Direct Digital Manufacturing Part Three
How to Identify Opportunities

By Scott Crump, CEO, Stratasys, Inc.

Direct digital manufacturing (DDM) can be difficult to characterize because it does not fit neatly into previously established categories built around conventional manufacturing processes. Due to its unique processing capacities and innovative advantages, it can be a challenge to easily identify target applications for DDM. Therefore, it is vital to understand how to recognize the opportunities.

Compounding the difficulty in learning to recognize when DDM should be considered is the breadth of opportunities. Unlike conventional manufacturing processes that are constrained to process specific classes of materials or targeted towards specific product characteristics, DDM is successfully used in a wide array of industry for a broad range of products manufactured from a many classes of materials. In this aspect, DDM is much like machining but without the manufacturability constraints.

With so many opportunities to leverage the process, companies may overlook good applications that could benefit from DDM. To prevent this oversight, there are five common traits of successful DDM implementations that designers and engineers can use to rapidly identify the next product that will benefit from DDM.

DDM Opportunity Indicators

Complexity

Although part complexity is not a requirement for DDM, the benefits that can be derived usually increase proportionally to the component's design complexity (figure 1). The reason is that for extremely simple shapes there can be multiple manufacturing methods available that can deliver a part reasonably quickly and affordably. This is true because conventional manufacturing methods' time and cost are usually proportional to the complexity of the part. So, as design becomes more intricate, or more feature-laden, the cost of tooling, machining, molding, casting, stamping and forming are likely to rise. Likewise, the lead time to receive the first manufactured parts also increases.

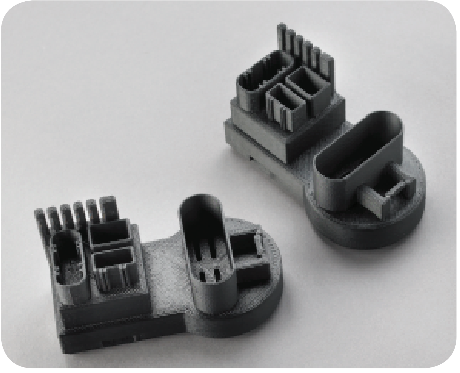

Figure 1: Complex geometries are likely candidates for DDM

With DDM, there is no link between complexity, time and cost. Unlike traditional methods, manufacturing lead time and expense are more closely tied to the size and volume of a part than they are to the component's design. As a result, the advantages of DDM over traditional methods are more significant with more complex components.

Large Up-front Investment

Manufacturing has an investment in each of its products. There is a substantial investment of labor, time and money for the creation of tool paths, fixtures, molds and machinery. For example, a single injection mold can cost $75,000, or more, and take eight to 16 weeks to make. As the initial investment of money and time grows, DDM becomes an increasingly viable alternative.

When products are made with DDM, there are no tooling cost and no waiting for the first production parts. Since DDM eliminates tooling cost and expedites production, it minimizes the start-up investment for a new product. For a manufacturing company, this translates to better cash flow, improved profit and decreased debt.

Lowering the initial investment also opens the door to more product introductions and the launch of products with low projected annual demand. With DDM, the high amortization cost for tooling of a small demand item is no longer a decision making factor. Rather, companies may elect to create the new product and build a new market without consideration of the cost per unit attributed to manufacturing start-up expenses.

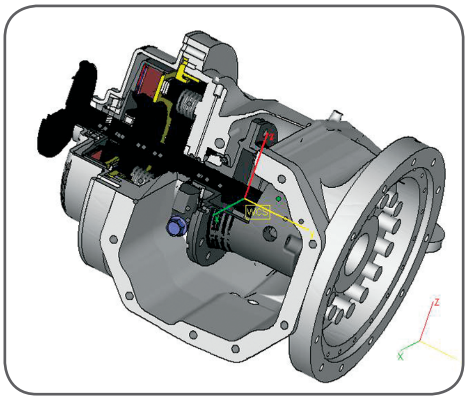

Figure 2: Freedom to redesign at will even complex geometries.

