Choosing the Right 3D Printing Materials for Automotive
How to Know Which Polymer to Use

Solution Guide

When the manufacturing engineers at General Motors needed to replace parts for an overhead conveyor, they made an interesting decision. Those parts, called "risers," were made of steel, but their weight hindered the efficient function of the overhead equipment. GM engineers wanted a lighter alternative to reduce the load on the system.

You might think aluminum would be their obvious choice for the new parts. It's lighter than steel yet satisfies the "metal-equals-strong" paradigm. The problem was that aluminum risers would involve periodic removal for offsite maintenance. Fabrication and repair would also require welding the aluminum; a process engineers wanted to avoid.

Instead, GM engineers used plastic – but not just any plastic. They 3D printed the risers using a nylon polymer reinforced with carbon fiber. The result was a bolt-on solution that lowered the weight by 32%. This also cut implementation lead time by 75% compared to traditionally fabricated metal tooling.

3D printing, or additive manufacturing (AM) as it's also known, offers multiple benefits for the auto industry. That's why GM's decision to modify its conveyor system using AM is no real surprise. What's interesting about this story is the engineers' decision to 3D print with polymer and forego the traditional "use metal" approach. It's a growing trend that's backed up by expanding adoption, not only at GM but by other automakers as well.

AM technology comes in multiple flavors, with certain technologies being a better fit for some auto applications than others. It's a topic we cover in our companion Solution Guide "**How to Choose the Right 3D Printing Technology for Automotive Manufacturing**." But once you've chosen the appropriate AM technology, it's all about the materials. And we're here to say that polymer 3D printing offers a sweet spot for the automotive industry. That's true for several reasons, because compared to metal 3D printing, polymer AM offers:

- Fewer resource constraints (facilities, training, safety)
- Greater accessibility and ease of use
- Broad material capabilities and price points
- Lightweight but strong options for applications where it can replace metal

With such a wide range of polymers – from thermoplastics to thermosets to photopolymers – how do you know which material to choose and the use cases where each is appropriate? That's the challenge this Solution Guide will clarify by highlighting the Stratasys AM technologies and materials suitable for each phase of automotive production:

- Product Development
- Production Support
- Part Production

Let's break it down.

AM Materials for Product Development

Product development includes creating mock-ups, models, and prototypes to develop, refine and validate design concepts. Additive manufacturing is beneficial at this stage because it makes parts without any support tooling, accelerating the design and ideation process.

AM materials best suited for this phase of automotive production include polymers with a broad color selection and texture capabilities, able to reproduce or mimic the look and feel of other materials. This makes them an optimal choice for concepts and prototypes that need to represent their finished configuration – particularly helpful for auto interiors, external molding and lighting. Other factors include easy printability, fine surface finish, and the ability to replicate other types of plastics like acrylic.

For this phase, the following materials are the best fit for these applications:

Visual Prototypes and Concept Models

In many applications, these materials avoid the need for additional post-processing steps like painting and texturizing, which shortens the design cycle.

Stereolithography Photopolymers

- Somos® WaterClear Ultra 10122 – An optically clear, moisture-resistant material that simulates acrylic's visual characteristics and clarity.
- Somos® WaterShed XC 11122 – A clear stereolithography photopolymer with superior moisture resistance that mimics the look and feel of transparent ABS (acrylonitrile butadiene styrene) and PBT (polybutylene terephthalate) thermoplastics.
- Somos® EvoLVe 128 – Durable SL material designed for easy finishing and capable of highly detailed features with a look very similar to finished thermoplastics.
- Somos® Taurus – A material with excellent surface finish and mechanical and thermal performance capable of functional testing.

PolyJet™ Thermoset Resins

- Vero™ and VeroVivid™ – This photopolymer family can print over 500,000 colors and combine with other PolyJet materials to create multiple shore values and simulate textured finishes.
- VeroUltraClear™ – A clear photopolymer that achieves 95% light transmission suitable for simulating glass, acrylic, and other transparent polymers.
- Agilus30™ and Elastico™ – These photopolymers can produce flexible, tear-resistant rubber-like textures in Shore A values of 30 and 45, respectively.

