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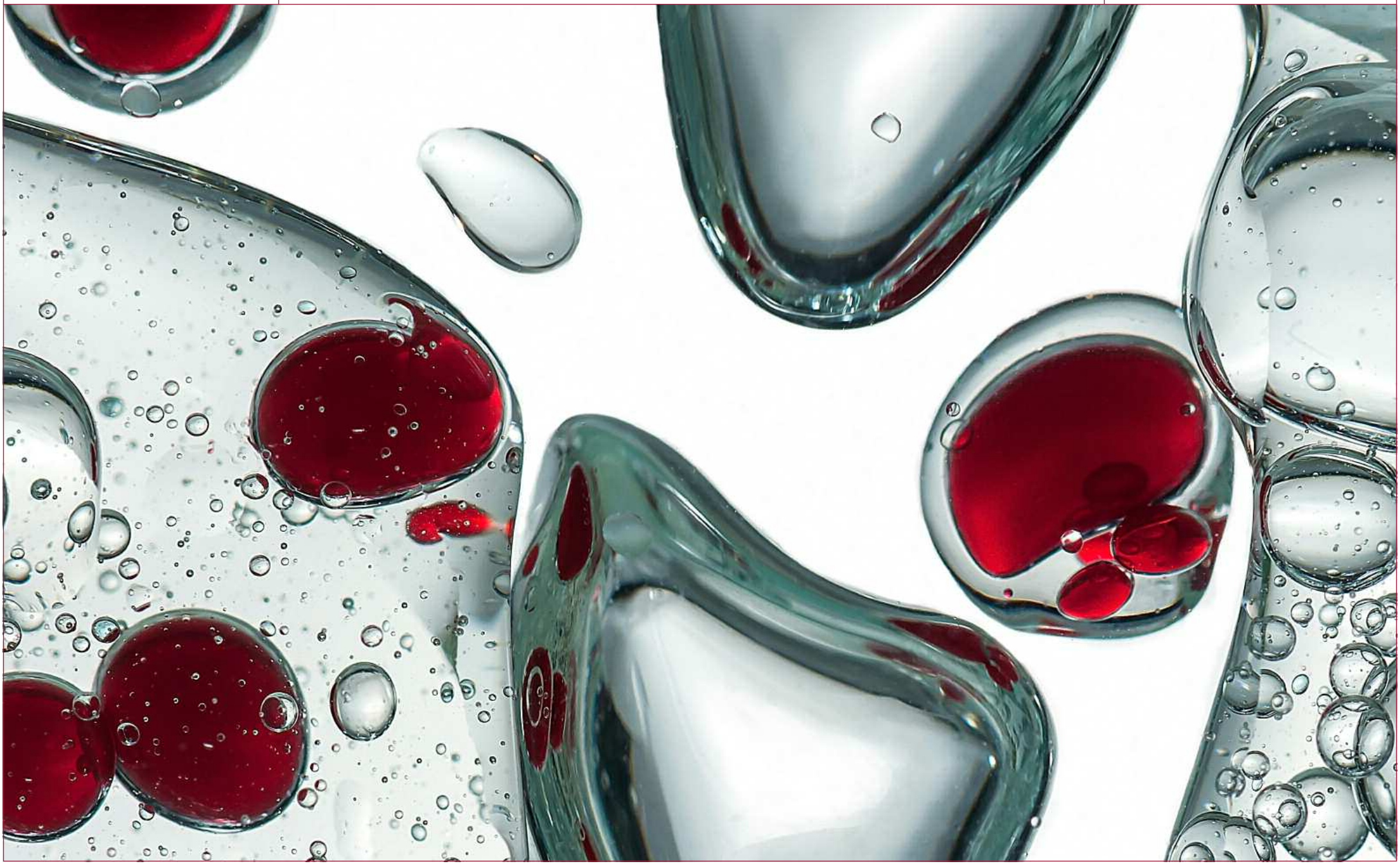

Surface Generation

A revolutionary heat-cool process for composite and injection moulding

Compression mould tool build.

Subtractive Pin Tooling™ technology (SPT)™

SPT is designed to overcome the traditional lead time and cost issues associated with large/short run component manufacturing by using a combination of subtractive and additive build strategies to create the front face of the tool, as opposed to the entire solid mould insert. It is achieved by assembling disposable square pins on a continuous surface, which can be moved into a near net position and then machined. The idea is that rather than milling the tools for such parts out of solid blocks of material, the system mills just the tops of an array of disposable pins.

based on the realisation that a hybrid additive/subtractive manufacturing build strategy could offer significant benefits for composite structure prototyping. Rather than offer it as a license he discussed spinning out the technology into a company which would capture more of the value for Pera. This was to be Pera's first spin out.

