**Is 3D Printing for Real?**
Imagine an electronic device, such as a cell phone, being printed entirely in one pass. No individual parts; just a single, one-piece phone. Possible?

Consider the following:

- **GKN Aerospace** and the **University of Warwick** have jointly developed *Carbomorph*—a material that possesses the ability to change electronic resistance as the material is squeezed. This means that functional switches and other electronic circuitry can be printed "into" the case of a device. The story of this miraculous material is detailed in the September 7, 2013 issue of *The Economist*.

- **Optomec** has perfected a process called *Aerosol* Jet that embeds electronic circuitry into structural members of a device. They are currently printing circuitry directly into handsets for mobile phones. Additionally, they have many exciting products under development including wallpaper with embedded LED lighting and micro-engineered parts for small drones.

- **3D Systems** has a new scanner priced at US $399 that provides the ability to scan existing 3D objects and create 3D print files for use with a 3D printer. This announcement is important because it places a fully functional, home-based 3D print system within the reach of most families.

**3D printing is delivering on the promise … today.**

Cincom®

Industry Profile: **3D Printing**

# 3D Printing – Is the Promise Finally Being Delivered?

## 3D Printing Is Disrupting Manufacturing

Much has been written about 3D printing. It is not a new technology, but it is a technology that over the last 20 years or so has begun to develop into a real alternative to the traditional casting or machining of parts. It does have real potential to disrupt many of the notions we have about manufacturing and plant operation today.

*IBISWorld* provides market data on specific vertical industries. Their profile of the 3D manufacturing space is particularly interesting. IBIS splits the 3D market into two major segments:

- 3D print prototyping services
- 3D printer manufacturers

Together, these two segments generate annual revenues of about 2.5 billion dollars.

## Print Prototyping Services

The recent economic downturn was not kind to the entire 3D printing industry, but service shops had the advantage of being able to offer all of the benefits of a prototyping capability without companies needing to invest in machines, supplies, training and support associated with the technology. Over the past five years, the printing services segment sustained an annual growth rate of over 10 percent.

## Printer Manufacturers

Within the entire $1.7 billion 3D printer manufacturing segment, revenue is divided into three major markets:

- Printer sales – 36 percent
- Maintenance services for installed units – 25 percent
- Sales from the material used by the printer to make things – 39 percent

In contrast to 3D print prototyping service shops, the printer manufacturing segment experienced a more anemic 7.2 percent growth rate.

