Reimagining Military Re-supply With 3-D Printing

Push is on to certify 3-D printing for critical military parts

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Military planners are beginning to imagine how additive manufacturing (AM) can enhance operations. The potential gains that AM—also known as 3-D printing—offers are transformative and require new ways of thinking from suppliers and end-users to achieve them.

The benefits include: rapid development and iteration of prototypes, design and fabrication of complex shapes that cannot be made by conventional manufacturing, part consolidation, less material waste, low cost compared with standard production techniques and rapid availability.

Nevertheless, for critical applications AM may prove more challenging to integrate than traditional methods of design, production and distribution. As in conventional manufacturing, an AM component needs extensive testing and certification—performance must be demonstrated to achieve confidence in the part as well as the fabrication material, which is typically metal or plastic in powder or liquid form, and in the repeatability of the process itself.

Credit: Angus Batey/AW&ST

The outlook, however, looks promising. In 2015, AM systems and materials specialist Stratasys partnered with Aurora Flight Sciences of Cambridge, Massachusetts, on a self-funded demonstration program that succeeded in taking a new unmanned aircraft system concept from initial design to first flight in eight months. With the exception of an off-the-shelf engine,

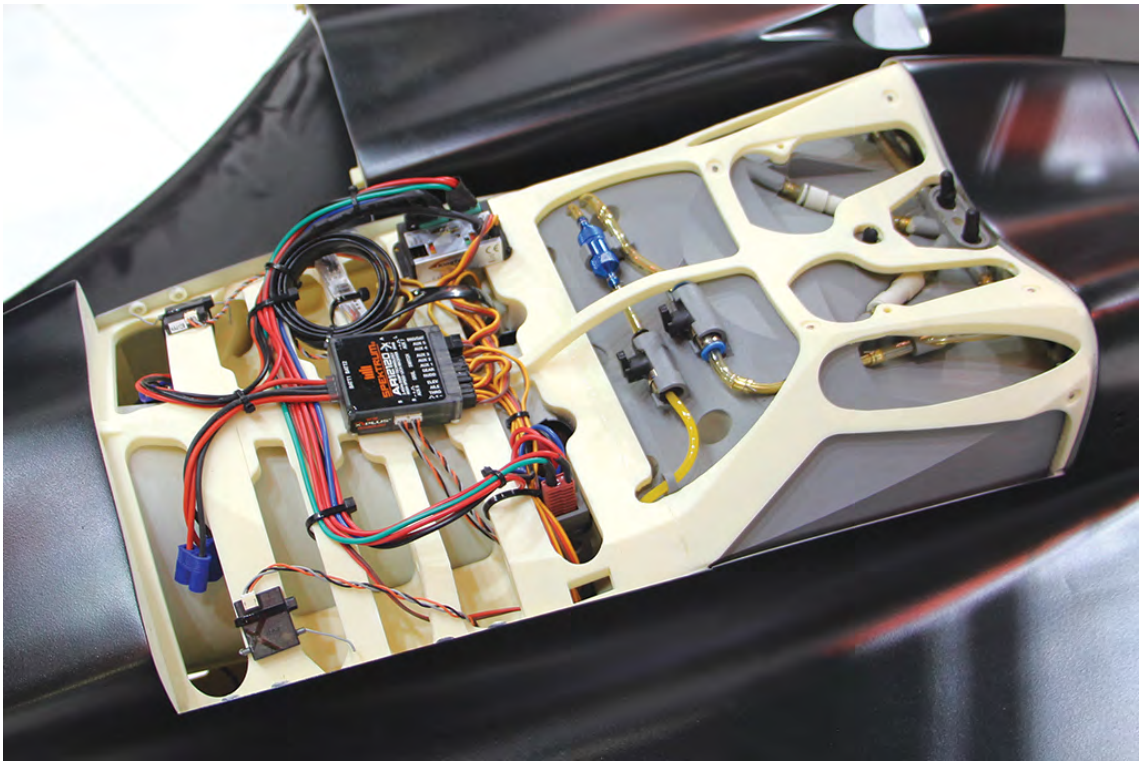
some electrical components and elements of the undercarriage, the aircraft was fabricated with 3-D printing and materials. Some components—such as the fuel tank, which was designed to be conformal to the engine and have integrated ducts for cabling—were too complex to be manufactured by conventional processes.

More than illustrating the technology's potential for rapid prototyping, the demonstration suggested that—in the not-too-distant future—computer-aided design (CAD) software and 3-D printing systems could be applied to design an aircraft for a specific task, print the aircraft and have it flying very soon thereafter in a tactically responsive timeframe if printed in a forward location near a battlefield.

Yet rather than just promote the capability and get on with the job of further developing and placing the process, Stratasys decided to advocate for AM technology more generally to fully exploit its potential and build a sustainable market. Early last year it acquired the British consultant Econolyst to establish Stratasys Strategic Consulting, which will provide impartial recommendations to clients about 3-D products and services, including those from rivals.

