stratasys

Large-Scale 3D Printing Applications for the Agricultural Equipment Industry

Application Opportunity Brief

How 3D Printing Addresses Manufacturing Challenges

While processes like machining, molding and casting have proven to be reliable ways of making things, they also come with inherent drawbacks. Making prototypes, tools and production parts with these methods is usually associated with significant burdened cost and lengthy lead times. The need for skilled labor and reliance on long, conventional supply chains make them vulnerable to labor shortages and unanticipated disruptions that also drive cost and add delays. Traditional manufacturing systems also preclude the ability for customization and low-volume production because tooling costs often negate a satisfactory return on investment.

In contrast, additive manufacturing (AM) using FDM® technology offers a faster and less costly alternative to these traditional manufacturing practices. Prototyping with FDM allows manufacturers to iterate more often to arrive at a better design. 3D printed tooling can be created and deployed faster and for less cost than heavier metal tools. Out-of-production and customized parts can be produced cost-effectively due to the tool-less nature of additive manufacturing.

For example: Caterpillar 3D printed replacement drill collets instead of incurring the lead time to buy new and avoided $150,000 in production delays. Similarly, Caterpillar used a 3D printed assembly aid which cut rework time by 3 to 5 hours per day.

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An Additive Manufacturing Solution for Large Parts

Despite these benefits, 3D printing large parts – approximately 600 mm (24 in.) and up in a particular X / Y / Z direction – is challenging. Many 3D printers cannot build large parts due to build chamber size limitations. For many manufacturers, 3D printing large parts requires dividing them into multiple pieces and fastening them together. But this adds more time and cost to the workflow.

The Stratasys F770™ 3D printer was developed to provide manufacturers with an affordable and reliable means to use AM for big parts. The F770's build chamber dimensions are 1,000 x 610 x 610 mm (39.4 x 24 x 24 in.), providing an overall build volume of 372 liters (13 cubic feet). The F770 is also built on the proven foundation of Stratasys FDM technology. Precise thermal control within the build chamber, linear motors and industrial-grade components provide reliable, accurate print performance. Soluble support material lets you build complex parts since the support material can be dissolved hands-free in a solution bath.

Included in This Application Report

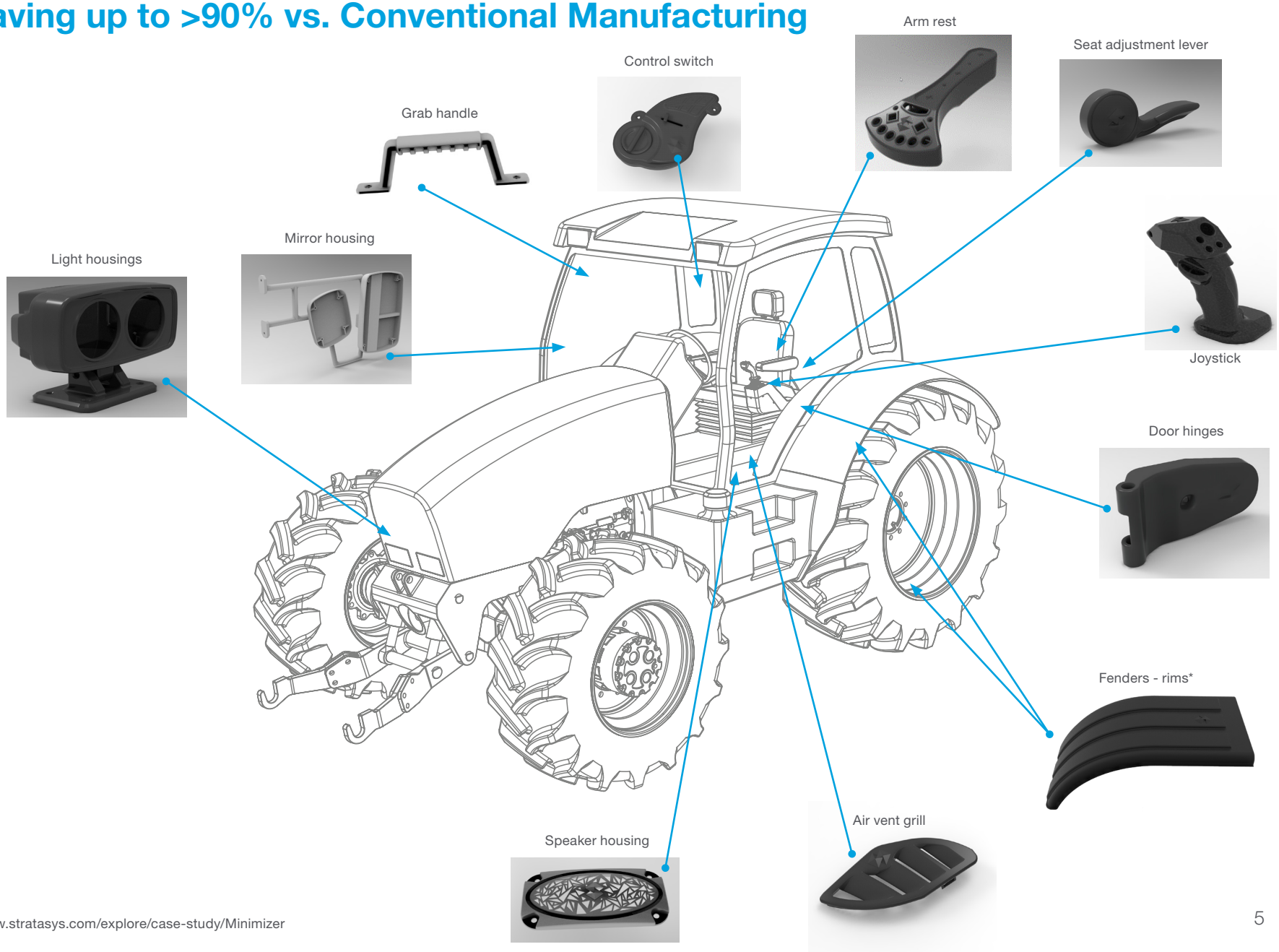
This application report highlights relevant AM applications for manufacturing agricultural equipment using the F770 3D printer. It also identifies the challenges associated with printing large parts. Finally, it concludes with how the F770 is equipped to meet those challenges to provide successful large-scale FDM printing.

