3D printing can keep aging Air Force aircraft flying

Enlarge / USAF Boeing B-52H Stratofortress taking-off with undercarriage retracting and trailing-edge wing flaps lowered at the 1998 Fairford Royal International Air Tattoo RIAT.

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Glenn House and his colleagues spent more than four years making a new toilet for the B-1 Lancer. The challenge wasn't fitting the john into the cockpit (it went behind the front left seat) but ensuring that every part could handle life aboard a plane that can pull five Gs, break the sound barrier, and spend hours in wildly fluctuating temperatures. The end result didn't just have to work. It had to work without rattling, leaking, or revealing itself to enemy radar. Getting it OK'd for use aboard the bomber was just as complex as making it. "Getting a part approved can take years," says House, the cofounder and president of Walpole, Massachusetts-based 2Is Inc.

Until last year, 2Is was in the military parts business, furnishing replacement bits for assorted defense equipment. (Pronounced "two eyes," it sold off the parts business and now focuses on defense-related supply-chain software.) Providing spare parts for the military is a peculiar niche of the economy. Things like aircraft and submarines spend decades in service, and the companies that made them or supplied their myriad parts often disappear long before their products

retire. So when something needs a new knob, seat, or potty, the military often turns to companies that specialize in making them anew.

These outfits must work from dusty two-dimensional drawings or recreate long-lost molds that exactly match the standards of the original parts. Working on very small orders—sometimes for just two or three of a given item—they don't enjoy the economies of scale that make it reasonable to spend five figures on tooling. A fussy approval process can mean waiting years to recoup an investment. And so, in many cases, they don't bid on these military contracts, preferring steadier, more reliable jobs.

That's a problem for the Air Force, whose fleet dates largely from the Cold War. Its C-5, B-52, and KC-135 planes average 40, 56, and 57 years old, respectively. The average Air Force aircraft is 23 years old. Every quarter, the military branch sees 10,000 part requests go unfilled, despite its readiness to pay an exorbitant amount of money to replace bits and bobs that once cost pennies—try $10,000 for a toilet seat cover in a C-17 Globemaster III.

"We're gonna have to find better ways to keep old things flying," says Will Roper, the assistant secretary of the Air Force for acquisition technology and logistics. And he has one, represented by the toaster-sized piece of plastic he keeps in his office. It's a latrine panel for a C-5 Supergalaxy cargo plane. In the past, the Air Force has paid $8,500 to replace this part. But this one cost just $300, because it's 3D-printed.

Roper says that 3D printing, also called additive manufacturing, can produce many of the parts for which the Air Force finds itself desperate, from C-5 gasket handles to F-15

longerons. “If I need two or three parts for a B-52,” he says, “I can just turn that over to one of our printers.” In the past few years, the Air Force has made thousands of parts this way, and it can work for just about anything made of metal or plastic. Composite and carbon fiber could work, too— even circuit boards.

Advanced Manufacturing Olympics

But a novel approach means novel problems. It’s still not easy to turn a two-dimensional drawing into something a 3D printer can understand. The Air Force needs new ways to prove that these parts can handle the rigors of life in the air, that they’ll be as durable and reliable as the originals. Its scientists are exploring new techniques and creating their own mixes of metals to suit their needs. But Roper is eager to move their work out of the experimentation phase.

That’s why he’s organizing a new kind of war game: the Air Force Advanced Manufacturing Olympics. Slated for July 8-9 in Salt Lake City, the competition aims to bring in all sorts of players—additive manufacturing companies, traditional defense contractors, tech startups, universities—to compete to solve various problems.

The “open box of parts floor exercise” will ask teams to replicate certain parts without being given the design specifications, while meeting the Air Force’s exacting standards. “Approval sprints” will be about developing new ways to prove their work is as good as what came before. In the “supply chain marathon,” teams will puzzle over how to get a fresh part to a given place, like Afghanistan. Maybe it’s better to make it in the US and ship it, or to keep 3D printing machines at the front line, or something in between. Roper and his team at the newly created Rapid Sustainment Office are still working out the prizes for these events, but those rewards will be some mix of money and the chance to work

with the Air Force or its contractors. Medals will be 3D-printed, of course.

Beyond solving these individual problems, Roper hopes to rethink how the Air Force maintains its arsenal. Upkeep and logistics account for 70 percent of a platform’s total cost, and every dollar saved here can go to another program (or back to taxpayers).

When 2Is was founded in 2002, House thought additive manufacturing had a lot of potential. But until a few years ago, the technology wasn’t at the point where it could make parts that were precise and durable enough for military use. “We retreated to the standard manufacturing process,” he says. While he thinks these techniques are a tough sell for safety-critical parts like struts, engine blades, and landing gear, he says he’s encouraged to see the Air Force take an aggressive approach to advancing the new technology. And that if he was still in the parts business, he’d make the trip to Salt Lake City and go for the gold.

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