Direct Digital Manufacturing: Impact and Opportunity

Part 3—Bridge to Production

By Todd Grimm

T. A. Grimm & Associates, Inc.

www.tagrimm.com

PREFACE

Direct digital manufacturing, otherwise known as rapid manufacturing, is a process that employs additive fabrication technology (aka rapid prototyping) to produce end-use items. Directly from CAD data, components are manufactured without molding, casting or machining. The impact of direct digital manufacturing is far-reaching, and the opportunities and advantages are extensive. This is why direct digital manufacturing is heralded as the next industrial revolution.

Since the earliest days of rapid prototyping, experts have envisioned the application of the technology in the manufacturing process, and the focus of this vision has been on the initial cost and time savings that are realized when tooling is eliminated. However, the relative impact pales in comparison to the wide ranging advantages that exist when rapid manufacturing is implemented.

Industry has failed to recognize many of the opportunities that direct digital manufacturing offers. Some will yield unprecedented efficiencies; some will generate annual savings that far exceed the cost of a tool; and others will facilitate new methodologies that address age-old constraints. Direct digital manufacturing will benefit nearly every discipline within a manufacturing organization, and it will change fundamental business processes. When adopted en masse, it truly will be an industrial revolution.

In this series of white papers, the often unrecognized benefits of rapid manufacturing will be disclosed to reveal the huge potential that the process offers. Part 1 discussed the positive impact of a newfound freedom to redesign or alter products while in production. In Part 2, the discussion highlighted direct digital manufacturing's elimination of design constraints imposed by conventional processes. In Part 3, we investigate direct digital manufacturing's role as a bridge to production.

Direct Digital Manufacturing

"Rapid Manufacturing" has become a generic term that is applied to any process that produces manufactured goods quickly. To avoid confusion, the Society of Manufacturing Engineers has adopted a new term, direct digital manufacturing. The association's definition of direct digital manufacturing is "The process of going directly from an electronic, digital representation of a part to the final product via additive manufacturing. "

STATUS QUO

Bridge to production is not a technology. It is a method, tactic and strategy to overcome the time delay between the present and the anticipated date for receipt of tools or parts. Bridging the gap allows manufacturers to meet production schedules when problems are discovered or tooling is delayed. It is also an alternative for accelerating product launches or piloting new products. In each case, the goal is to use an alternative manufacturing approach that offers shorter lead times with reasonable costs.

Although bridge to production is commonly associated with tooling, as in the often used phrase "bridge-to-production tooling," molds and dies are not the desired outcome. What manufacturers want are parts, components that can be used in their products. Whether as a short-term fix or a long-term solution, manufactures of high-volume products frequently find themselves needing rapid delivery of a small quantity of production-grade components. Without them, product launches are delayed and manufacturing comes to a grinding halt.

Another scenario is also quite common. Manufacturers whose unit sales do not number in the millions may apply a direct digital manufacturing solution as the primary production process. To avoid the investment in a steel tool for injection molding, for example, low-volume manufactures use the bridge-to-production processes to accelerate delivery and lower the investment in tooling. While the part cost may be higher and the cycle time longer, production runs of hundreds or thousands of parts are completed faster and cheaper than if high-volume production tooling were used.

Bridge to Production:

Any process that overcomes the time delay between the present and the anticipated date for receipt of tooled parts.

Historically, manufactures commonly used one of four processes as a bridge-to-production solution. Listed in ascending order of viable production quantities, first article lead time and upfront cost as well as descending order of unit cost, these processes are:

- Machining
- Rubber molding
- Reaction injection molding (RIM)
- Injection molding (machined aluminum tools)

Selecting a bridge-to-production process from this list of alternatives requires an evaluation of technical, financial and business requirements. Since the bridge-to-production methods are not identical to the production process, concessions are required.

Every process has its own set of constraints, so there may be alterations to the design, substitution of materials and reduction of order quantity. Additionally, with the exception of machined parts, each of these alternatives requires tooling, which bars immediate delivery and requires an investment in molds that will be discarded when the production tool is online.

The underlying factor is always the ability of the parts to perform as specified, and this must be matched to the quality and quantity needed as well as the total cost for tooling and parts. Yet, the overriding issue is lead time. For every day that production is halted, revenues decline, inventory mounts and schedules slip. Therefore, the ultimate goal is to deliver product as fast as possible while minimizing costs.

BRIDGE TO PRODUCTION

With direct digital manufacturing, bridge to production is fast, simple and flexible. In the time it takes to receive a quote for conventional, bridge-to-production processes, direct digital manufacturing can deliver parts that keep manufacturing churning. With less upfront effort and no commitments, it can be implemented quickly, and it is adaptable to changes in product designs or production schedules.

