Te Matataua

The Scouting Party of Air Power

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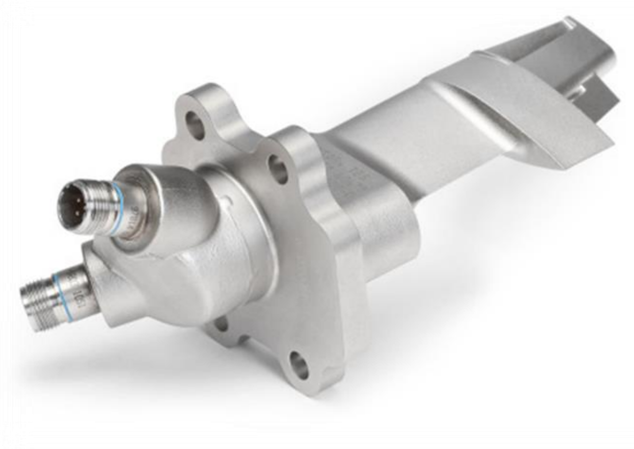
DEPLOYABLE ADDITIVE MANUFACTURING FOR IN-FIELD AIRCRAFT REPAIR

Replacing No.8 Wire in Minimising Deployed Loss of Capability

This edition of Te Matataua was written by Mr Peter Cook MEng, MSc

"In recent years it has become increasingly clear that 3D printing is a key emerging tool that is reshaping the part's design and manufacturing processes ." [1]

Deployment of air assets into theatre can create an increased maintenance burden, due in part to the lengthened supply chain meaning some replacement parts may be days, even weeks away. This is even more prominent for larger aircraft such as the 757 or the C-130 Hercules as they cannot easily be transported home for repair (for example, an A109 can fit inside the back of a C-130 Hercules, whereas another Hercules cannot).



3D-printed T25 housing used by GE aviation on Boeing 777 GE90-94B engines

Many underestimate the importance of aircraft maintenance as part of airworthiness in the projection of air power, but without the ability to keep an aircraft properly maintained, airworthy and able to fly, deployment would be impossible. An airworthy aircraft is one that is designed, constructed, maintained and operated by competent individuals to approved standards, certified and accepted by the NZDF.[2]

Deployment is an essential part of military life, and when an aircraft is grounded on deployment due to broken or unserviceable components, there are considerable costs in terms of time, money and resources. There is also a loss of potential and actual capability whilst the aircraft sits waiting for parts. This doesn't just have a cost impact on the NZDF, but also a political and public relations impact on New Zealand as a whole; the media backlash after the recent grounding of an NZDF Boeing 757 in Townsville in October 2016 being a prime example. Carrying a full supply of spare parts on deployment is unfeasible, but there is now a way of manufacturing components which could be used for replacing broken parts in the field.

Additive Manufacturing (AM, also known as 3D printing) is a process of taking data from CAD (Computer Aided Design) generated 3D models and manufacturing them autonomously as three-dimensional objects. The object is created by laying down successive layers of material until the entire object is created. It is a popular process in rapid prototyping applications due to minimal material wastage and the swift design-to-production process.

This is still a relatively new and novel process, and additively manufactured components have yet to be certified for widespread use within the RNZAF. Additively manufactured parts are typically not manufactured to meet a functional (i.e. structural) requirement for use on aircraft, and current RNZAF policy only allows for 3D printing to be used for concept development and prototyping. However, if it can be shown through engineering design that the properties of the additively manufactured parts are compatible with the intended usage, and approved through the engineering change process, they may be approved for use, given appropriate approval has been granted.

Early analysis suggests that components produced in this way are as structurally sound as products manufactured using traditional methods and as more and more analysis is being conducted, and the technology is used more and more, we get ever closer to additively manufactured components being certified for widespread use on RNZAF aircraft. Other nations' militaries are already heavily involved in developing the technology; the RAF currently uses AM on their aircraft, and the International Space Station even has 3D printer. The US Army has a special unit, known as the Rapid Equipping Force,[3] which has been stood up to develop rapid solutions to evolving situations in the field, using AM, and the Chinese military have fitted a 3D printer to one of their ships, the Harbin, for the replacement of small but critical parts.[4]

AM covers a number of production techniques using a range of materials, from plastics to metals, and in most cases only the material that is used is required, eliminating wastage and the need to carry bulky products. Additionally, AM machines are usually somewhat smaller than traditional machining tools, making them easier to transport. To effectively deploy AM in the field, a maintenance unit would require some sort of 3D printer (the type of machine required would depend on the complexity of parts being made), a computer capable of storing and executing software and sending printing commands to the 3D printer, plus a library of parts for manufacturing.

The long-term future goal for the RNZAF on deployments would be to take a computer, a library of computer models representing all possible spare parts required, and a 3D printer in to the field so that components can be quickly and efficiently produced and fitted on-site and 'on the fly' with minimal effort and wastage, without having to wait for spare parts to arrive. Even without certification of AM for widespread use on aircraft, these parts may well be suitable for the aircraft to return to base for a full repair. This is still some way off yet, but by embracing this technology now, the future is looking bright.

Key Points

- The lengthened supply chain for deployment of air assets can create increased maintenance burden.
- Additive manufacturing, or 3D printing, is a relatively new process of manufacturing components directly from 3D computer models.
- Deployment of an additive manufacturing system in the field can reduce maintenance burden.

References

[1] Anthony Vicari – *GE Races Ahead on 3D Printing* www.machinedesign.com

[2] DFO 92, Defence Force Orders for Airworthiness

[3] www.ref.army.mil

[4] Sarah Anderson Goehrke – *China's PLA Navy Deploys 3D Printers Onboard Warships to Replace Small Parts* www.3dprint.com

APDC Update

The APDC has a page on the RNZAF website with links to air power learning resources, and electronic copies of APDC periodicals. Visit: www.airforce.mil.nz/about-us/who-we-are/apdc/

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