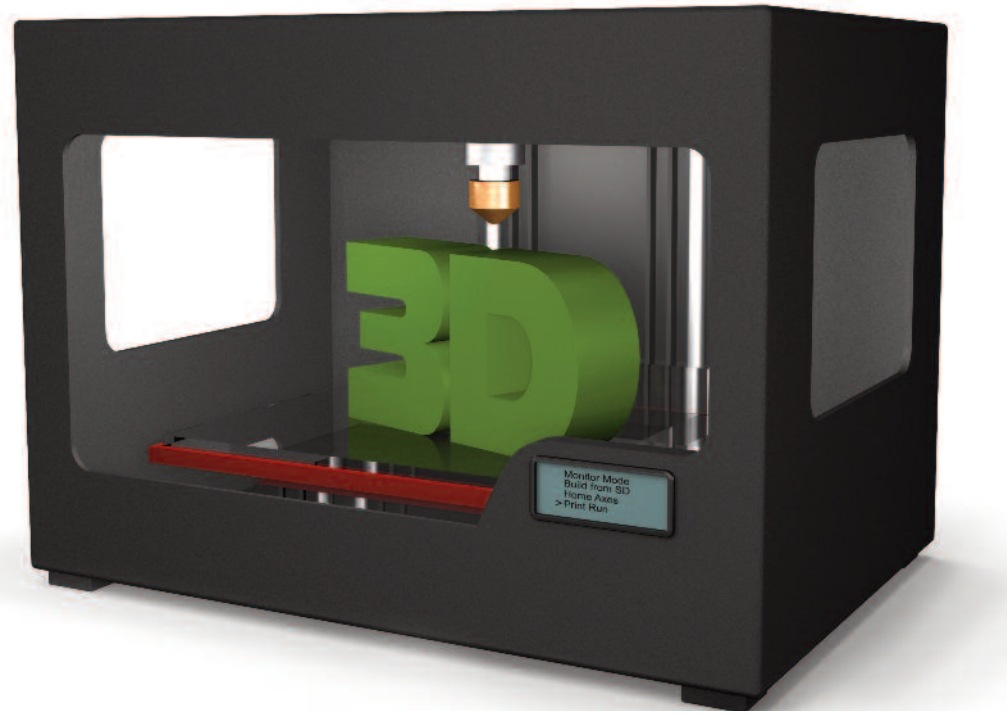
## The Outlook for Industry Growth

Both groups (print prototyping services and printer manufacturers) are forecast to have strong growth over the next five years: 14 percent for manufacturers and 12 percent for services. As the general economy improves and as construction picks up, the overall demand for this technology will increase even more.

However, the economic recovery to date has only begun to manifest itself in the real estate market. It is essential that real growth become sustained and strong in this area. New building projects mean higher demand for architectural and design services. Both of these segments are heavy users of 3D print technology. Architects include scale model versions of their proposed projects with proposal submissions, and 3D offers a fantastic capability in this area.

The other aspect of growth is one-off or customized products. In down economies, the tendency is to make do with off-the-shelf capabilities as a cost-saving strategy. As things improve, people are more likely to want a custom-designed, highly specific version of whatever they are buying. They have less hesitation to risk capital for better capability.

*3D printing is forecast to have strong growth over the next five years: 14percent for manufacturers and 12 percent for services.*

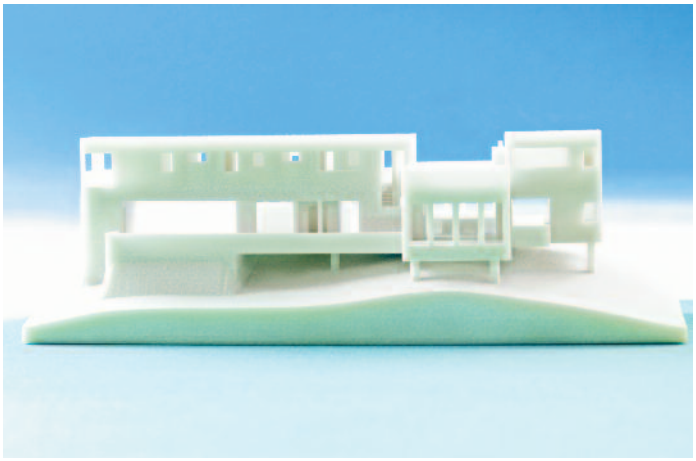


## Specific Growth Industries for 3D

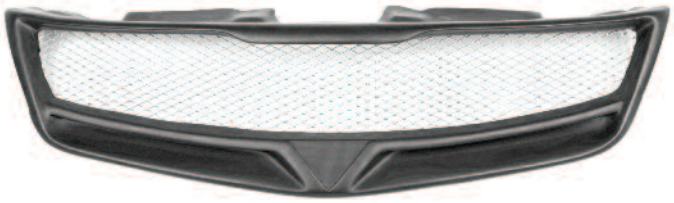
**Medical and Prosthetic Devices** – This is a market that's full of promise and demonstrable success. There are two primary types of opportunity here:

- **Building customized artificial limbs and body parts**. This technology is already delivering solutions to users around the world. *Forbes* magazine published a piece on its website about two people who printed replacement digits for someone who lost his fingers in a table-saw accident. The article, "*3D Printing and the Future of Prosthetics*," tells the story of how this technology, in the hands of a couple of creative people, was able to create a set of working fingers. Perhaps the most astounding part of the whole story is that the end cost of the fingers was about US $150.
- **Bio-Printing Technology**. More astounding than building plastic replacement parts is the bio-printing technology currently under development. This technology facilitates the growth of actual human tissue to fabricate blood vessels, skin grafts, bones and even entire organs. The use of stem-cell technology facilitates the development of the recipient's own tissue in the replacement part. This eliminates the rejection problems that are common in so many transplant patients.