This custom tail light concept was created with PolyJet materials, highlighting the capabilities of PolyJet technology for extremely high realism, clarity and color capability for automotive prototyping.

Custom Light Concept

Fit/Form and Functional Prototypes

For these applications, a broad range of versatile thermoplastics provide choices to tailor the material to the particular application requirements. Lower-cost engineering plastics like ASA give designers a suitable material for fit and form prototypes while carbon-reinforced polymers offer stronger options for functional prototypes.

FDM Thermoplastics

- ASA – Easily printable thermoplastic producing an excellent surface finish for an extrusion-based print process. Available in multiple colors and highly resistant to long-term UV light exposure.
- FDM® Nylon 6 – Characterized by good tensile strength, toughness, and wear resistance in a 3D printable form of this stable material.
- FDM® Nylon 12 – Offers the ductility needed for snap fits and applications requiring many flex cycles.
- FDM® Nylon 12CF – A nylon 12 polymer infused with carbon fiber, 35% by weight, resulting in a very rigid, strong thermoplastic filament.

Skorpion Engineering used FDM technology to print a full-scale prototype automotive bumper, reducing the cycle time by 50% compared with traditional clay model production methods.

50% Turn Time Reduction

Skorpion ENGINEERING touch your idea

AM Materials for Production Support

Production support comprises the tools and infrastructure to sustain the manufacturing process. 3D printing plays an important role, enabling more efficient ways to make and use tools across multiple departments and disciplines including R&D, assembly, quality control, health and safety, and others.

Additionally, 3D printing offers a fast, cost-effective solution for making surrogate parts. These parts stand in when the genuine parts are not yet available for tooling setup verification with new model-year production line changes. This can dramatically reduce the time for tooling validation and quickly identify where changes are needed, long before final parts and assemblies are available.

Stratasys polymers best suited for this phase of automotive production are listed below, grouped into three categories.

Fixtures – Manufacturing Aids – End-of-Arm Tooling

Polymer 3D printing materials for production support center around durable thermoplastics due to their capabilities, particularly the carbon-reinforced varieties. Less critical applications benefit from lower-cost, easily printed engineering grade thermoplastics.

FDM Thermoplastics

- ASA – Easily printable, general-purpose thermoplastic with a good surface finish suitable for CMM inspection fixtures, assembly jigs, and low-to-medium load fixtures.
- ABS-CF10 – ABS material filled with 10% chopped carbon fiber providing a stronger thermoplastic than standard ABS material.
- FDM® Nylon-CF10 – A nylon-blend polymer infused with 10% chopped carbon fiber providing additional strength above ABS-CF10. Prints with a very smooth surface finish.
- FDM Nylon 12CF - Nylon 12 combined with 35% carbon fiber for high-requirement tooling that needs high rigidity and strength, such as end-of-arm tooling.
- ULTEM™ 9085 resin – PEI (polyetherimide) thermoplastic suitable for tooling applications involving elevated temperatures and exposure to chemicals.

Surrogate Parts

As mentioned previously, surrogate parts can be easily printed with strong but lightweight material like ASA. When those parts need to represent the weight of the real part, steel shot can easily be added to the sparse infill interior after it is printed and capped off.

FDM Thermoplastics

- ASA – Capable of sparse infills (internal structure) to reduce material use and model weight without sacrificing strength. Does not become brittle over time with exposure to UV light like ABS-based plastics. Available in multiple colors for identification purposes.

AM Materials for Production Support (cont.)

Investment Casting Patterns

Select stereolithography photopolymers have a niche for specific tooling applications like investment casting pattern development. 3D printed casting patterns can be made very quickly and enable a faster and lower-cost option to validate the final tooling, avoiding expensive changes to hard tooling if the original design is not optimal.

