3D Printing in Metal

"There are cases where pursuing 3D printing of metal parts for Classic cars may be the best way to go. The most likely candidates are 'must have' parts that are complex in shape, not too large in size and not available through traditional channels."

By: Craig Devine

In the first article on 3D printing in the Spring 2019 edition of the Bumper Guardian, we briefly described 3D printing process using plastic. The desired part is carefully measured and a CAD drawing file is created. That CAD file is sent to a 3D printer, and a plastic part is printed, with thin layer upon thin layer of plastic deposited in exactly the right place. After what can be hours of time, a complete plastic part is printed.

In that article, we described how we then used the "lost wax" process to make a metal part from the printed plastic part. Through many steps by a craftsman, a wax version of the part is created, and a ceramic mold is created around the wax part. Then, molten metal is poured into the ceramic mold, melting the wax away (thus the term "lost wax"!). The metal part is cooled and released from the mold. This process creates a metal part that then needs some "cleaning up". It would have certain imperfections related to the numerous steps involved in the molding and casting process. In the case of the part made for holding the sun visor on Barrie Hutchinson's 1948 Jaguar 3 ½ Litre Drophead, the quality of the resulting parts was ok, but not quite "good enough" for the standards of a concours bound car. But this process can be successfully used for the production of some parts. In the creation of a different part… the reverse release knob on the fire engine in the Danz Garage… the lost wax process produced an excellent part that fit the needs of that situation perfectly.

So, one might wonder… is there a way to print metal directly, and avoid the lengthy and skills-based lost wax casting process? The answer is yes… there are 3D printers that can print directly in metal. Are all the challenges avoided with these new metal-capable printers? And is it cheap? Well…

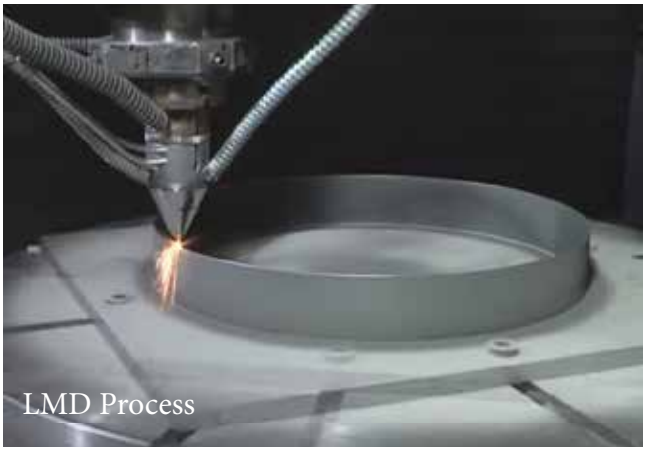
3D printing is a fast-developing technology, and there are a growing number of companies in the Pacific Northwest and beyond that offer 3D metal printing (and related) services.

Different Processes for Metal Printing

It turns out that there are a number of ways… a number of different technologies… that are used to directly print parts in metal. All start with the creation of an accurate CAD drawing with detailed dimensions. Then… the printing process can vary. The three types of processes for printing parts in metal follow.

DMLS Process

1. **Direct Metal Laser Sintering (DMLS):** DMLS is the current technology used by most large companies. An energy source (a laser or another energy beam) fuses an "atomized" layer of powder (perfectly round, tiny, spherical particles) to create layers of an object. Layers of powder are accurately spread over a bed, and a scanning laser "sinters" the particles together in the desired places. Layer upon layer of powder is added, each layer is sintered by the laser, and in time these layers build upon each other to create the desired 3-s shape.



LMD Process

2. **Direct Energy Deposition (DED or LMD):** This process works like the plastic 3D printer. A narrow rod of powdered metal (like a welding rod) moves very slowly down toward the printing base, and a highly controlled

laser beam fuses metal powder as it is slowly released and deposited to form the layers of an object, moved by an industrial robotic arm. Although the process is usually executed inside a closed chamber, a recent project used a similar approach to 3D print a full-size bridge.

3. **Binder Jetting:** Another approach that uses a powdered metal mixture bed is "binder jetting". In this case, the layers of a part are formed by gluing together the metal particles and later sintering (or melting) them together in a high-temperature kiln.

Post Print Heating: Sintering

The DMLS and Binder Jetting processes are then followed by the sintering process, which melts the powdered metal mix and finalizes the properties of the metal. This process causes a shrinking of the part on the order of about 15%. Necessarily, parts are printed a little too big to allow for this shrinkage. This requires judgment and skill and creates certain challenges that affect the accuracy of the outcome. A common level of stated precision on 3D printed parts is 0.2%. In a 4" wide part, this would be +/- 0.008".

Creating a CAD File

All 3D printing requires the creation of a CAD drawing file with all of the part dimensions. Besides the ability to use a precision measuring device like a caliper or micrometer, this would require a computer and a CAD program to accomplish. There are PNR-CCCA members who can do this work if you are interested (contact Craig DeVine to discuss.) Or, some companies will perform the precision measuring and CAD file creation service for you… at a cost, of course. The other modern alternative for creating a CAD file is to do a "3D Scan" of a part to create the CAD file. A 3D scan of a part is created by rotating a part 360° in front of a scanning laser. It will quickly create a file showing the complete surface dimensions of a part. This service is also offered by some 3D printing companies. It can be considerably faster than creating a CAD file with a caliper and a CAD software program. Once a part is mounted on a scanner, the file can be created in as little as 5 minutes. The drawback of a scanned 3D file is that the resulting file is a close approximation of the part, and it is a file type that is harder to edit if you need subsequent design changes, taking time and considerable skills in CAD to accomplish. But… 3D scanning can be a great way to go for getting a CAD file quickly and easily.

Different Metals

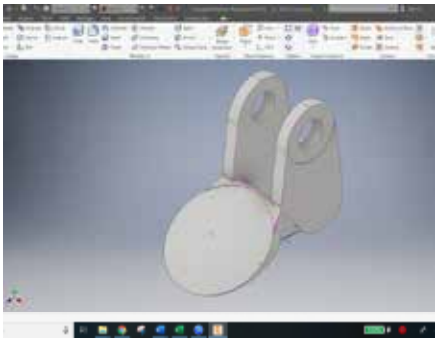
Classic car parts are made from a variety of metals depending on size, stresses, surface finish and cost considerations… and of course, vintage. Today's 3D printing can be done with many different metals including aluminum, stainless steel, titanium, and inconel.

Real Costs

3D printing in metal is not inexpensive. Here's the paragraph I received from a contact at one company as I did my research:

> *"We receive quite a few inquiries from car enthusiasts looking for replacement car parts. Unfortunately, they are often sticker-shocked at the price of 3D printing… If you are trying to make a custom part or a part that no longer exists,… one should be ready to spend thousands of dollars not hundreds. We would also require a CAD file to provide a quote."*

I sent an RFQ for the Danz Fire Engine's metal reverse release shift button to three companies. I provided an "STL" CAD file. The part has a complex shape… it would be difficult to machine as there are very few flat surfaces, and it fits in about a 3" cube. But the tolerances aren't that important on this particular part either… +/- .030" would work just fine. I asked for quotes in aluminum.



iD3: $300 NR / $670 3-4 wks +/- 0.005"
Fathom: $1,195 2½ wks, +/- 0.005"
Stratsys: $1,624 2 wks, +/- .012"

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