**Design and Architecture** – It may be slow and deliberate, but the construction business is starting to pick up. After a protracted period of time with virtually no new construction, demand is starting to increase. There is a great deal of pent-up demand that will become active as funding resources become more available over time. The ability to model large projects is a requirement for architects and design professionals. 3D printing is the ideal solution to build out project models and to see how they fit into an existing skyline or green area. Planning and zoning commissions, purchasing committees and project managers expect to see models along with homeowners considering room additions or a new deck. 3D printing technology provides economy and incredible detail in these renderings.

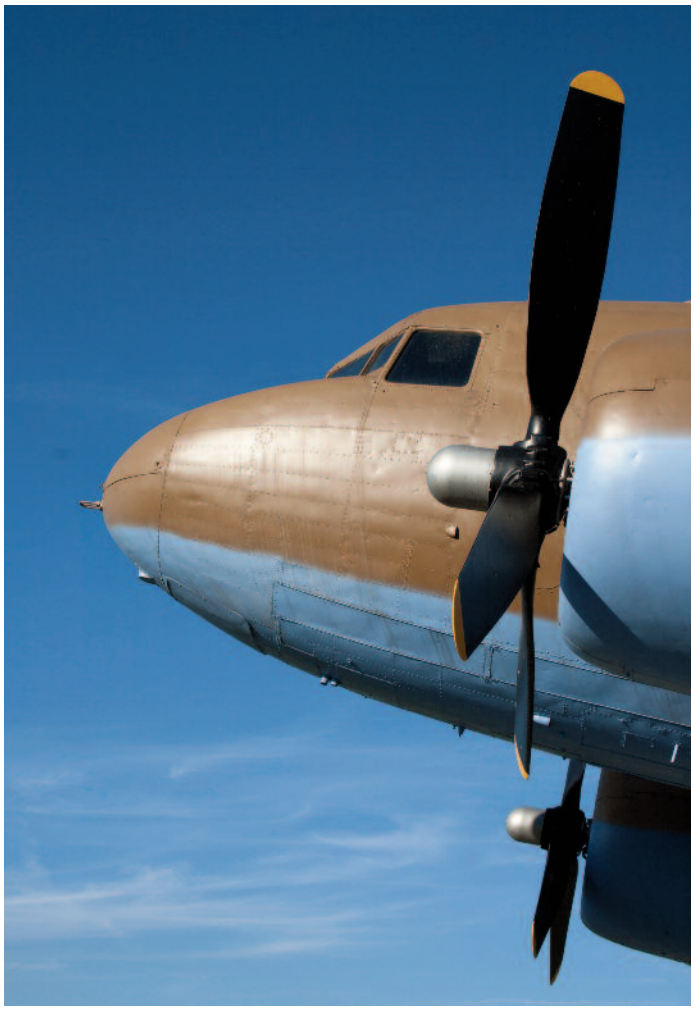


**Automotive** – 3D printing finds itself in the new model development area of automotive as designers build out body-design concepts and part prototyping. The resurgence of the automotive industry worldwide will stimulate new sales for new and more-capable 3D printing technology. In the aftermarket, more and more people are discovering the hobby of personalizing their automobiles. Add-on aftermarket parts include simple placards or emblems that attach directly to the body of the car or more elaborate parts such as replacement grills, taillight surrounds, hood scoops or spoilers. Virtually all of these are built with ABS, which is a plastic compound that is completely at home in the 3D printing environment. This market is huge.



**Aerospace** – In 2014, NASA will be sending a 3D printer to the International Space Station. This is a natural for space travel. One of the limiters or cost factors on launch is the sheer mass of the object(s) you are lofting into space. Consider that 3D allows you to send the building material into space in a compact form. The building plans (the printer software itself) does not take up any room. It can even remain on the ground. Once in orbit, the printer is brought online and the needed objects are created when they are needed. As parts break or wear out, they too can be printed when needed. There is no requirement to store extra stuff on board; it can be built strictly on demand.