"We have to be technology- and product-agnostic in the consultancy, otherwise we're a salesperson, not a consultant," says Andy Middleton, president of Stratasys Europe. "Getting this right is more of a mental than a physical challenge, and it's also [a challenge] to get acceptance within our company. But it's a payable consultancy, and it establishes Stratasys as an advisory company and not just a box-mover."

Stratasys Strategic Consulting is a natural outgrowth of the company's decision to think about the AM marketplace not as an "us and them" environment where Stratasys touts only its services to customers, but an ecosystem in which users and suppliers benefit each other.



Internal view of the UAS at the 2015 Dubai Air Show highlights the design flexibility 3-D printing enables. Credit: Angus Batey/AW&ST

"It was clear to us that, for customers who could potentially use our products and solutions, we could wait years until they knocked on our door, because for them to understand what the benefits can be could take some time," Middleton says. "So we said not only will we sell products, services, materials and parts, we will sell consultancy."

Middleton points to his company's experience working with Airbus as an example of how AM providers have to invest heavily before seeing benefits.

"It took almost two years working with Airbus to help them understand where there can be advantages to using 3-D printing for certain parts of their supply chain and for understanding what material developments, certification and compliance we needed to become an Airbus supplier," he says. "Airbus wanted a specific material from us, which they helped develop. They also helped us through the certification process. We can guarantee that this material will work on this production system under jointly defined parameters."

There is a risk in this time-consuming approach for small specialty suppliers. If, for example, the value proposition relies in part on convincing a customer that it needs an AM capability, Stratasys and other suppliers may end up inspiring the client to establish its own in-house 3-D-printing operation.

An RAF Tornado during maintenance. The ability to 3-D print sub-beam replacements assures full access to the fighter without damage that could take it out of service. Credit: BAE Systems

“We think about this all the time,” Middleton acknowledges. “Clearly, we are a small company in comparison with some of the giants we supply, but over the last 20 years we have built up knowledge, expertise and intellectual property. Why would [a customer] want to start that learning process again [for an in-house operation]? Isn’t a partnership a much more sensible route?”

Preaching the gospel of AM as Stratasys and other vendors do is attracting an eager and growing congregation of users. The advantages of AM for defense applications in particular include its ability to generate strong, lightweight components in complex shapes, as well as the prospect of designing customized air, sea or land platforms and parts for manufacture on demand wherever necessary. Little wonder then that defense technologists are intrigued. Before widespread use takes hold, though, AM has to establish its utility and address concerns about certification and reliability.

Military users are evaluating AM for applications that would broaden the technology’s usefulness in a variety of operations. AM could, for example, reduce the burden on supply chains by replenishing inventory and manufacturing spare parts in forward locations, rather than awaiting deliveries. At the Aerospace, Defense and Space conference in London earlier this year, Royal Air Force Sqdn. Leader Simon Haseltine, military advisor to the U.K. Defense Science and Technology Laboratories and co-chair of NATO’s AVT 258 committee, which examines AM for military hardware, explained that the Royal Navy has tested 3-D printers on ships to demonstrate their effectiveness. With such a process in place, CAD files can be emailed to ships or other deployed locations, enabling them to manufacture replacements for components broken during operations without having to return to port.

AM processes bring major cost benefits as well. Haseltine cites a new part, designed and printed at RAF Marham in England by BAE Systems at a cost of £20 ($30) per copy, which has the potential to save the RAF millions every time it is used. The part protects sub-beams on Tornado aircraft that could be irreparably damaged during maintenance procedures that were never envisioned when the type was built.

“Because the Tornado is an aging aircraft, there are panels that were never designed to be opened for us to work in,” he says. “If you have a man crawling through tight gaps, it is easy to damage the sub-beams at the back of the aircraft. Those can’t be replaced, so the aircraft would have to be written off. That piece of bracket, designed and produced by the small team at Marham, has the potential of saving £10 million every time it would be used.”

The key to exploiting AM’s potential, Middleton said at the conference, is in encouraging designers to keep the process in mind from the outset.

“It’s all about freedom of design, to enable designers to create much better parts with fewer components than in the past,” he says. “There are hardly any limitations in manufacturing a part that’s been designed for 3-D printing, because the limitations of conventional manufacturing processes are almost gone.”

The U.S. Office of Naval Research (ONR) shares this view. “What gets me excited is that we have the potential to get new capabilities, because [3-D-printed components] can’t be fabricated any other way,” Jennifer Wolk, an AM specialist at ONR, tells DTI. “We’ve been constrained sometimes in how we design because we’re bound by traditional manufacturing. Right now, with AM, we’re opening up that base.”

But before these ambitious goals are achieved, users have to trust an AM component as much as they would a conventionally manufactured one. Organizations such as ONR are therefore placing a high priority on qualification and certification efforts.

“Some of the biggest hurdles are associated with qualification, certification and understanding the properties and reliability of materials, including inspection,” Wolk says. “We’re looking at using modeling and simulation, coupled with sensor controls, to really understand what’s going on in the process and the material, to build confidence in the reliability of what’s being fabricated for the end-user and to more rapidly qualify and certify parts.”