An F/A-18D Hornet with Marine All-Weather Fighter Attack Squadron (VMFA) 242, Marine Air Group 12, 1st Marine Aircraft Wing, on the flight line at Marine Corps Air Station Futenma, Okinawa, Japan.

U.S. Marine Corps photo by Lance Cpl. Savannah Mesmer

Need A Part Halfway Around the World Quickly?

WE CAN DO THAT

NAVAIR Continues Solving Emergent Fleet Requirements Using Additive Manufacturing

By Rob Perry, Naval Aviation News Staff Writer

A damaged metal plug, roughly the size of a shot glass, was keeping a Marine All-Weather Fighter Attack Squadron (VMFA) 242 F/A-18D Hornet in Japan on the ground.

Damaged in June during maintenance on the aircraft, the shorting plug tells the pilot how many weapon stations are available on the aircraft.

The squadron reached out to the manufacturer who told them it could take up to 500 days to manufacture and ship a replacement part to Japan.

Unwilling to allow a plane to remain grounded for a year and a half, the fleet reached out to the additive manufacturing (AM) team at Naval Air System Command (NAVAIR), based at Naval Air Station Patuxent River, Maryland, to see if the team, led by Liz McMichael, could find a quicker solution.

Over the weekend, the AM integrated product team (IPT) and program office engineers built a technical data package for a replacement plug and sent it to the team in Japan. Marine Aviation Logistics Squadron (MALS) 12—one of the fleet maintenance organizations that has a 3D printer—printed, installed and validated the new plug and worked with the AM IPT to tweak and finalize the design.

The final design was printed and installed by MALS-12 and the aircraft was back in service seven days after their request.

This incident highlights the speed NAVAIR's additive manufacturing team delivers to the fleet.

NAVAIR's AM Process

Additive manufacturing is the process of building an object in layers using 3-D printers that extrude materials such as plastic polymers or powdered metals. Traditional or "subtractive" manufacturing typically involves cutting or machining bulk materials into an object.

Using digital models, 3-D printers can create in hours what would normally take days or weeks to make using traditional methods. The technology also allows for innovative designs that are either not possible or unfeasible via subtractive manufacturing.

"3-D printing is really not about the printers; it is about having the right data so that the printers consistently make a part we know will work on an airplane. The digital technical data the team develops for the fleet ensures that they get the same part every time," McMichael said."

"Digital technology enables us to use AM to accelerate manufacturing and provide agile solutions," she added.

When it came to creating the replacement cap for the F/A-18, McMichael explained the steps the AM team takes in addressing requests for parts.

The first step is to contact the AM help desk via email at navair_am.fct@navy.mil to request assistance. Then, the team goes to work, first determining the risk level of the part.

"If the part fails, is there a safety issue or mission performance issue? Or is it a part that doesn't impact safety or mission and we can be more flexible in how we make it?"- said Ling Xu the NAVAIR AM IPT engineering lead. "We work closely with engineering to understand the airworthiness and performance risk of every part we want to make via AM."

AM parts are sorted into "blue box" or "green box" categories based on their risk level. Blue box parts have airworthiness, safety or mission performance implications and require higher levels of manufacturing controls and approvals. Green box have no airworthiness, safety or mission performance implications if they fail.

"Once we had agreement from the [F/18 Program Office] that the shorting plug was in the green box category, our next step was developing a design that did the same thing as the metal plug but could be made by the fleet. Since they only had a polymer printer we had to develop a polymer design," said Jor-El Sanchez, AM innovation cell lead. "We have the same printers that the fleet uses so we were able to develop and prototype the new design before we sent it to them. We also make sure that we prototype using the same materials they have."

There was one other obstacle to clear: The polymer plug needed to add electromagnetic interference shielding and wiring to match the functionality of the metal plug. The AM team worked with program office engineers to quickly develop the updated wiring design for the plug.

U.S. Navy photo

The additive manufacturing team at Naval Air Systems Command recently used 3-D printing technology to create a shorting plug backshell for a VMFA-242 F/A-18D Hornet. The replacement backshell, seen in orange here, was created with a polymer-based substance, making it tougher than the original

"As far as polymer goes, every AM part we redesign to meet required performance. The redesign we did here is a more efficient, lighter-weight design that does the same thing as the metal plug," Xu said.

From there, the team developed the first iteration of the technical data package, which included detailed instructions on how to manufacture the part and emailed it to MALS-12.

"Instead of sending parts back and forth, we're sending data back and forth. We're sending them a full manufacturing package [via the Internet], and because we are sending the data, the timeline is much shorter," McMichael said.

MALS-12 then printed out the part, installed it on the F-18, tested and documented that it worked. The AM team incorporated feedback from MALS-12 and formalized the technical data package before the aircraft was cleared for flight.

The technical data package is now available on the AM repository site and can be downloaded and printed anywhere in the Navy or Marine Corps should the part be needed again. In the meantime, the AM team is refining the package to make producing the part even easier, McMichael said.

Contributing to Fleet Readiness

"Additive manufacturing is not only supplying parts on demand but increasing agility," said Dan Krivitsky the NAVAIR AM manufacturing lead.

"Our goal is to make the parts that are holding our airplanes down, the ones-y, twos-y parts needed right now. We have the organic capability to do that and meet those needs quickly, but we don't want to replace the supply system or the original equipment manufacturers—we need them," he said.

The next challenge the NAVAIR AM IPT is working on is quantifying AM's contributions to fleet readiness. They are looking at aircraft dashboards, which list the equipment and part challenges affecting each type/model/series to identify which parts additive manufacturing can produce. Those potential AM parts will then be analyzed to see how fast they can be produced and at what cost.

U.S. Navy photo

The shorting plug backshell reassembled.

"The intent is to figure out where the return on investment is. As the technology improves, we are seeing costs going down, even for metal and some of the more complex components," McMichael said. "So far, we are seeing a significant cost improvement for low criticality, low-risk polymer parts. Our average is about a 70-percent cost improvement over the supply cost, with our average delivery time 97 percent faster than supply," McMichael said.

To find out more, contact the AM help desk at **navair_am.fct@navy.mil.**