This has obvious application in the context of maritime use as well. Ships could fabricate many parts they once had to store onboard. Again, this is a huge cost savings in terms of space economy. As a whole, aerospace typically involves a lot of prototyping and low unit-count production. As metal technology evolves and 3D printers increase their ability to utilize metal versus plastic or ceramic materials, the technology as a whole will become more commonplace.

**Maintenance Repair and Overhaul** – More and more high-value products are expected to last for many years. This is driven by several factors, including economy in terms of service life and Total Cost of Ownership (TCO) as well as the more beneficial nature of products that aren't dumped after a short life span. Consider aircraft such as the DC-3/C-47 built by Douglas Aircraft in the WWII era. These planes still fly and provide freight and passenger service in some areas. Parts for older machines become more and more expensive on a unit basis and demand steadily trends lower and lower. 3D offers the ability to build parts on demand for these types of applications. No inventory is required, just a job file with the part specs encoded for the printer. This is a real growth area.

**Building Material** – An area that has great potential is in the development of building material for 3D printers. Most of the compounds used for this are based on plastics, resin or metals. The limiter that is always cited for holding 3D back is the strength and durability of the parts manufactured by the printing process. Great progress has been made. However, aerospace, automotive and medical applications are all very demanding in terms of longevity, stability, strength and durability of products used in those domains. Companies that develop better "ink" will find their products in high demand.

## The Future of 3D

Imagine buying a car that is customized to fit you. Everything about the vehicle would be reflective of your own unique dimensions. The pitch of the seats, the height of the seat and the size and position of the steering wheel would be built around you. The door size would allow you to easily enter and exit your car.

If you are less than 5 feet tall or more than 6.5 feet tall, cars are uncomfortable. Doors are too small and pedals are too far away or force your knees up under your chin. The steering wheel either obstructs your view or your head is rubbing the ceiling liner in the car. If the car were designed and tailored to the driver, these things would not happen. 3D makes that type of personalization possible with almost no cost increase.

*Today, products aren't really customized, they are approximated.*

*3D printing aims to change all that.*

Currently we try to personalize things with S-M-L-XL-XXL. We provide incremental seat or steering-wheel adjustments, and our shoes are sized narrow, standard or wide. Products aren't really customized, they are approximated. In some things, approximation works fine. However, in medical, aerospace or even in sports, approximating is simply not good enough. No one wants a nose that's almost the right size or an ear that is slightly larger than the one opposite.

In aerospace, part tolerances are very exacting. With machined parts, there are always slight differences in the replicated piece. If a machine tool is recalibrated every 1,000 cycles, there will be a difference between the first unit produced and the 950th unit produced. The more we expect out of technology, the more demanding the application and the less likely are these differences to be tolerated. Parts will need to be exactly the same. Digitization and 3D accomplishes that.

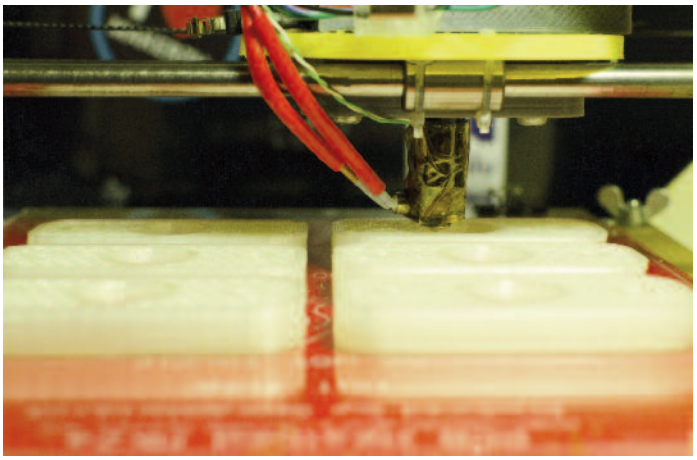
## Making and Selling 3D and the 3D Advantage

When we talk about selling 3D, we are talking about selling products made with this technology. The range of options for sizing products means the end of incremental product sizes. The primary advantage 3D brings is infinite variability. This means configuration specs are no longer incrementalized with the traditional metrics.