Stereolithography Photopolymers

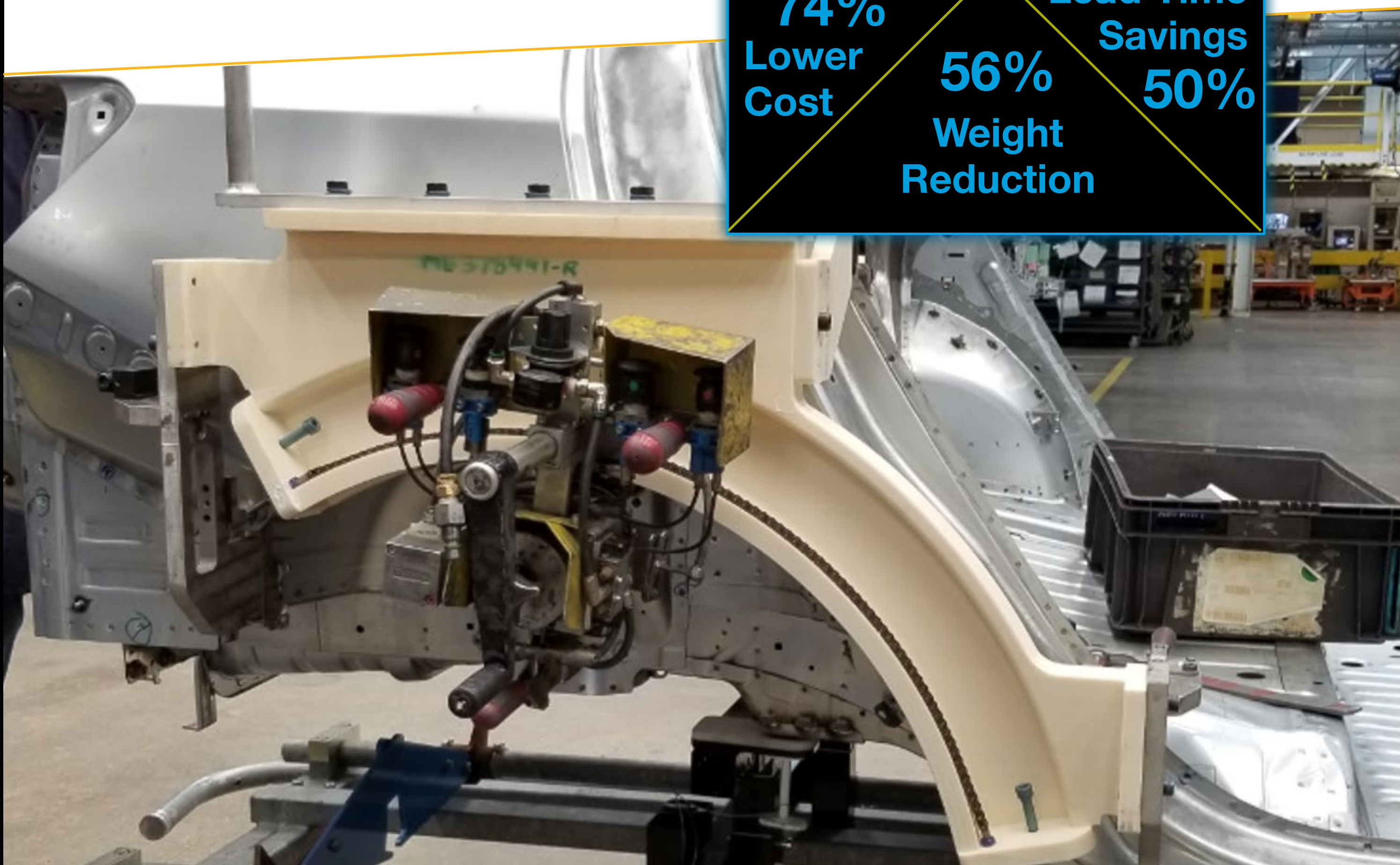
- Somos® WaterShed AF – Antimony-free material that leaves only trace amounts of ash residue after burnout, reducing clean-up and accelerating mold production.

General Motors switched from a heavy aluminum wheel arch hemming tool to a 3D printed version made with FDM ASA thermoplastic. The result was a lighter tool more easily manipulated and a significant savings compared to a machined metal tool.

74% Lower Cost

56% Weight Reduction

Lead Time Savings **50%**



AM Materials for Part Production and Spare Parts

Despite its origin as a rapid prototyping tool, 3D printing's utility for automotive applications extends to the manufacture of end-use parts. Its benefit lies in overcoming limitations like manufacturability constraints or economic barriers due to production volume. Parts made with AM don't require support tooling, bypassing a costly and time-consuming step in the production process.

