



The RAPOLAC project builds on technology pioneered by Rolls Royce to explore the implications of Shape Metal Deposition for the aerospace sector.

By Tim Scherer

Adding value

THE answer to the question: 'What is a cutting tool?' has significantly changed from what it was three-hundred years ago. Ditto 'What is manufacturing?' An eighteenth-century engineer would likely find a contemporary tool as far from ideal as Henry Ford would find a blacksmith's concept of an efficient assembly line. But, regardless of how the tools and techniques have changed, the fundamentals of manufacturing remain the same. A cut is still a cut whether it is done with a piece of flint or a carbide cutting tool, and although the instruments have changed, the basic processes have not.

But, lack of change, whether in cutting tools or drill bits, doesn't necessarily mean lack of advancement. More importantly, in manufacturing, there isn't necessarily need for change if customer needs are being met. In the past, this has been accomplished by convergence between robotic systems, computers, modelling, dynamics research, machine tools and measuring systems.

All of these advancements have significantly reduced the amount of waste generated in manufacturing, and have increased component accuracy and reliability. However, they fail to account for their impact on the environment. Furthermore, as customers begin to look for greener solutions, inspired by their own conscience, legislation, or cost, there is slow development in satisfying a need for new tools and techniques that meet these requirements.

However, one UK manufacturer pioneering an environmentally friendly manufacturing technique is Rolls-Royce, a leader in aerospace, energy and naval engine manufacturing. The process is known as Shape Metal Deposition (SMD) and it works in a somewhat opposite way to traditional manufacturing. It isn't opposite in the sense that it destroys or reassembles materials; but rather that SMD is an additive process, meaning it begins with an empty palette and grows the parts by depositing layers of molten metal into complex shapes by using 3-D CAD/CAM models.

The patented technology is capable of depositing a complex range of metals such as nickel, nickel alloys, titanium and titanium alloys with improved material

AMRC's specialist engineering team is working on increasing the usability of SMD technology

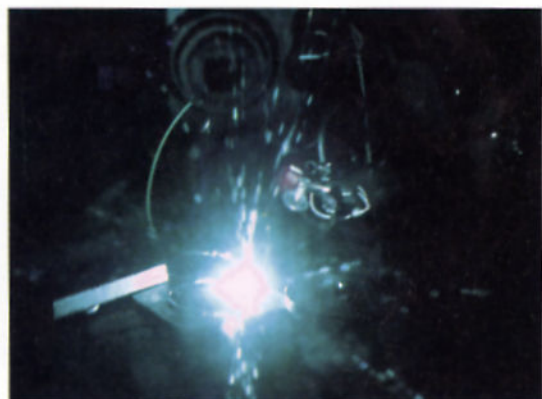
properties, and it is even possible for hybrid components to be created. There is no tooling or featuring cost for SMD, so it has the potential to significantly reduce materials cost because very little material is wasted. Furthermore, because there is no cutting of materials, there is no need for scrap disposal; no coolants are required to cool cutting tools - and less cutting fluid means less chemicals in the environment.

Building on the strengths of SMD, the University of Sheffield Advanced Manufacturing Research Centre with Boeing has won a €4.5 million (£3 million) grant for the Rapid Production of Large Aerospace Components (RAPOLAC) using SMD. RAPOLAC is a strategic research project from the European Commission and has the goal of increasing the usability of SMD technology. It is hoped that this research will lead to the development of a successful business model that can be employed across a wide range of industries. The international research team for RAPOLAC includes one of the world's oldest universities, The Catholic University of Leuven in Belgium; as well as a wide range of companies from as close as France, to as far away as Argentina.

This research isn't just 'university centric research' either. Small and medium enterprises have the opportunity to gain from the work the RAPOLAC partnership undertakes; Sheffield-based SME Footprint Tools, a partner in RAPOLAC, is using this opportunity to establish itself in a position to develop knowledge on the growing field of additive manufacturing. In recent years, the company has been badly hit by the low labour cost competition from the Far East and as managing director Christopher Jewitt explains, it is now looking to diversify into the aerospace market.

'We are delighted that our project has been successful' he says; 'it will assist us in refocusing our traditional tool-making expertise in a new emerging technology market. Footprint Tools has always had expertise in metal forming - in particular precision tool making, forging and heat treatment. We are keen to commercialise the Shape Metal Deposition process and increase our

SMD in action: the patented technology is capable of depositing a complex range of metals such as nickel, nickel alloys, titanium and titanium alloy



expertise in metal working through this project.'

