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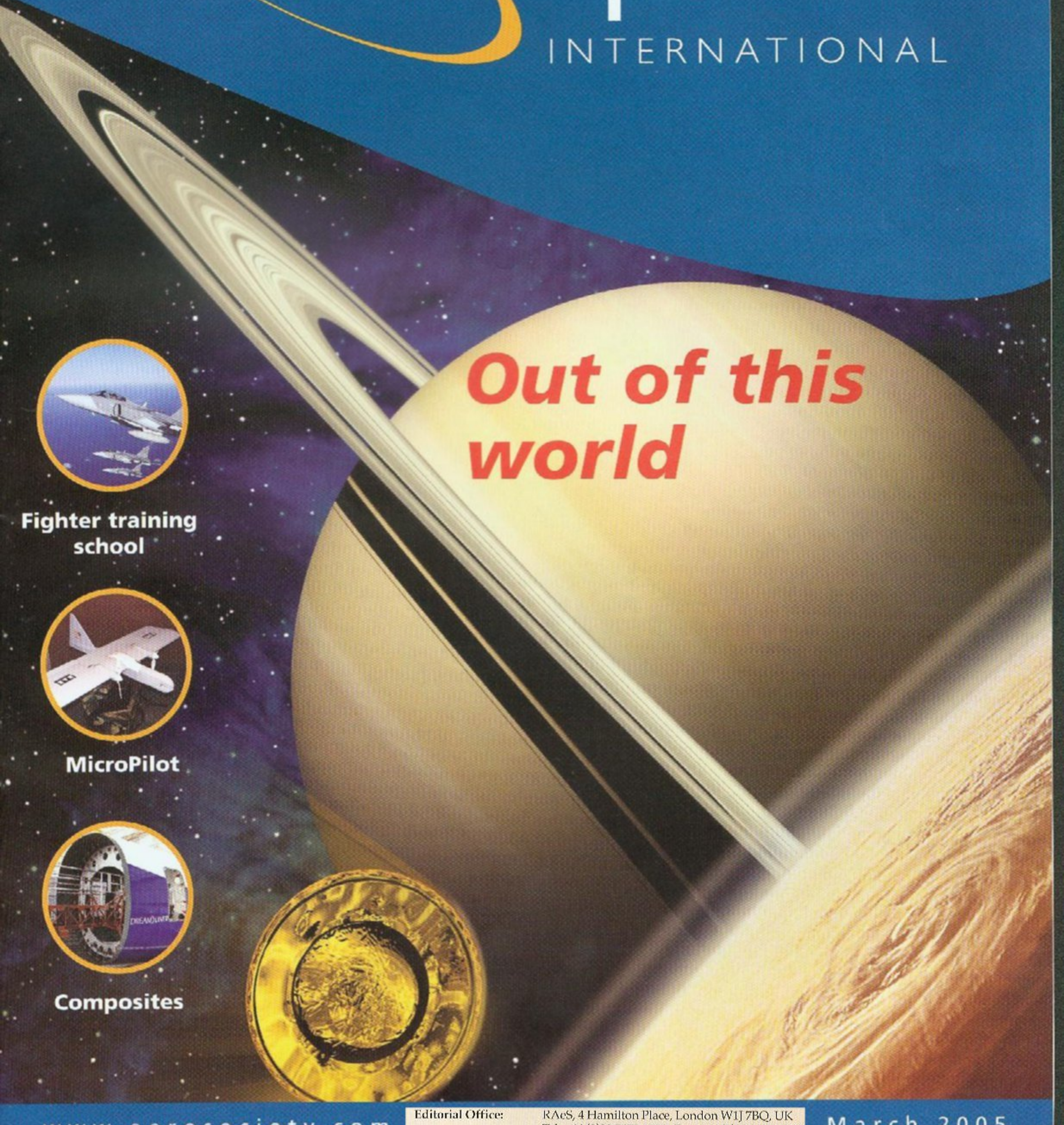