With the other phases of auto production, the applications usually drive the best material choices. However, the process is a little different when producing end-use parts. That's because your total part quantity plays a role in determining the best 3D printing technology to use – and that, in turn, controls your available material choices.

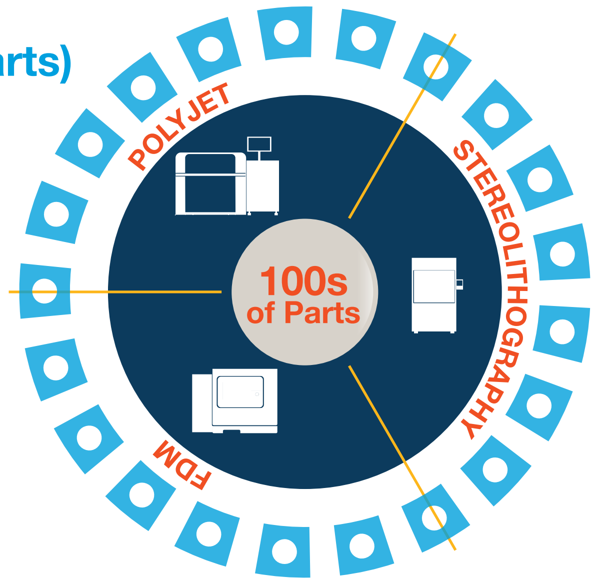
Low-Volume Production (100s of parts)

The following 3D printing technologies are suitable:

- PolyJet
- FDM
- Stereolithography

The material choices for these technologies are typically influenced by several factors:

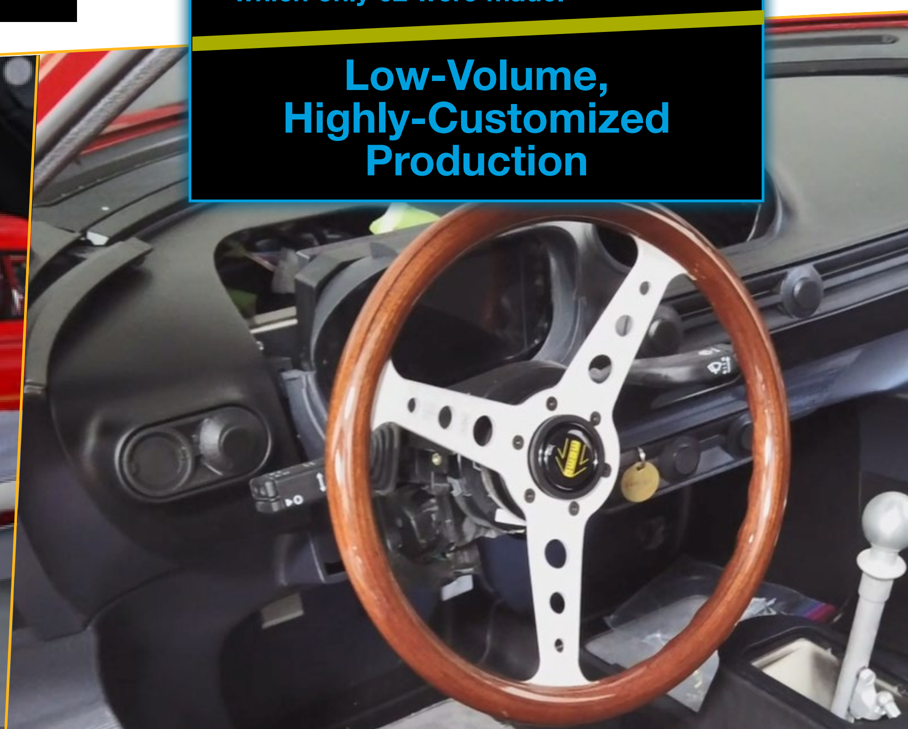
- Desired mechanical and/or aesthetic properties
- Material cost per part
- Available print technology and printer build capacity



RADFORD

Custom automaker Radford Motors used FDM technology to produce the dashboard framework for the Radford Lotus Type 62-2 production car, of which only 62 were made.