Throughout the project, the RAPOLAC research team will examine ways to reduce the amount of manual controls currently needed to operate SMD. This will lead to the development of new innovative technologies for maintaining, controlling, and process modelling for expanding the range of materials that can be used on SMD. The project will be led by AMRC project manager and SMD cell manager, Dr Rosemary Gault.

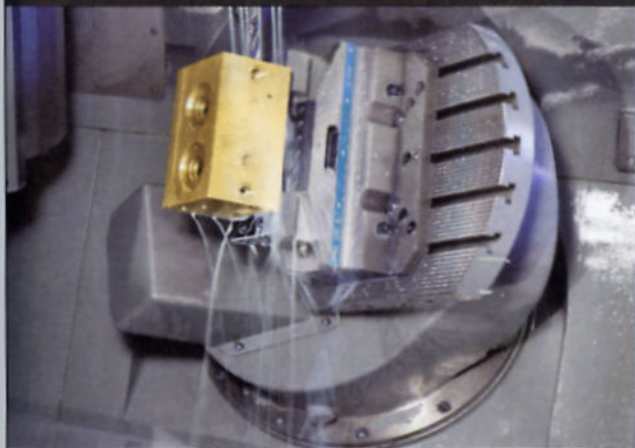
'The goal of the RAPOLAC project is developing SMD into a value-added process for manufacturers. Currently, SMD is limited to small range of materials, but the research we are undertaking will allow the process to use a much wider range of materials,' she says. Part accuracy for the process depends on the thermal stresses induced during the welding process.

Researching better ways to control heat transfer during deposition means a reduction in residual stress and therefore distortion will also be minimised.

Additionally, process modelling can also be used to predict the expected distortion and to compensate during deposition. Factors such as the way that temperature changes with the changing deposition geometry must also be considered. Wall thickness for SMD is controlled by the current, travel speed and wire feed rate and also to some extent by the wire thickness. Travel speed is the result of the rotation and tilt of the table and the movement of the robot. The faster the travel speed, the thinner the wall thickness, but the speed is limited to values where a consistent arc is produced. If the correct parameters are used, the deposited components will be fully dense.

The RAPOLAC project is estimated to begin in early/mid 2007 and once started, will be a good example of the importance of strategic-repositioning within an industry to up-skill, and develop new partnerships and markets. 'SMD is an excellent opportunity for companies willing to gain entry into the aerospace market,' says research director of the AMRC, Professor Keith Ridgway. 'We are confident that working with Rolls-Royce and Footprint, we can take SMD to the next level and improve the control systems so the process can run completely automated. When we do this, the process can then be used for making highly-accurate, large-batch production parts.' www.amrc.co.uk

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Transferring tradition

FOOTPRINT Tools was established in 1875 by Thomas Ellin who came from a long and distinguished line of Sheffield Cutlers. It is a traditional manufacturer of traditional, quality Sheffield products, primarily hand tools for tradesmen and particularly those with a cutting edge.

It moved to its present location in Hollis Croft in 1900, and came into the ownership of the Jewitt family in 1948. Since then Footprint has grown and prospered by providing a wide and diverse range of top quality hand tools primarily for the use by the professional and discerning amateur. The range includes tools for plumbers, masons, bricklayers, electricians, engineers, carpenters, joiners, decorators and several other specialist trades such as leather-workers and jewellers.

However, having spent over a century producing tools - and whilst tools will remain a very important part of the business - the company is looking to diversify by taking the skills and expertise it has in metal forming

through its involvement with forging, machining and heat treatment, and transferring them into other areas of activity of a more 'high-tech' nature.

For several years the company has been closely associated with the Mechanical Engineering department in the University of Sheffield, having worked on a number of projects including three teaching company schemes. It has now become involved with work that the Advanced Manufacturing Research Centre is undertaking on shape metal deposition in conjunction with Rolls-Royce.

Footprint is one of the partners in the RAPOLAC project which it is anticipated will take this important and innovative work forward with the aim of commercialising a process which has much to offer in terms of cost reduction and reducing material usage in producing large and medium sized aerospace components.

This move has coincided with the fourth generation of the business, Richard Jewitt who is son of the current managing director



Strong manufacturing traditions underpin Footprint Tools - but the sparks of technology are still flying as it transfers its skills and aspirations to 21st century challenges

Christopher Jewitt, joining the company.

Appointed a director in July this year, he comments: 'This is a tremendous opportunity for Footprint to turn itself into a twenty-first century manufacturing facility involving not only the traditional processes of drop forging for our existing range of quality hand tools but also move into other high tech areas of activity giving us a launch pad for the development of the business in the years to come.'

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