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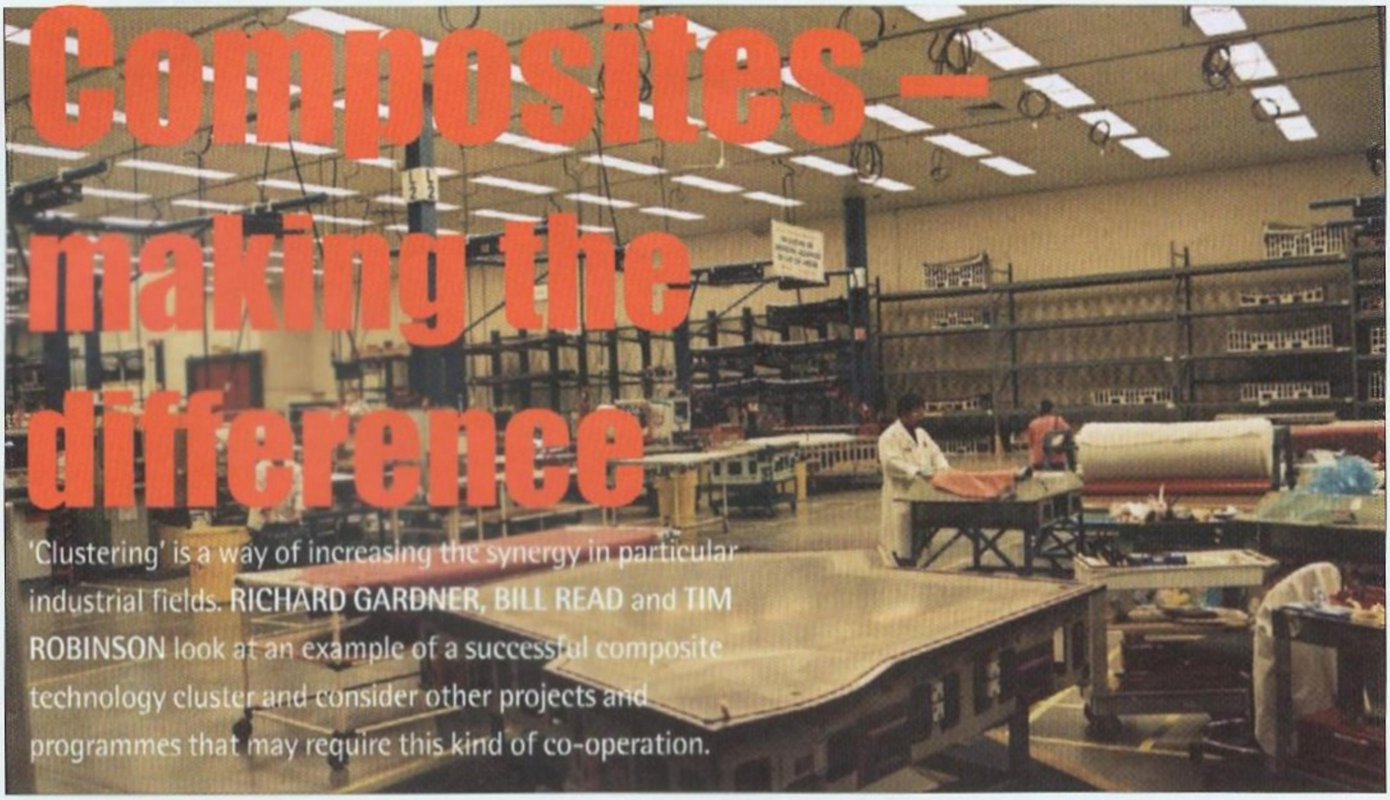

Composites – making the difference

'Clustering' is a way of increasing the synergy in particular industrial fields. **RICHARD GARDNER, BILL READ** and **TIM ROBINSON** look at an example of a successful composite technology cluster and consider other projects and programmes that may require this kind of co-operation.

In the development of centres of excellence in advanced composite innovation and production local conditions can make all the difference. Many companies have the aspiration to move into composites but, when it comes to establishing a prime environment for integrated composites clustering, few have the built-in advantages that are on offer in Winnipeg, Canada. The Province of Manitoba is home to the third largest aerospace sector in that country, with exports representing around 40% of its $1·2bn revenue. The main established aerospace companies are Boeing Canada Technology, Magellan, Standard Aero and Air Canada Engineering, but there are another 17 aerospace companies and a number of small to medium size enterprises supporting the sector.