The Stratasys F770 is able to print large parts for prototyping and validating new designs in the large agricultural equipment industry. It also offers an economically viable means for end-use parts either as a bridge to full production or to produce low volumes of out-of-production parts.

The F770 is also capable of quickly and cost-effectively making large jigs, fixtures and manufacturing aids. The design freedom of AM allows these tools to be more user friendly, ergonomic, lighter and more efficient than their heavier metal counterparts for certain applications.

Overview of 3D Printing Applications for Agricultural Machinery

Saving up to >90% vs. Conventional Manufacturing



* www.stratasys.com/explore/case-study/Minimizer

Headlight

Made of 3 parts

Build time	F770 1 day, 15 hours, 2 minutes (T14 Tip)
Material	ABS/ASA
Cost to Print	Material cost - $15 Material plus running cost* - $167
CNC Cost	$2,076
Savings	92%

* Includes printer depreciation plus annual service contract. Labor cost is excluded.

Speaker Grill

Made of 1 part

Build time	F770 5 hours, 10 minutes (T14 Tip)
Material	ABS/ASA
Cost to Print	Material cost - $1 Material plus running cost* - $21
CNC Cost	$732
Savings	97%

* Includes printer depreciation plus annual service contract. Labor cost is excluded.

Additive Manufacturing With the F770

The Realities of printing large parts.

Leveraging the benefits of additive manufacturing means eliminating time and cost constraints, letting you improve performance in design, manufacturing and production. The F770 printer lets you do this in a big way too. But building bigger parts means pushing the boundaries of extruded-plastic 3D printing technology. As part size grows, so do the challenges that must be overcome to achieve good results.

Longer Print Times

There's no getting around this fact. Printing a part 45 inches long with some measurable height is going to take time, considerably more time than you might be used to with smaller printers. Are there ways to speed things up? There are, but in the end, they may add more risk than you're willing to take.

More Material

It shouldn't be any surprise that printing large parts requires a higher volume of material, so having sufficient material capacity is important. Running out of material before a job is complete requires a pause in printing, which normally shouldn't be a show-stopper when you're prepared for it. It's when you're not prepared (like running out during a middle-of-the-night print job) that the results could be less than desirable. To avoid this problem, you'll need a printer with a generous material capacity that won't interrupt the build.

Need for Stability

Bigger parts require more stability the taller they get. The printer's natural vibrations translate to the part, affecting these taller areas. If they're not secured they may move out of plane slightly, causing dimensional inaccuracies.