The moment a delay or problem is discovered, companies can enact a direct digital manufacturing solution that delivers production-grade components in as little as a day. All that is required is 3D CAD data, machine capacity and materials. Eliminating nearly all steps required in conventional, bridge-to-production processes, including tool path design and tool making, direct digital manufacturing simplifies the process, minimizes effort and expedites manufacturing. Unlike conventional approaches that become big projects, direct digital manufacturing is a task, just one item on a manufacturing engineer's to-do list.

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As mentioned earlier, alternative bridge-to-production methods often demand design modifications to accommodate process constraints and accelerate product delivery. Days, even weeks, are lost in the discussion of suggested changes, evaluation of the viability and impact, and modification of the design data. Since direct digital manufacturing has few constraints, there is rarely a need for discussion, evaluation or inclusion of design modifications. With no alteration, production is initiated directly from an STL of the original design. And since there is no tooling, production begins immediately.

To overcome schedule delays, the rapid response of direct digital manufacturing is critical. However, there is another important factor to consider. Direct digital manufacturing can adapt to any changes that occur while waiting for production tooling. By the nature of the additive process, there is unlimited flexibility. Contrary to conventional processes where designs become frozen and order quantities are predetermined, direct digital manufacturing supports design modifications and allows frequent adjustments to quantities and delivery schedules.

> ***Tip:*** *Capitalize on the freedom of design. If more than one component in an assembly requires a bridge-to-production solution, consider consolidating these parts into one.*

Part 1 of this series of articles discussed that the elimination of tooling promotes design changes while a product is in production. This is also true in the case of bridge to production. Manufacturers receive parts that serve as prototypes, pilots and production goods. Should the parts reveal a design flaw,

changes can be made and implemented with the next batch of parts. If discovered early, these changes may be incorporated into the production tooling.

> ***Tip:*** *Evaluate the quantity of parts needed. When considering multiple solutions, companies may arbitrarily specify an order quantity dictated by the efficiencies of molding processes rather than the actual demand.*

With direct digital manufacturing, there are no minimum order quantities and no penalties for re-orders. This provides manufactures the flexibility to purchase a minimum quantity and specify a delivery schedule that matches the shop floor demand. Should the production tool come online earlier or later than planned, direct digital manufacturing allows schedule and quantity adjustments. For example, if using an aluminum injection mold as a bridge to production, costs are minimized and efficiencies maximized if all parts are molded in one run. Breaking down and setting up tools on the molding press takes time, and this translates to additional costs and delays if a re-order is required. In the case of rubber molding, an additional order may exceed the life of the mold, so another has to be constructed. Neither scenario is true with direct digital manufacturing. There is no penalty for frequent re-orders, decreases in anticipated order quantity or increases in total number of parts required.

Capitalizing on the on-demand nature of direct digital manufacturing, companies can adapt to any changes in the production plan. In fact, the ideal direct digital manufacturing scenario is to order only the quantity needed over the course of a few days or a week. With production schedule in hand, a replenishment order is placed to satisfy the needs for the coming period. This assures no scrap, no shortages and no delays to the production schedule. No other bridge-to-production method offers this ability to deliver small quantities rapidly and with no impact on costs or schedules.

Direct digital manufacturing is an ideal bridge-to-production solution because it is fast, simple and flexible. Delivering parts just days after a problem is discovered, it keeps production schedules on track, and it does so without the overhead, burdens, efforts and decision-making of alternative approaches. At a time when an organization is in a frenzy of activity to launch a product, the simplicity and flexibility frees the manufacturing staff to move on to other challenges that inevitably crop up when launching a new product.

RETURN ON INVESTMENT

The undeniable financial benefit of direct digital manufacturing is the additional profit generated from product sales during the time span between the present and the delivery of parts from production tooling. As the example shows, a company with $10 million in annual sales can realize $500,000 in additional gross profit with direct digital manufacturing.

However, there are additional financial gains to consider. While measureable, they vary greatly from company-to-company, so an example is not offered.

These gains include:

- Cash flow:
    - A delay in sales can constrict cash flow, which may force a company to borrow money or tap into sources of income or interest generating funds.
- Facilities and equipment:
    - Whether idle or operating, there are fixed expenses associated with the facilities, tooling, equipment, production lines and assembly lines.
- Inventory carrying cost
    - A delay in production tooling creates large work-in-progress (WIP) inventories for the balance of a product's components. For each day that inventory sits on a shelf, there is a direct cost to the company.