Wealth generation

Composites are now widely recognised in aerospace and the broader transport market as being at the forefront of future wealth generation. With this in mind, in 2003 the Composites Innovation Centre (CIC) was established as a not-for-profit company with tri-level government backing (bringing civic, provincial and federal sponsorship) to stimulate economic growth through the innovative research, development and industrial application of composite material technologies. This action followed on from earlier studies and consultations among 23 private firms and 12 public sector organisations that had indicated high levels of commercial expectation encouraging stronger government commitment to development priorities concerning innovative technologies.

The idea of a composites cluster rapidly gained ground. Today, the CIC Board embodies a spirit of collaboration with six industry leaders, two institutional representatives and three public sector observers. The CIC's offices are based at the University of Manitoba's Smartpark and provide a very convenient linkage between academia and local aerospace companies, with a steady flow of skills and experience between the two. Students are connected with integrated composites research which improves their own skill-sets for future employment opportunities.

By such partnering activities, the CIC spurs new economic growth by working closely with industry to develop and implement new materials, products and processes. An example of such new work is the current project on developing bio-composite processes exploiting some of the vast unused straw and hemp-based resources that are to be found in central Canada. Examining fibrous materials to establish suitability for composite uses and associated quality standards is just one area that is attracting much industry interest. With a large industrial base in the area, more than adequate power and transport resources, experienced human resources and plenty of likely customers, the potential future applications for bio-composite materials seems as limitless as the local horizon.

The CIC aims to strengthen relationships with industry, government agencies and educational institutions, as well as acting as a focus for clustering composites-related industries that attract new investment into the region. The CIC offers various value-added services for clients, ranging from technical assistance to project planning and management. The organisation also works to establish collaborative partnerships and is helping to identify and negotiate with project-funding agencies. The eventual purpose of the CIC operation is to discover, develop and transfer composite solutions to industry — across a wide industrial market and not just within aerospace.

Boeing Winnipeg

Boeing operates Canada's third largest aerospace facility at Winnipeg, where it enjoys a highly skilled workforce pool, low-cost infrastructure, multiple product process capability and a sophisticated value-stream management, all within the composite cluster. The main factory has

Left: Composite panels are getting bigger and bigger and increasingly taking on structural roles.

over 500,000sq ft of manufacturing space and its core business is the fabrication and assembly of complex, contoured composite panels for the whole Boeing jetliner product line. Typical products are thrust reverser doors, APU-ducts, landing gear doors, rudder fairings, wing/fuselage fairings and engine strut fairings. Some of these components, such as the wing/body fairings for the Boeing 777 and 747, are enormous and have led to Boeing's growing confidence in using advanced composite materials on the new 787 Dreamliner.

Some of the advanced processes currently in use include closed cavity moulding, acoustically treated structures and reinforced thermoplastic laminations such as wing slat flexible tabs. All composite raw materials are tested on arrival (some are time sensitive) and the giant rolls of prepared cloths are cut at desks to allocated shapes by the computer system. Many of the almost all-female cutting staff have dress-making skills and have become extremely skilled in reducing waste to the minimum. What is left over, and cannot be recycled, is made available to the training partners in the cluster so they can make use of these valuable off-cuts.

After the material shapes have been placed in the moulds, and the resin impregnated layers built up to the required thickness, special vacuum bags pull the laminations together before the 300 degree 'cooking' process takes place in one of the many autoclaves. Different components require different cooking and cooling times, and there are constant quality inspections. By evolving leaner and smarter procedures some 50% of workspace has been saved in recent times.

Larry Leiter, Boeing Winnipeg's director, business development & engineering, told *Aerospace International* that the company was engaged in large-scale composite manufacturing, research and development (including prototyping), engineering design, testing and analysis, project management and assembly. Engineering resources included the use of CATIA V5 and AutoCAD systems and advanced structural analysis workstations. As part of its commitment to R&D, Boeing's testing lab has its own machine shop, climate controlled clean room, universal testing machines, impact testers, a high speed data

acquisition system, a thermo mechanical analyser and a photomicrograph. It is a partner with the University of Manitoba composite labs, all within the composite cluster.

Larry outlined the company's technology roadmap approach. This took emergent technologies, current capabilities and new opportunities and programmes to focus a strategy that would use technology and knowledge to increase product value. Complex strategic processes and products would be targeted, providing best value solutions and giving the company with a world-class composites capability by drawing on the combined strength of the composites cluster as a resource. This translated into real performance gains, reducing raw material, overhead, labour and product life-cycle costs as well as making weight improvements in products and reducing non-recurring costs.

