. The crux of 5S is a neat and orderly workspace that places all tools and components at hand.

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At Thogus / rp+m, production aids, such as the yellow safety shield and gray diverter (foreground), have proliferated with additive manufacturing.

Gannon noted that without additive manufacturing, the majority of their 5S organizational aids would simply not exist. “If we outsourced manufacturing of these tools, the value equation just doesn’t work. With additive manufacturing, we see an opportunity, design a tool, print it and put it in service. It is that easy.

In the 5S category, Gannon offered two examples from the hundreds dispersed throughout the Thogus production floor: nozzle holder and knockout rod holder. Both of these 5S organizers

are located at each of the company’s 30 injection molding presses. Operators turn to these holders every time there is a change to a press setup. The nozzle holder eliminates seven minutes when a press operator is looking for the nozzle for a new setup. The knockout-holder eliminates 10 minutes. At Thogus’ burdened hourly rate, that results in a savings of \$4.70 per changeover, per press. With 30 presses and an average of 150 changeovers per year, Thogus realizes an annual savings of \$21,150 each year from just two simple organizational aids.

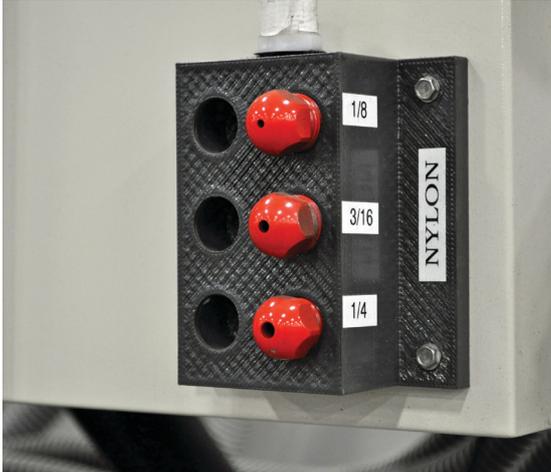
The total cost to make them was \$160.44. While this is approximately a 90% reduction versus outsourced machined pieces, Gannon doesn’t bother to calculate these savings because they are small when compared to those on the production floor and the AM justification is based on simplicity and ease. “We know it costs less, takes less time and requires less effort. We know that it yields operational time savings on the floor, so we just do it.” Thogus also uses AM-made work-piece holders on robotic arms, assembly fixtures, check



FDM 5S organizer for hand tools improves Thogus efficiency.

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Injection molding nozzles organized in an additively manufactured work holder to make them accessible to press operators.

expects 10 similar situations each year for a total savings of \$230,000. With results like these, Thogus has easily justified its investment in rp+m's six FDM additive manufacturing machines.

gauges and inspection fixtures. "There are so many on the floor, I stopped counting long ago," said Gannon.

In the quality assurance lab, he found one CMM fixture that is typical in the inspection process. He projects that this fixture will save Thogus \$23,625 by eliminating seven hours from the inspection process for each batch. Conservatively, Gannon



Even simple CMM fixtures can save hours in the inspection process.

As Digi, Oreck and Thogus / rp+m have shown, financial justification of a new AM system based solely on jigs and fixtures can be quite easy and the outcome quite profitable. The important elements of these justifications are to equate the ease and simplicity of AM with more fixtures put into service. Then carry the savings out to the production floor to calculate labor reduction and profit gains from getting product on the shelves sooner.



Three of rp+m's FDM additive manufacturing machines.



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