Adding a stabilizer wall to your part is one solution. A stabilizer wall is a separate structure of material built adjacent to the part with intermittent connections to reinforce it and keep it in the proper location. When the part is finished building, the stabilizer wall is removed.

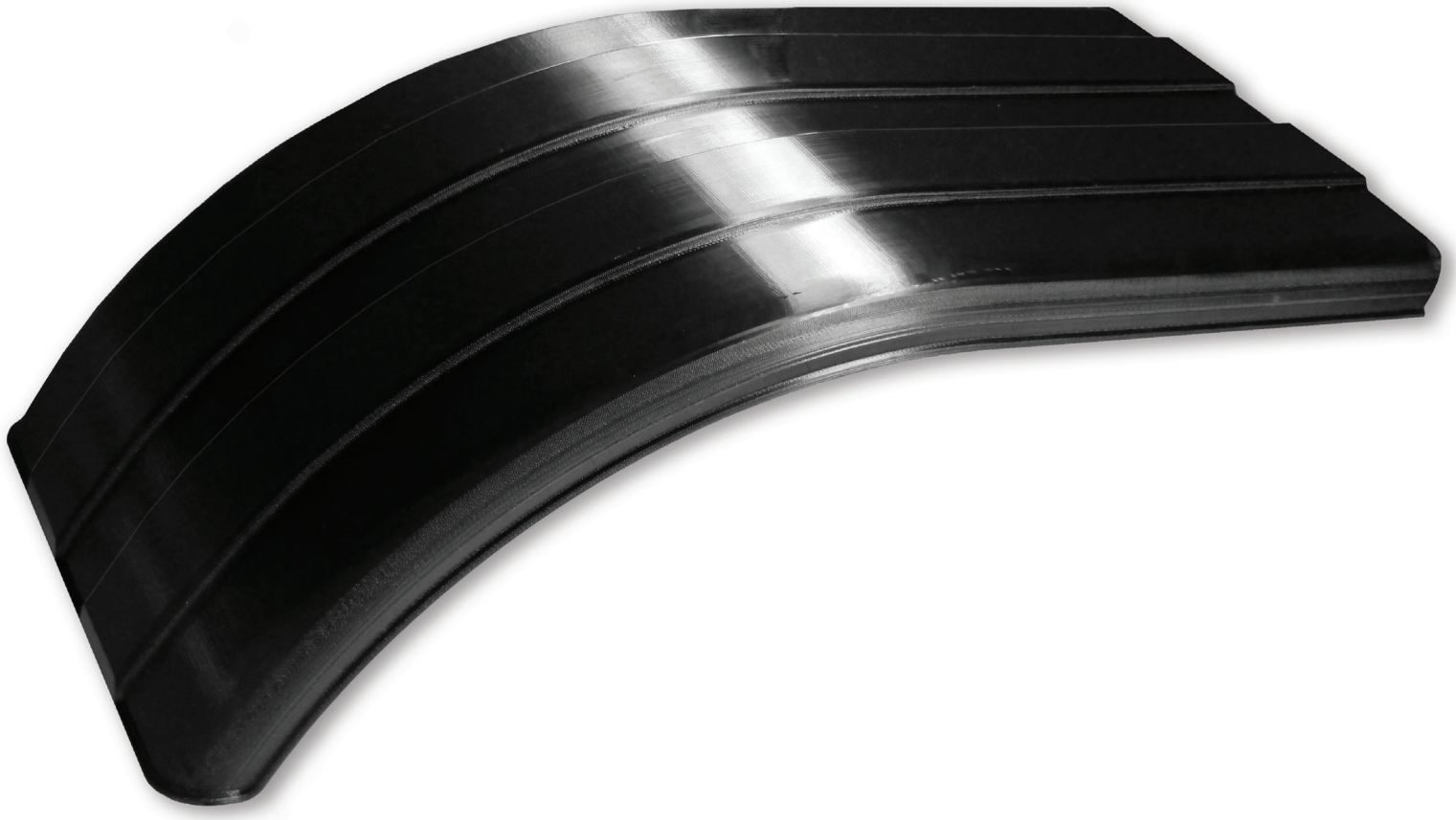
Additional support material can also be used to buttress taller parts and overhung geometries. Although this means increased material and print time, the result is better accuracy. Printers that use breakaway or soluble materials for support structures make it easier to remove them than printers that rely on model material for this purpose. The latter is usually more difficult to remove and may leave surface blemishes. Soluble support is the most effective and time-efficient solution since it also enables complex designs with internal channels and can be removed hands-free in a dissolution bath.

