# Machine learning making light work of AM aerospace alloys

**CAMBRIDGE, 14 January 2021** – Machine learning technology will be used to make the additive manufacturing (AM) process of metallic alloys for aerospace cheaper and faster, encouraging the production of lightweight, energy-efficient aircraft to support net-zero targets for aviation.

*Project MEDAL: Machine Learning for Additive Manufacturing Experimental Design* is led by Intellegens, a University of Cambridge spin-out specialising in artificial intelligence, the University of Sheffield AMRC North West, and global aerospace giant Boeing. It aims to accelerate the product development lifecycle of aerospace components by using a machine learning model to optimise additive manufacturing (AM) processing parameters for new metal alloys at a lower cost and faster rate.

AM is a group of technologies that create 3D objects from computer-aided design (CAD) data. AM techniques reduce material waste and energy usage; allow easy prototyping, optimising, and improvement of components; and enable the manufacture of components with superior engineering performance over their lifecycle. The global AM market is worth £12bn and that is expected to triple in size over the next five years. Project MEDAL's research will concentrate on metal laser powder bed fusion – the most widely used AM approach in industry – focussing on key parameter variables required to manufacture high density, high strength parts.

The project is part of the National Aerospace Technology Exploitation Programme (NATEP), a £10 million initiative for UK SMEs to develop innovative aerospace technologies funded by the Department for Business, Energy, and Industrial Strategy and delivered in partnership with the Aerospace Technology Institute (ATI) and Innovate UK. Intellegens was a start-up in the first group of companies to complete the ATI Boeing Accelerator earlier this year.

**Ben Pellegrini, CEO of Intellegens, said**: "*We are very excited to be launching this project in conjunction with the AMRC. The intersection of machine learning, design of experiments, and additive manufacturing holds enormous potential to rapidly develop and deploy custom parts not only in aerospace, as proven by the involvement of Boeing, but in medical, transport and consumer product applications.*"

**James Hughes, Research Director for University of Sheffield AMRC North West**, said the project will build the AMRC's knowledge and expertise in alloy development so it can help other UK manufacturers.

"*At the AMRC we have experienced first-hand, and through our partner network, how onerous it is to develop a robust set of process parameters for AM. It relies on a multi-disciplinary team of engineers and scientists and comes at great expense in both time and capital equipment," said Hughes. "It is our intention to develop a robust, end-to-end methodology for process parameter development that encompasses how we operate our machinery right through to how we generate response variables quickly and efficiently. Intellegens' AI-embedded platform Alchemite will be at the heart of all of this.*

*There are many barriers to the adoption of metallic AM but by providing users, and maybe more importantly new users, with the tools they need to process a required material should not be one of them. With the AMRC's knowledge in AM, and Intellegens' AI tools, all the required experience and expertise is in place in order to deliver a rapid, data-driven software toolset for developing parameters for metallic AM processes to make them cheaper and faster.*"

**Sir Martin Donnelly, president of Boeing Europe and managing director of Boeing in the UK and Ireland**, said the project shows how industry can successfully partner with government and academia to spur UK innovation.

"*We are proud to see this project move forward because of what it promises aviation and manufacturing, and because of what it represents for the UK's innovation ecosystem," Donnelly said. "We helped found the AMRC two decades ago, Intellegens was one of the companies we invested in as part of the ATI Boeing Accelerator and we have longstanding research partnerships with Cambridge University and the University of Sheffield. We are excited to see what comes from this continued collaboration and how we might replicate this formula in other ways within the UK and beyond.*"

Aerospace components have to withstand certain loads and temperature resistances, and some materials are limited in what they can offer. There is also simultaneous push for lower weight and higher temperature resistance for better fuel efficiency, bringing new or previously impractical-to-machine metals into the aerospace material mix.

One of the main drawbacks of AM is the limited material selection currently available and the design of new materials, particularly in the aerospace industry, requires expensive and extensive testing and certification cycles which can take longer than a year to complete and cost as much as £1 million to undertake. Project MEDAL aims to accelerate this process, using Machine Learning (ML) to rapidly optimise AM processing parameters for new metal alloys, making the development process more time and cost-efficient.

Pellegrini said experimental design techniques are extremely important to develop new products and processes in a cost-effective and confident manner. The most common approach is Design of Experiments (DOE), a statistical method that builds a mathematical model of a system by simultaneously investigating the effects of various factors.

"*DOE is a more efficient, systematic way of choosing and carrying out experiments compared to the Change One Separate variable at a Time (COST) approach. However, the high number of experiments required to obtain a reliable covering of the search space means that DOE can still be a lengthy and costly process, which can be improved,"* explained Pellegrini.

"*The machine learning solution in this project can significantly reduce the need for many experimental cycles by around 80%. The software platform will be able to suggest the most important experiments needed to optimise AM processing parameters, in order to manufacture parts that meet specific target properties. The platform will make the development process for AM metal alloys more time and cost-efficient. This will in turn accelerate the production of more lightweight and integrated aerospace components, leading to more efficient aircrafts and improved environmental impact.*"

Intellegens will produce a software platform with an underlying machine learning algorithm based on its Alchemite platform. It has already been used successfully to overcome material design problems in a University of Cambridge research project with a leading OEM where a new alloy was designed, developed, and verified in 18 months rather than the expected 20-year timeline, saving about $10m.

Ian Brooks, AM technical fellow at University of Sheffield North West said by harnessing two key technologies, artificial intelligence, and additive manufacturing, Project MEDAL hopes to unlock big benefits aligned to the Aerospace Technology Institute's strategic themes on aerostructures, propulsion and power, and systems.

"*It targets future integrated structures by accelerating development of new metal alloys and optimising an AM process to create lightweight components; its key driver is to protect the environment by reducing material usage and waste; and it looks to minimise fuel consumption through light weighting of components for flight controls and potentially landing gear systems*," said Brooks.

While this new method is being developed with aerospace in mind, the team believes it will have applications for other sectors too. Brooks said: "T*he opportunity for this project is to provide end-users with a validated, economically viable method of developing their own powder and parameter combinations. Research findings from this project and the project output will have applications for other sectors including automotive, space, construction, oil and gas, offshore renewables, and agriculture*."