Subtractive Pin Tooling Technology

The idea initially was to commercialise a method which uses only the 'surface' of the tool to form the mould [see box]; the difference therefore is it does not use the entire mould as previously. He called this Subtractive Pin Tooling (SPT™). This has the benefit that it consumes no more than 5% of the material of an equivalent subtractively produced tool per unit volume, and the operator is able to re-use 90% of the previous mould material when creating new tools. Hence it reduces overall costs for tool manufacturers.

Start up

Halford decided to test the robustness of his business plan by attending the Cambridge Entrepreneur's Summer School, now called Ignite, in 2001 [mentioned in our 'Cambridge (Entrepreneurial) Phenomenon' article in Issue 16]. Encouraged, he set up Surface Generation within six months of attending the course. The new company went on shortly after to win two start up competitions, one at Oxford VentureFest, and the other at a Cambridge Entrepreneurs event.

Highs and lows

The company started with a small amount of Angel seed capital, keeping expenditure to a minimum – for example, the garage at his house was the workshop - and earning income from consultancy projects including those from Pera. By 2007 it was on the point of winning a multi-million pound contract from Huntsman Corporation of the US. Negotiations stalled however after Huntsman became

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the subject of a bid, and then came the financial crisis of 2008 when all new capital investment was frozen. Banks would not extend credit, and it was only thanks to the continued support of its shareholders, including Sir Martin and Lady Audrey Wood, the founders of Oxford Instruments, that the company survived.

Production to Functional Specification (PtFS) process

After that the company "hunkered down" and focused on R&D, says Halford. What emerged is now its flagship technology, the Production to Functional Specification (PtFS) process. The inspiration came after reading a US Department of Defense tender document in which material for a novel wing 'skin' was specified that could not be produced using a traditional approach (isothermic or autoclave). It was the sort of challenge on which Halford thrives: "I am only interested if we can make a step change in how a process works".

Out-of-Autoclave

In the production of composite aerospace and aircraft components, autoclave curing has traditionally been used to achieve the desired fibre content (resin-to-fibre ratio) for the production of light weight and strong components. Autoclave curing achieves this by placing the part under vacuum and then applying pressure during the thermal cycle. The PtFS process is an 'Out of Autoclave' method because it uses localised thermal control, rather than pressure, to achieve the same results, but more efficiently and at lower cost [see box, 'Core idea'].

Core idea

Instead of prioritising heating or cooling the PtFS process uses a single fluid stream (typically air) flowing at variable rates through the mould which is itself divided into multiple regions (think pixels) to heat and cool dynamically on demand during the cure process. As a result it is very normal in a PtFS system for a region to be cooling during a heating cycle and vice-versa. This 'pixelated' digital configuration is managed in real-time by a proprietary software application which maps business rules over the mould face to control multiple nested pixels into zones. This 'digital moulding environment' then allows users to fix issues, such as distortion, in software rather than hardware.

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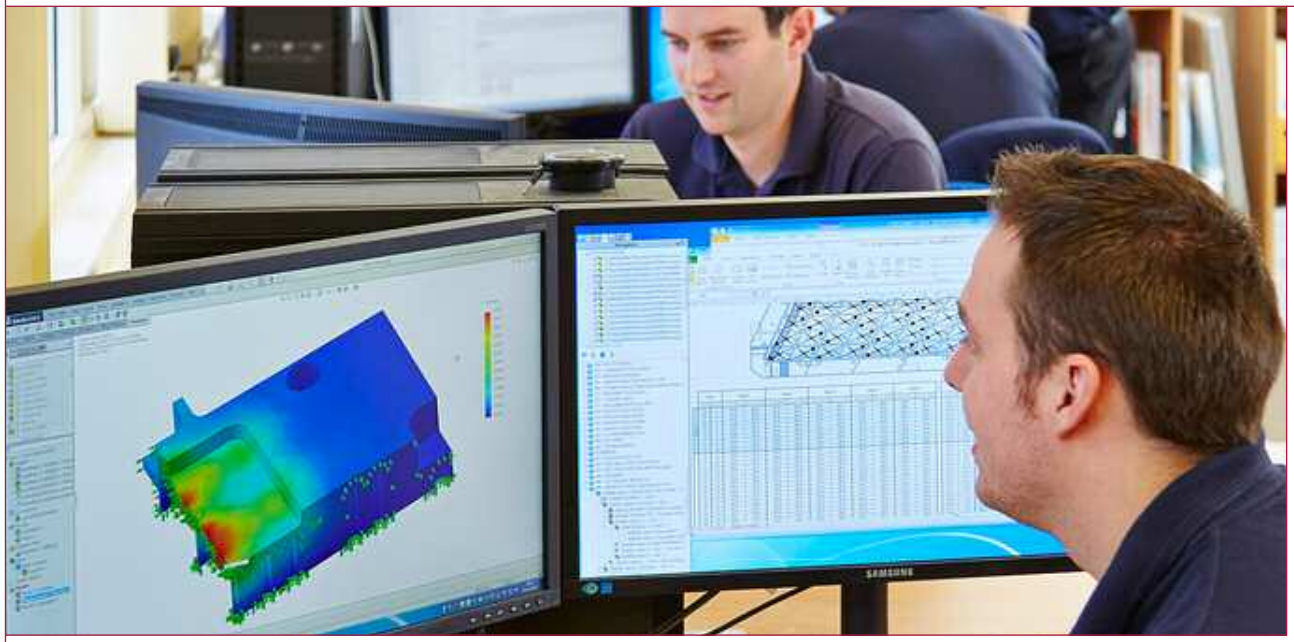