Low-Volume, Highly-Customized Production

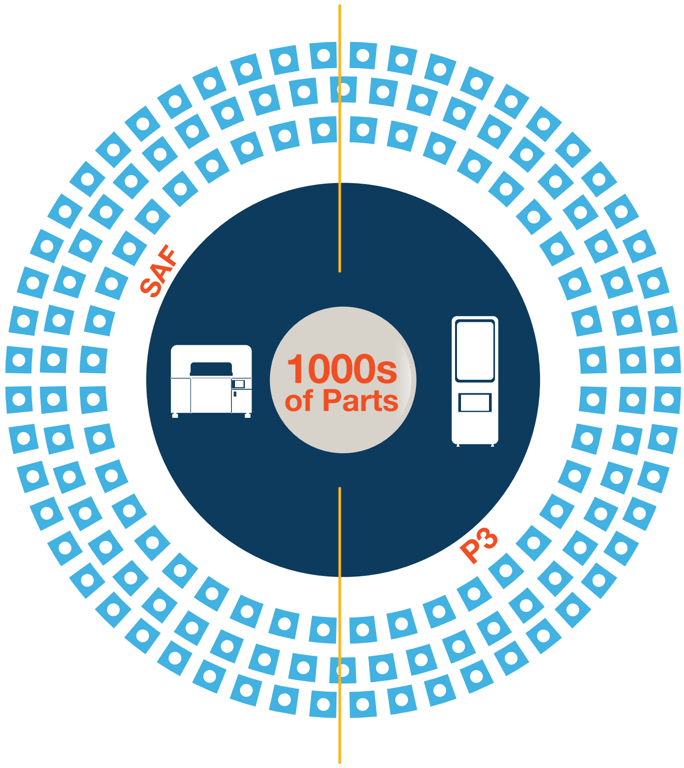


High-Volume Production (1000s of parts)

These are your best print technology options:

- P3™ (Programmable PhotoPolymerization – a form of digital light processing)
- SAF™ (Selective Absorption Fusion™ – powder bed)

For these technologies, the following materials are optimal choices for end-use part applications:



P3 Photopolymers

- LOCTITE® 3D 3955 FST – Flame-retardant polymer exhibiting excellent tensile and flexural mechanical properties suitable for end-use parts such as electrical connectors.
- LOCTITE® 3D 3843 High Toughness – An impact-resistant, high-strength polymer that results in parts with a superior surface finish.

SAF Powdered Polymers

- PA12* – Versatile nylon polymer that is one of the most widely used additive manufacturing materials.
- Polypropylene* – Another widely used polymer known for fatigue resistance, toughness, and chemical resistance.
- PA11 – A nylon offering high impact resistance and ductility, an important characteristic when the latter is a crucial design requirement.

* Available late 2023.

Roush Performance used SAF™ technology and PA11 to print the F-150 grill-mounted camera housing for its entire production run after a late-stage design change, meeting schedule and saving 35% in cost compared to injection molding.

35% Cost Savings

Cycle Time Reduction 50%

The Bottom Line

When it comes to additive manufacturing, printer technology is important. But the right materials are the essential ingredients for success, and polymer 3D printing offers fertile ground to address many automotive applications. Polymers have the versatility to cover a wide range of use cases simply due to the scope of available materials. In addition, they have the properties and the aesthetic qualities to tackle applications from prototyping a lens cover to making ventilation scoops for every car fielded in the NASCAR Cup Series.

Use this guide as a starting point to get familiar with 3D printing materials that best serve the automotive industry. If they're not available on the particular type of 3D printing technology you currently have, or if you don't have access to 3D printing yet, we can still help. **Stratasys Direct Manufacturing** is a service bureau that's served countless customers with their additive manufacturing needs. It has all five Stratasys AM technologies and offers a fast and convenient way to test drive the benefits of 3D printing or augment your current AM capabilities.

Also keep in mind that material technology is an ever-evolving landscape, with new materials continually being developed to address new applications. You can explore the full range of Stratasys 3D printing materials at **Stratasys.com/en/materials/materials-catalog/**.

The bottom line? Polymer 3D printing is a highly effective tool for taking time and cost out of all phases of automotive production. **Contact a Stratasys team member** to learn more about how our technologies and material versatility can benefit your operation.

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