*The primary advantage 3D brings is infinite variability. This means the end of incremental product sizes.*

Individuals selling products will need to be able to configure things to the $n^{th}$ level of detail. This will be critical for quality assurance as well as for accurately pricing whatever product is being built. Configurators that are limited to specific incremental options may not have the robust capabilities needed to function in the world of infinite variability.

Sales will also need to understand the relative nature of, or the interrelationship of, parts and options in much greater detail. Materials used are subject to stress loads that at one size may be inconsequential and at yet another critical to the performance of a part or product. Again, configuration technology must be able to deal with that kind of variability during the sales and specification processes.



## Blurred Lines between Process and Discrete Manufacturing

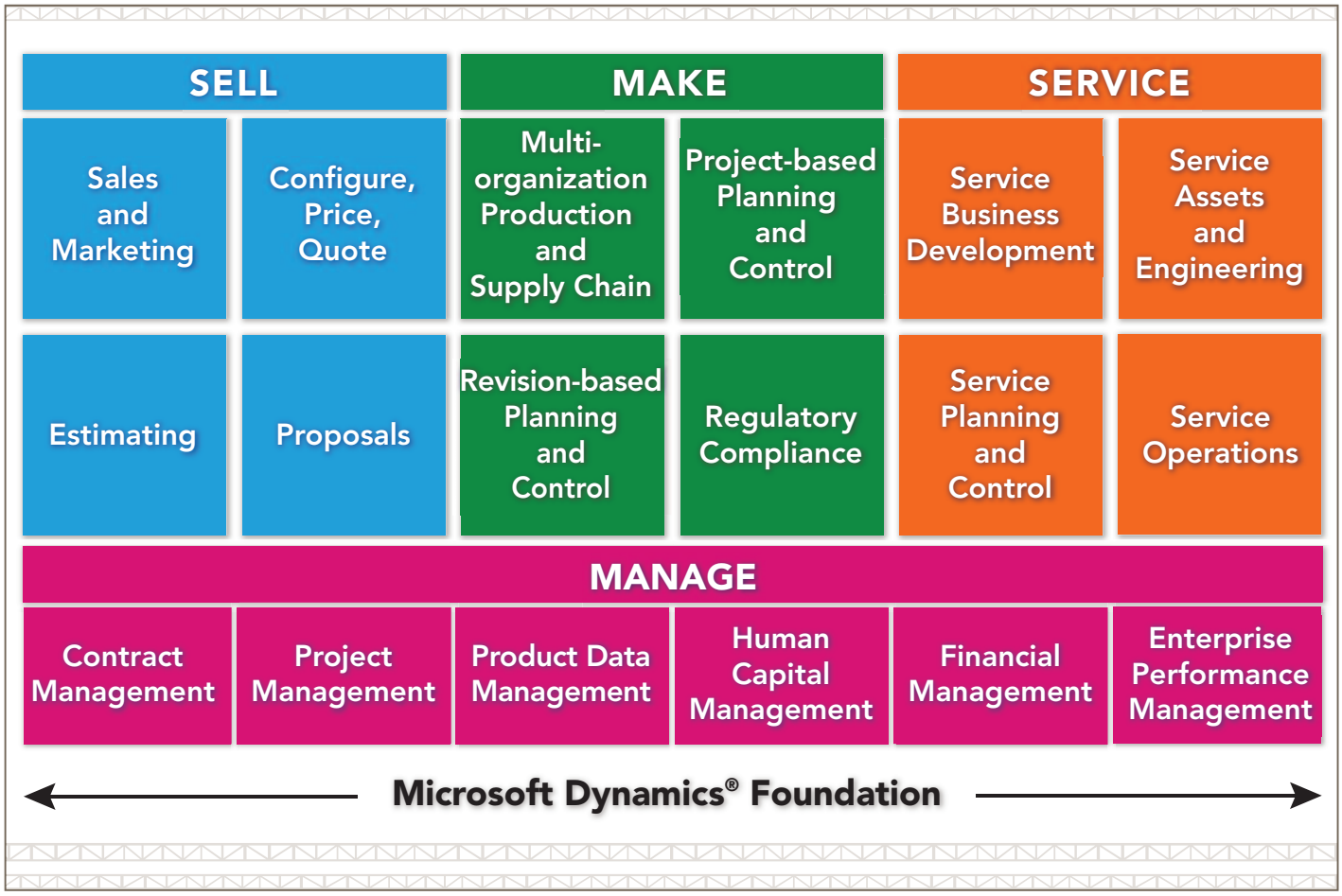
A rules-based, knowledge-enabled configurator such as the one offered by Cincom is ideally suited to this type of product variability. For instance, a part that might be currently spec'd at a 10-inch diameter and used for "medium-size" openings might now be custom spec'd at a 9.986-inch diameter to cover one particular opening of 9.982 inches. The configurator needs to handle any size requested by the buyer.