Computer Aided Design and Simulation Department.

Single system

In the PtFS system the several elements required to produce a composite – the mould tool, heating system, cooling system, and controller – normally supplied by different suppliers – are combined into a single system, "optimised around itself for the common good". Halford makes the comparison with how Apple revolutionised computing by integrating the hardware, firmware and software into a single system.

Digital molding

The 'intelligent moulding environment' allows temperatures to be dynamically controlled to the exact requirements of each mould area and process stage by up to 1,000°C, using only air heating and cooling. Under the digital control of the software, users can adapt heating and cooling levels in real-time, assuring quality and increasing throughput; they can also control how long materials remain molten in the mould allowing material flow to fill thinner complex moulds accurately using up to 75% less pressure (and energy). According to the company, clients have cut up to 80% of processing time with energy savings of 90%.

Lightweighting

This new approach makes it possible for the next generation of moulded products to be made significantly lighter and more efficiently, with no reduction in strength or quality. It can be applied not only to the high-end aerospace industry but to consumer electronics, automotive, packaging products and beyond. In trials with major consumer electronics and automotive manufacturers the company says it has been possible to create thin fibre-reinforced plastic components where weight and material have been cut by half.

Patent power

"We have developed the transistor while the rest of the industry is still using valves", says Halford. There are six families of patents filed and granted around the world, including China, and the core family of IP is being strengthened by the addition of application-specific filings.

Consumer electronics

Overseas markets are the main target where PtFS can offer radical improvements in weight reduction to volume applications, like consumer electronics. Halford uses a retailing analogy likening the market in the UK to 'Savile Row' (custom design for advanced, low volume applications), and 'Marks and Spencer' (or M&S) for the higher volume markets overseas which still demand good design. He gives the example of working with one major US brand to make thinner, more functionally attractive computers. In this

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instance the PtFS system is being used to engineer an extreme shape while preserving flatness and maximising yield.

Aerospace

In aerospace, weight is the key factor to improve fuel efficiency. The company is currently working with major OEM's and Tier 1's going through due diligence to demonstrate its technology readiness. The key breakthrough has been the signing of a five-year multi-million pound contract with the Japanese engineering giant, IHI, for jet engine parts which was finalised in March 2014. IHI is using PtFS for the production of thermoplastic structural guide vanes which will be used in the next generation Airbus A320 single aisle commercial aircraft programme.

Automobile

Lightweighting is also a key goal in the automobile sector. Surface Generation has joined a supply chain consortium which has received funding under the Government's Advanced Manufacturing Supply Chain Initiative (AMSCI) to accelerate vehicle lightweighting. Partners include composite and engineering specialists, as well as Cranfield University and three automotive OEMs (Bentley, Volvo/Geely and Nissan UK). The main opportunity for Surface Generation is to improve its understanding of the sector's dynamics and how to interact with it.

Business status

The IHI contract has contributed to a doubling of revenues in the year ending March 2015. It has also given the company what Halford calls "more freedom to operate" in new markets like consumer electronics. Shareholders made a further £3m equity investment in 2015 so that the company can increase head count and production space to meet new orders.

Revenues are derived from a mixture of consulting fees, royalties, and equipment sales. At least 90% of sales are generated from customers overseas. The largest market is Asia where the company has engagements split evenly between companies in aerospace, automotive and consumer electronics. To support sales, it has secured a partner in Taiwan to carry out trialling and sample preparation locally.

Outlook

The challenge now says Halford is to transition its customer R&D programmes smoothly into production by increasing its delivery resource, expanding strategic alliances and licensing non-core applications. Given the earlier highs and lows it experienced these challenges are clearly positive. ■

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