Redesign

Conventional manufacturing processes are best suited for fixed and static production runs. Any change to a product's design results in an unwanted investment of labor, time and money. Once in production, design changes are expensive and time consuming. Therefore, the goal with current manufacturing processes is to minimize changes to maximize productivity and profit. DDM circumvents this traditional rule. Since DDM promotes the freedom to redesign at will, any product that is likely to warrant design revisions becomes a candidate for the additive manufacturing process (figure 2).

When using DDM, manufacturing a revised design is simply a matter of modifying the CAD data, exporting a new file and launching the DDM machine. There is no additional cost for rework or retooling and no interruption in production schedules. Therefore, if a product is likely to change, DDM is a good alternative to traditional methods.

The freedom of redesign is the reason that many manufacturers are now using DDM as a bridge to production. It gives them the flexibility to change the design after a product's launch.

Figure 3: Measure of annual volume - large number of small parts or small number of medium to large parts ideal for DDM.

Customization

With customized products, there is a 100% guarantee of redesign. If a product is customized for each client, DDM should be the first process that is considered. It provides labor-less customization that is fast and affordable. Although most manufacturers do not offer customized products, and therefore would not benefit from this aspect of DDM, it may be worthwhile to consider if any items in the current product line could benefit from customization. If a static, unchanging product where to capitalize on DDM, would it offer more value to your customers?

Currently, the medical and dental fields are the most likely to implement DDM for large volumes of custom products because many items have to be custom fit to each patient. Accordingly, they have proven to be early adopters of DDM.

Low Production Volume

If sales forecasts are measured in millions of parts a year, and the design doesn't change, it is unlikely that DDM will be an alternative to high-volume manufacturing methods. The ideal DDM applications have low annual production volumes because of the rate of throughput and unit cost.

Where injection molding can pop out six parts a minute at a few pennies each, DDM will typically take several hours and tens to even hundreds of dollars for each part. So, high production volumes are not ideal applications for DDM. It is, however, critical to note that production volume is not measured solely in terms of pieces per year.

To correctly identify a DDM opportunity, evaluate production volume in terms of cubic inches per year. Calculate the annual volume by multiplying the total of number of parts by the parts physical volume. Using this measure of annual volume there are two cases where DDM works well. The first case is a large number of small parts. An example of a good DDM application is the production of 100,000. Because of the small size, the production rate could be 500 per run and the run time could be a few hours. The second case is a small number of medium to large parts. If you want to make a part the size of a blender, a reasonable production plan would call for part quantities in the thousands (figure 3).

Conclusion

These five characteristics are key indicators that DDM should be considered. However, it is vital to note that they are just easily evaluated indicators that serve to build general guidelines. For DDM success, all five indicators need not be present. In most cases, just one or two characteristics can make DDM a viable and valuable process. There are also successes where the products demonstrated none of these characteristics, yet the unique, innovative capabilities of DDM proved too valuable to ignore.

Since engineers and manufacturers are not up to speed with DDM concepts, the simple recommendation is to review products as they pass through the design and manufacturing process. Review them to see if the demonstrate any of the traits common to successful DDM implementations. In doing so, new and interesting DDM opportunities and applications will become visible.

The FDM Process

FDM® is an additive fabrication process used for both prototyping and direct digital manufacturing of thermoplastic parts. Following a toolpath created from CAD data, the FDM machine extrudes plastic in layers as fine as 0.005 inch (0.127 mm), building a part from the bottom, up. The process uses ABS, polycarbonate, sulfones, and blends.

FDM System Info:
www.stratasys.com

Product Inquiries:
E-mail: info@stratasys.com
Phone: 888-480-3548

For more information about Stratasys systems and materials, contact your representative at +1 888.480.3548 or visit **www.stratasys.com**

Stratasys Inc.
7665 Commerce Way
Eden Prairie, MN 55344
+1 888 480 3548 (US Toll Free)
+1 952 937 3000
+1 952 937 0070 (Fax)
www.stratasys.com
info@stratasys.com

Stratasys GmbH
Weismüllerstrasse 27
60314 Frankfurt am Main
Germany
+49 69 420 9943 0 (Tel)
+49 69 420 9943 33 (Fax)
europe@stratasys.com

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