*Flexibility is needed to correctly handle recipe-like inventory formats right alongside BOM-type part and assembly formats.*

Making products with this type of variability will require some special capabilities in terms of production planning, inventory and work station re-supply. Since most of the building material is formula-based and the parts produced are likely part of a BOM, flexibility is needed to correctly handle recipe-like inventory formats right alongside BOM type part and assembly formats. While this may blur the lines between process and discrete, it is not an insurmountable barrier to fully functional MES or ERP systems.

Cincom ERP is perfect for this type of variability. It is very much at home with fully mixed manufacturing modes on the same line. Building products with 3D will contract the supply chain in that parts may be fabricated in-house to meet an on-demand spec that will be used once and then never used again. The building material (3D printer "ink") is tracked like a recipe-based supply item. The actual part produced is part of a BOM. That takes experience and a super flexible system like Cincom's.

## Cincom ERP




*Cincom ERP is an advanced version of Microsoft Dynamics AX designed specifically to meet the needs of complex manufacturers.*

## Is 3D Printing Another PC?

The idea of tinkering with 3D as a hobby may seem farfetched or perhaps a little weird to many people.

However, it is a current reality for some. The price of printers is dropping, and some very basic versions are in the sub 10K price range.

You may ask, "Who in the world would want to print and "manufacture" items in their home?" Like those who were scratching their heads about home-based PCs in the early 1980s, skeptics will tend to minimize the home-3D market as a "for geeks only" hobby. However, this technology has the same potential as the PC to disrupt mindsets.

*3D is coming to your factory, your office—and your home.*

People have been building things in their basements for centuries. Woodworking is a still a huge hobby today. Many people grew up in homes furnished with desks, chairs, bookcases and other items built by a hobbyist. Combining that same motivation in a digital technology is not a stretch at all. Home 3D printing may very well become a common household activity in a relatively short period of time.

It is not a stretch to see 3D pattern files sold via Amazon or other online marketplaces. User groups will develop; people will share ideas and patterns. They will use 3D printers for making a variety of items for use in the home. Hobby stores will carry pattern files and project supplies. In short, 3D may well be another PC. And just like the PC, it is here to stay.

## About the Author

Lou Washington started his career in information management with the University of Missouri System Office of Records Management. He joined Tab Products Company in 1980, where he became the first product manager for Tab's Tracker system software products. In addition, he was peripherally involved in Tab's Laser Optics division. In 1990, Lou joined Cincom, where his present role is as senior marketing manager for manufacturing business solutions.

## The Cincom Business Suite

An advanced version of Microsoft Dynamics® AX designed specifically to meet the needs of complex manufacturers. It helps manufacturers win more business, operate efficiently and deliver as promised.



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