Images courtesy Dassault Systemes

ADDITIVE VALUE

STEPHEN CHADWICK LOOKS AT RECENT ADVANCES AND APPLICATION OF ADDITIVE MANUFACTURING IN THE AEROSPACE INDUSTRY

Additive manufacturing (AM) goes beyond 3D printing. It has evolved into a production and manufacturing technology that displaces or complements conventional processes in an increasing number of applications in aerospace and defence, as well as other industries.

At its genesis some 30 years ago, 3D printing was restricted to plastic. The advent of laser sintering metal powder changed the game because it allows metal objects to be printed. Almost every type of metal can be used for AM by putting down successive layers of metal powder that is then solidified using precisely targeted heat from lasers.

The technology allows a 3D digital model to be perfectly reproduced as a solid metal object. AM can build parts on demand with designs that include internal cavities and lattices – known as bionic structures – that reduce weight and maximise strength without compromising mechanical performance. Even complex mechanical parts, such as an encased set of gears, could be made without assembly.

3D printing relies on digital simulation technology for design. The process differs from that for manufacture with subtractive machine tools because there is no machining and minimal finishing required to create parts. Furthermore, because parts do not have to conform to the strictures of machining they can take on new forms.

Using integrated design and analysis software on a unified platform enables 'hard points' – points of contact – to be defined as design drivers. This means that points of contact, space envelopes and functional and structural requirements can be used to define forms automatically in a process called generative design. Integrating finite element (FE) analysis into the design process in real-time makes it possible to develop products with the precise structural characteristics needed to match their function. Designing this way not only saves time but can also help overcome the current skills shortage for highly qualified design engineers because part of the design process is automatic.

BOMs away

Predictability of form, performance and lifespan are built into AM because digital designs are exactly reproduced as solid objects. The digital model has all the characteristics of its physical twin. Residual stress, thermal evaluation and cooling rates can also be calculated prior to part manufacture. Another benefit is that there is no wasted material as happens with subtractive machining where shapes are cut from a solid block of often valuable metals such as

titanium. Deploying AM means that tooling does no need to be set up which helps reduce lead times and AM uses 90% less energy than traditional machine tools.

In many cases, AM reduces bills of materials (BOMs) because the process can replace, with a single part, what used to be constructed from several components. Material requirements are also reduced since only the precise quantity of material needed is used to make a part. That can lead to weight reductions of up to 50%. This is very attractive to the aerospace industry where weight reduction is of significant benefit because it leads to better fuel consumption, longer range, reduced carbon footprint and more innovative design possibilities.

Technology take off

AM is used extensively by aerospace OEMs including Airbus Group, which after a two-year comprehensive benchmarking process is extending its use of Dassault Systèmes' 3DExperience platform to its AM programmes integrating design, simulation and production.

Airbus Group will deploy collaborative design and simulation applications as part of the 'Co-Design to Target' industry solution experience, for the additive manufacturing of tooling, prototyping and parts for test flights and for production use on commercial aircraft. This provides Airbus Group with digital continuity to optimise its conceptual designs by virtually validating each phase of the AM process. Using this approach, Airbus Group can explore design and manufacturing possibilities to meet engineering and manufacturing requirements for the additive manufacturing of tools and parts.

Robert Nardini, senior vice president engineering Airframe at Airbus, says: "Numerous projects across Airbus are accelerating the use of additive manufacturing to produce prototypes as well as production components potentially delivering lighter and less expensive parts that meet technological, performance, safety and cost standards. Airbus has long used 3D simulation applications to accelerate the structural analysis and virtual testing of aircraft and now we can define a new way of designing parts by leveraging simulation-based design to better answer aviation market needs."

AM creates new opportunities in many different areas such as remote fabrication for support and maintenance, rapid prototyping for realizing new concepts and experiences and, perhaps most importantly, developing designs that were previously impossible to fabricate. Airbus Group will be able to take advantage of the 3DExperience platform's automated design assistant for parts, whether they are 3D printed or not, thus accelerating a new wave of transformation in the aerospace industry. Using this platform Airbus will have an end-to-end solution, including all engineering parameters, for the additive manufacture of parts inclusive of material science, functional specification, generative design, 3D printing optimisation, production and certification.

Images courtesy Dassault Systèmes

End-to-end AM

Another AM partnership is with Safran Group, a leading international high-technology group in aerospace, defence and security, where virtual validation of the AM process will be developed. The partnership combines the 3DExperience platform with Safran's expertise in innovative technologies, for the development of a world-class, end-to-end digital solution for AM. It addresses upstream material design and downstream manufacturing processes and testing. This will provide digital continuity for all engineering parameters necessary for the additive manufacturing of engine parts. That includes: material science, functional specification, generative design, 3D printing optimization, multi-robotic production and certification.

Pierre Fabre, senior executive vice president R&T, innovation at Safran, says, "Research and technology is a fundamental part of Safran, allowing us to drive continuous improvements for safer and more environmental-friendly air travel. Safran is currently leading the field in using 3D printing technology to manufacture its engines. By pooling expertise with Dassault Systèmes and its 3DExperience platform, we can accelerate the innovation process and better meet customers' needs."

4D design

Deploying AM in the aerospace industry brings otherwise dispersed islands of expertise onto a single unified platform. This provides the ability to access all relevant data from a single source, meaning there is only one version of the truth. Digitally simulated parts can also be placed in real-life context to show how they will behave and perform when made. 3D simulations can also include the fourth dimension, time, to demonstrate product performance over its lifecycle.

AM represents a new arena not just for aerospace but for many other manufacturing sectors. When it is run on a seamless unified platform that builds bridges between skills, the advantages and benefits of this exciting technology are multiplied. Its dynamic evolution is attracting interest and bright minds because AM is the cutting-edge of technology that like all good technology makes complexity simple.

AM CAN REPLACE, WITH A SINGLE PART, WHAT USED TO BE CONSTRUCTED FROM SEVERAL COMPONENTS

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HOW TO USE AM IN PRACTICE

Many 3D modelling systems, including Dassault Systèmes Solidworks, can print directly to 3D printers in a similar way to printing a document on an office printer, or they can output the widely accepted .STL format for transfer to other systems.

However, the 3MF and AMF (Additive Manufacturing File) formats provide more information on parts and assemblies, such as the colour and materials of the objects being printed.