3D printing in food manufacture

Simon Hammond of 3D Systems Europe describes the application and advantages of 3D printing in food manufacturing processes.

Although 3D printing is perceived as a brand new technology, it has in fact been around for over 30 years. There are more than 100 commercial materials available on seven print platforms including plastics and metals. The technology is being adopted by a number of sectors, including automotive, medical, aerospace and design. It is predominately being used for prototyping but we are now entering the next big step change: machines and platforms for production.

The food industry is exploring the potential for 3D printing. The headlines are being grabbed by food that is sculpted into interesting shapes, but a more scientific approach to the development of the technology and establishing appropriate applications is required.

This article focuses on the value that Additive Manufacturing (AM), the term that industry prefers to 3D printing, is currently adding to the production of food and drink. Two technologies are important here: Selective Laser Sintering (SLS), which makes parts in a PA12 Nylon, and Direct Metal Printing (DMP), which makes real metal parts in several different materials, including Stainless Steel 316L – a food grade material.

Direct Metal Printing case study

A confectionary company making a range of products was looking for a solution to an age-old problem: successfully mixing colours into the product with easy maintenance and marginal gains to speed up production.

The existing extrusion of materials was through bespoke machined nozzles that were CNC (computer numerical control) machined from steel for the basic geometry, but required further processing to make holes to push through and mix the colours and ingredients. The process used was deep hole drilling, which is expensive and rather limited as holes can only be made in one direction. Several parts were required to make a complete assembly. Cleaning and maintenance of the nozzles proved to be complex and time consuming as traditional manufacturing of complex geometry results in sharp corners and features.

In CNC manufacture, also known as reductive manufacturing, parts are made from blocks of stone, lengths of wood and billets of metals by accurately carving material away. It is simple but very wasteful, with up to 90% of the value of the material falling on the floor and being scrapped.

AM is a simple process of melting or curing very fine layers of powder or liquids. The process starts with a CAD model sliced into cross-sections; each cross-section is mapped onto the surface of the material by laser which joins the particles together. As materials are joined together, the solid material acts as a support structure, allowing highly complex geometries to be created, layer by layer. Features, such as tunnels, that can travel in any direction and can change course inside solid material can be created. Weight reduction can be achieved as complex lattice can replace solid walls. Designers have the freedom to design in new and previously impossible ways.

Designers at 3D Systems came up with a novel solution for the mixing of colours into confectionery using a form of AM that takes atomised metal powder and uses a laser to accurately melt the material in layers of between 30 and 60 μm. The material in this case was Stainless Steel 316L, a food grade material.

The first design improvement was to change the shape of the holes of the nozzle. Speeding up the conventional assembly line would force materials through round holes resulting in misshaped sweets. The geometry that worked at speed was an oval shape, which can be built using the AM manufacturing technology. A small channel of 0.8mm was also created to allow compressed air to be pumped in to cool down the extruded product, allowing the assembly line to speed up making more product in a given time period.
idaho steel now makes the same number of parts in 90 hours of virtually unattended, continuous run-time on the SLS machine. the machine can work through the night or over a weekend and the forming pistons require only about three to four hours of manual labour. 3D printing also frees up the CNC machines that would be tied up doing this job for 25 days.

A big advantage of the ‘one-part’ approach is the sanitation benefit. the removal of harbourage areas, such as fasteners, in food manufacturing equipment and the elimination of potential contamination risks is a significant benefit. the risk of fasteners being over-tightened and damaging parts is also reduced.

The company wanted to build shapes more quickly for customers to reduce lead time for new product development. it purchased a 3D systems SLS 3D printer for manufacturing key production parts for fabricating machines to enable increased strength and durability, not possible through traditional machining. 3D printing allows more control over individual parts in a much faster timeframe and parts can be designed for added strength. Typically, the weak points in conventional manufacturing are where separate pieces have been bolted together.

One of Idaho Steel’s prime applications for 3D printing is customising forming inserts and pistons for its Nex-Gem Former machine that forms potato products in different shapes. the forming inserts and pistons were formerly made from five parts, machined out of plastic and held together with 25 or more fasteners. using multiple CNC operations and manual assembly, it took up to 250 hours [25 working days] to complete a set of 16 forming pistons.

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Manufacturing of housing for a laser that detects the material level of a hopper or bin and relays it to the control system was previously outsourced to another company, but the quality was not meeting standards. Idaho Steel began printing the part on the SLS machine, yielding major improvements. The opening at the top was made larger for easier access to the sensor, corners were rounded and the housing was made as a single part with a plastic chain connecting the screw-top cap to the housing so it will not be misplaced when the sensor is being accessed.

Idaho Steel sees 3D printing and CNC as complementary tools for creating new parts. 3D printing is ideal for prototyping new designs, creating better low-volume parts and assemblies and customising new parts for existing machines. CNC is still the go-to option for simpler designs or larger parts produced at a higher volume. the company’s machinists have adopted 3D printing enthusiastically and are interested to see what the 3D printer can do and how it can be used to advantage.

one of the machining industry’s greatest obstacles is lead time. When customers get approval for projects they need forming pistons, which could be any shape imaginable, right away. Some of the shapes are fairly complex and could take up to a month to CNC machine, but the time can be reduced to a week with the SLS machine.

Idaho Steel has found that new ways to create better parts with 3D printing continue to present themselves, adding much greater flexibility to its processes. it is no longer limited by traditional machining tools, but by the imagination and creativity of its design group.

Conclusion
Additive Manufacturing can offer the food and drink industry a number of competitive advantages, including better parts, reduced costs and rapid delivery of novel solutions. it will complement traditional manufacturing rather than replacing it.

3D PRINTING

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