A Design for Manufacturing and Assembly (DFMA) strategy has brought measurable cost and quality improvements, with documented lessons learned and skill development considerably broadened. With a design to cost approach, value stream mapping and closely-knit team environment, the company's lean manufacturing efforts have transformed the production system at the plant. Ultra-reliable methods and processes have been introduced, mistake proofing, reducing waste and maintaining a highly satisfactory manufacturing velocity (using JIT principles), while keeping everything as simple as possible. There is also a supply base management system in place to bring a structured supplier performance rating, supply base rationalisation based on performance and much joint training and working together. Over recent years the number of employees directly working at the plant has shrunk from around 1,500 to today's 875, though output continues to rise.

Magellan Aerospace

Magellan Aerospace provides another massive local aerostructures capability within the Winnipeg composites cluster. With 71,600sq ft of floorspace available, the company's cellular manufacturing centre contains all the resources to supply a wide range of composite aerostructures and components to the world's aerospace companies. There are two automated ultrasonic cloth cutters and two 10ft diameter autoclaves, with automated trimmers, horizontal and vertical core cutters, a paint booth, ultrasonic inspection facilities and a laser ply locator. The company provides a full range of subsystem integration services including design, development, testing, qualification and certification. Typical products include wing-to-body fairing kits, engine skirt beams, tailcones, lower fuselage panels, engine cowlings, horizontal stabilisers, ailerons and a helicopter wire strike protection system. Customers include Boeing, Airbus, Hurel-Hispano, Hamilton Sundstrand, Eurocopter, AgustaWestland and the US DoD.

On a smaller scale, but very much a niche specialist in composite rotor blade, prop spinners, panels and flight control surface repairs, is Advanced Composite Structures. This Winnipeg company has built up its reputation to the extent that it is now able to match factory-finish quality with composite repair costs that are around 25% cheaper than conventional OEM prices. It can offer a complete package of composite services from highly trained and skilled personnel to an high-tech composite component repair facility.

As a small business, Advanced Composite Structures has an *ad hoc* approach to gathering new business, with fast turnround, good value and high quality as main selling features. The company has various curing/bonding ovens and positive and negative pressure tooling, with a positive pressure cleanroom. In handling composite repairs, the initial priority is always defining the extent of the damage.

Left: Repairing composites is now a major business.

Left: Increasingly complex shapes can now be fabricated in composite materials.

Obvious surface damage is not always the whole picture, according to Mike Turk, production manager. "There is a lot you can't see, so we have to do comprehensive non-destructive investigating. There may be a clue through surface marking but we check deep into the material using ultrasonics, x-rays and a good old-fashioned sound-tap!"

During our visit, *Aerospace International* saw very intricate repair work underway on a spinner from a CP-140 Aurora patrol aircraft. A technician was painstakingly restoring the broken heater wire in the composite spinner. The final result has to be perfect, with an ultra thin insulating paint finish. After the repaired spinner has been patched and cured, then given a surface sealer and finally painted, it has to be balanced and then given a final inspection. "By then, it's better than brand-new," adds Mike.

Cross-training gives the technicians the flexibility to switch activity between helicopter rotor blades, spinners or panels, wherever the customer priority lies. The sensitivity of the materials used in composite manufacturing and repair means that humidity, dust suppression and temperature must be perfectly controlled to ensure permanent protection during the storage and manufacturing processes. The latest equipment has been installed in a very neat, well laid-out plant, designed to smooth production flow while allowing work to proceed on different activities.

As well as main and tail rotor blades for Bell Textron, Eurocopter, M-D Helicopters, Schweizer and Sikorsky designs, ACS also repairs metal bond honeycomb and composite bond honeycomb components. Fixed wing aircraft components include spinners for DHC5 Buffalo, P-3 and C-130 aircraft. Civil work ranges from Airbus A320 elevators to Beech King Air and Cessna Caravan lower cargo pods.

The specialised world of composite technologies is growing ever more exciting as more ambitious uses are found to supplement established applications. So much progress in such a short timescale suggests that the influence of composites on all aspects of aerospace development will continue to transform the sector for the foreseeable future. And where there has been the foresight to support composite clusters, or centres of excellence, future commercial success looks a very good bet. ◆