Curling and Warping

The tendency of plastic parts to curl during the printing process isn't exclusive to large parts but the problem can be pronounced due to size. The primary cause is the lack of consistent temperature control within the build chamber across the entire build platform.

This same problem can occur on printers that only use a heated build platform rather than a fully heated build chamber. As the height of the part increases during the build, the new material being applied at the top moves farther way from the heated platform, resulting in a temperature difference. This temperature gradient results in portions of the part heating and cooling at different rates, causing it to curl.

Another effective tool for this condition is the stabilizer wall mentioned above. Depending on your part's geometry, this capability is another useful way to preclude warping on very large and/or taller parts.



The opportunities of large-scale printing with the F770.

3D printing large parts on a reliable scale is no longer the exclusive realm of high-end, premium systems. The Stratasys F770™ 3D printer offers over 13 cubic feet of build volume and the ability to print parts up to 46 inches long. But there's more than just size here. Several key features offer valuable benefits that address the challenges raised earlier.

Generous Build Capacity

You don't need to worry about running out of material if you have a full material load. F770 material cartons provide 200 cubic inches of material, giving you up to 140 hours of continuous print time.

Soluble Support Material

An effective soluble support material means your large parts can be as detailed and intricate as they need to be. It lets you print the part you want and doesn't limit you to the part you can because of a less-capable printer.

GrabCAD Print™ and Insight™ Software

Good software gives you the tools you need to get the results you want. Print large parts with an effective blend of speed and favorable aesthetics using adaptive slice that automatically adjusts the layer thickness to optimize throughput and visual appearance. Dial in the right amount of infill where you need it to balance part strength and build time as well as material use. Easily create stability walls to ensure accurate parts. Incorporate perforation layers in your support structures for faster hand removal and quicker time-to-part.

Three Layer Thicknesses

Leverage the flexibility to tailor big parts for speed or detail with multiple layer thickness options. Or, rely on the adaptive slice capability for an optimized blend of both.

Fully Heated Build Chamber

An enclosed build oven and time-tested FDM® technology ensure a uniform temperature profile throughout the build volume. You'll build large parts that won't warp and curl, so what you model in CAD is what comes out of the printer.

When it comes to applications, the F770's value cuts across multiple industries including automotive, aerospace, heavy industry and agriculture, to name a few. Prototyping body panels and fenders is just one example of a typical use case for large agricultural vehicles.

Tooling is a particularly favorable application for agricultural equipment manufacturers. Typically large and heavy, these tools can be made lighter by replacing metal with plastic under the right circumstances. 3D printed tools can also be easily customized and made more ergonomic for worker comfort and safety.

It's not that you can't achieve these objectives with smaller 3D printers. You'll just have to make the parts in sections and fasten the pieces together, provided your printer is sufficiently accurate to achieve that. All of this requires more up-front design time and post-print processing. It's precious time most manufacturers are hard-pressed to spend.

Instead, the F770 offers the opportunity to avoid that time and effort. It precludes having to stay with the slower, more expensive status quo of machining large prototypes and tooling fixtures or piecing parts together with smaller printers. Virtually any manufacturer that deals with larger tools and components can benefit from the F770's capabilities.

Using a 3D printed assembly aid, Caterpillar was able to cut rework time on an engine assembly task by 3 to 5 hours per day.

Time for
big decisions

If you or your team already has experience with reliable 3D printing, you understand the positive impact it can have on your production schedule and your budget. Now ask yourself this: what if you could 3D print even larger items than you're making now – what opportunities would that open for you?

And what if you haven't adopted 3D printing yet? You simply need to determine if making large tools and prototypes in less than half the time it currently takes you, at a lower cost, is worth it. There's plenty of readily available evidence that supports 3D printing's value as a time and cost-saving supplement to existing manufacturing approaches. If the price tag of current large-format 3D printers has kept you from joining the additive manufacturing party, consider the F770 your open invitation.

Reliable, large-scale 3D printing is the F770's primary mission. And it's designed to do that so virtually anyone can initiate the print job – and then get back to their real job. Combined with its affordable price, it makes reliable large-format 3D printing, and the time and cost savings it embodies, much more accessible.

Find out how the F770 can scale up your operation.

Contact your local reseller:

Technical Training Aids
SERVING EDUCATION SINCE 1963
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