ROI CALCULATION

Assumptions

Number of parts per product:	25
No. requiring bridge to production:	1
Weeks saved:	5
Number of products:	10
Annual sales per product:	$1,000,000
Gross profit:	50%

Profit Gains

Sales:	
Weekly gross profit:	
$1,000,000/50 weeks:	$20,000
X 50% gross profit:	$10,000
X 10 products:	$100,000
Gross profit:	
5 weeks @ $100,000:	**$500,000**

Delays are costly. Eliminating them yields significant and measurable financial benefits. However, there are also other advantages and gains that cannot be directly translated into financial terms. While they stem from the same factors— speed, simplicity and flexibility—they are not quite as tangible.

Productivity

Notice of a tooling delay sends the manufacturing staff scrambling for a solution. All planned actions are put on hold while an alternative is sought. This unexpected activity diminishes manufacturing productivity.

Conventional bridge-to-production solutions require discussion, analysis, decisions, documentation and oversight. From the moment a quotation request is submitted until the last part is received, manufacturing employees will be actively involved in the bridge-to-production project. The time demands postpone other important, but not as critical, projects and tasks. While there is a direct labor cost associated to this work, the biggest impact is on the overall productivity of manufacturing and shop floor personnel.

Direct digital manufacturing gets production back on track while minimizing productivity declines. Production begins immediately, and since the technology is so fast, so automated and so independent of other processes, parts can be produced in a single day.

As stated previously, direct digital manufacturing is more of a task than a project. While technologies and materials need to be evaluated, the balance of the bridge-to-production effort can be executed with little direct labor. From an STL file, a quote is prepared and submitted, often within hours. There are no discussions or negotiations of design modifications. Once the order is released, production begins immediately, and since the technology is so fast, so automated and so independent of other processes, there is much less likelihood of a second round of delays and schedule juggling. Direct digital manufacturing gets production back on track while minimizing productivity declines.

Efficiency

Manufacturing operations are intertwined, tightly coupled and carefully sequenced. When one operation fails to deliver as scheduled, all connected operations are affected and inefficiencies mount. And since people, equipment and operations are often shared amongst products, the lag on one product may have a ripple effect on all others.

Shifting manpower, breaking down lines and juggling schedules lead to inefficiencies that have a direct impact on profitability, capacity and throughput. With a direct digital manufacturing solution, unexpected delays in production tooling are bridged, and operational efficiency is protected.

Reputation & Commitments

The impact of a manufacturing delay reaches far beyond the manufacturing floor. Missed delivery dates rise to the executive level of the corporation, spread throughout all departments and extend to the customer. The ramifications are deep, wide and impossible to quantify.

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Using direct digital manufacturing to preserve promised launch dates allows customers, as well as corporate sales, marketing and finance, to operate to predefined schedules. Without the rapid response to manufacturing delays, the inefficiency, turmoil and cost that would affect the manufacturing floor are passed on to other departments and corporate entities. Manufacturing copes with the fact that schedules are tough to keep, even when there are no outside influences. When a schedule is missed because of another's actions, frustration, animosity and anger can arise, which jeopardizes long-term relationships, and in the case of the customer, risks future sales.

CONCLUSION

Reputation is priceless. Productivity and efficiency add value. Delivering on schedule raises profits. As a bridge-to-production solution, direct digital manufacturing delivers these benefits. Quick, simple and efficient, it is the ideal alternative when production delays are identified. Combined with the advantages of the freedom to redesign (Part 1) and freedom of design (Part 2), the benefits are staggering and impossible to ignore.

And yet, there are even more advantages that the process offers. Part 4 in this series will reveal the benefits gained when direct digital manufacturing is applied to jigs and fixtures. Although perceived as a process for making production goods, direct digital manufacturing is equally powerful as a tool for manufacturing engineering. With fewer demands and less perceived risk, it is easily adopted by companies of all sizes and in all industries.

Direct digital manufacturing will be the next industrial revolution. With it, as with any revolution, there will be a total upheaval, a radical change and an overthrow of existing practices. Direct digital manufacturing will infiltrate all processes and every discipline within a company. It will change how manufacturing is done.

About the Author

Todd Grimm is president of T. A. Grimm & Associates, Inc., an independent consulting firm that focuses on rapid prototyping and reverse engineering. Todd has worked in the field of rapid prototyping since 1990. He is the author of "Users Guide to Rapid Prototyping" and holds a Masters Certificate in Rapid Prototyping. Todd serves on the Society of Manufacturing Engineers' Rapid Technologies and Additive Manufacturing steering committee, and he chairs the 3D Data Capture/Reverse Engineering technical group.