Marko Bosman, chief technologist of additive manufacturing at GKN Aerospace, provided *Shephard* with an overview of the benefits that such technology can bring to rotorcraft engineering, highlighting the importance of tailoring the selected process to the application.

Appearing in print

The adaptation of additive manufacturing (AM)/3D printing in the aerospace industry is growing beyond prototyping, with various applications on many different flying platforms.

Proving that the technology is suitable for defence applications as well as on civil platforms, the Royal Netherlands Air Force completed its first rotorcraft flight with a 3D-printed aircraft part one year ago.

The component was a titanium bracket fitted to an NHIndustries NH90 helicopter tail plane. It was redesigned to a more bionically optimised shape and is 40% lighter but stronger and more durable than the original design. The demonstration project was a collaborative venture, with GKN Aerospace's Fokker business, the Netherlands Aerospace Centre and the Dutch Defence Materiel Organisation.

Making the right choice

There are many different AM technologies available, which can be generally split into two categories: powder bed, where a part is made by selectively fusing a bed of powder layer by layer; and deposition, where the material is accurately deposited at the required location.

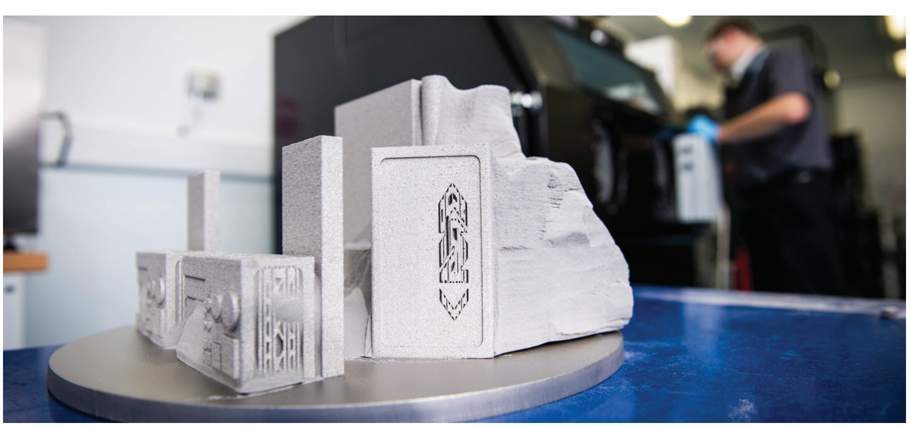
Numerous applications for AM can be found in the rotorcraft sector, from single parts to integrated systems. The challenge is selecting where to initially apply the technology when currently aerospace regulators and OEMs are still learning about this unique process. GKN's AM offerings focus primarily on metals, and the company has the know-how to tailor the process and solution to each application.

As the increasing trend of using carbon-fibre composites requires more titanium to be used – since aluminum suffers from galvanic corrosion – there has also been a corresponding increase in the use of titanium alloys in aerospace.

The cost of titanium is high and it is hard to machine, making it relatively expensive when using traditional manufacturing technologies and materials. AM offers the opportunity to change the cost equation, as it produces near net shapes with a very limited amount of waste. AM allows the printing of titanium, but selecting the right process for the application is critical. Powder bed processes are good for very fine details, but relatively slow, limited in part size and require post-processing to improve surface roughness to meet required properties such as fatigue life. Wire deposition processes are suitable to make larger parts with little less detail, but are quicker. For more detailed depositions, blown powder technology can be used.

Different energy sources can be used for titanium wire deposition, including plasma, electron beam and laser, each having their own characteristics and benefits. For example, plasma is relatively quicker but has poorer resolution, requiring extensive post-machining. Electron beam requires a vacuum chamber, limiting the part size. Laser is the most accurate and has the highest process control.

AM can be applied across both the civil and defence rotorcraft sectors. (Photo: GKN Aerospace)



Freedom to fly

The initial applications for this technology are driven by the cost benefits arising from significantly enhanced buy-to-fly ratios of conventionally designed parts. Next-generation applications will benefit from the design freedom that AM offers to reduce weight by using optimised designs.

This freedom is true for material as well as shape, because the microstructure built during the AM process enables the potential to tailor the material properties locally. Laser wire deposition AM technology is not a future potential, it is applied today by GKN.

We are just at the start of the revolution of design and manufacturing that AM can enable, but already GKN has applied the range of AM processes to a variety of products in aero engines and airframes that are now successfully flying, and as the technology improves, the applications and benefits will too. ■