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Connection

The official magazine of Composites Australia

Inside

allnex is the market leader in the manufacturing and distribution of composite materials in Australia, New Zealand and the Pacific Islands. We are the largest and only local producer of composite resins such as gelcoats, flowcoats, and unsaturated polyester and vinyl ester resins.

Our materials are used in a diverse range of composite applications and products such as boats, swimming pools, truck bodies, tanks, roof sheeting, pipelines and many more.

We pride ourselves on offering the region's most comprehensive product portfolio and end-to-end service ranging from research and product development to application advice and ongoing technical support.

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Globally, allnex is a leading producer of coating resins and additives for architectural, industrial, protective, automotive and special purpose coatings and inks with an annual revenue of €2.2 billion.

With 33 manufacturing facilities, 23 research and technology support centres and 6 joint ventures, the allnex group is present on four continents and serves customers in over 100 countries.

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Front Cover
The Hunter-class frigate is a future class of frigates replacing the Anzac-class. Expected construction begins in 2020 with the first of nine vessels to enter service in the late 2020s. Story page 10. Image supplied by RPC.

Feature article

The power of two: RPC Technologies and UK's Tods Defence, two great companies come together to leverage the strengths, capabilities and deep experience to supply defence contracts.

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President's letter

Welcome to the current edition of the Composites Australia *Connections* magazine. This edition features a number of inspiring stories on companies within the advanced composite sector and journeys of the people involved. There is a comprehensive round up of our 2018 conference that was an all-round success as well as examples of innovative uses of advanced composites.

In April, the 2018 Advancing Composites Innovation Conference, Australia's biggest networking and knowledge sharing event for the Australasian composites industry, was held the Australian Synchrotron in Clayton, Victoria. The event focused on manufacturing, with hands on demonstrations, and a range of presentations that were enthusiastically attended by the 150 plus attendees. Glen King, Director of Kings Fibreglass fascinated the audience by sharing the journey from his first meeting with the National Gallery to the opening of the Ron Mueck's Mass 2017 installation of 100 fibreglass skulls. See the conference round up story on page 8-9 for more details. Contributing to the success of the conference was the fascinating venue, the Australian Synchrotron which is one of the most significant investments in scientific infrastructure in our nations' history. If you are wondering what the Synchrotron is and its role in advance materials – the story on page 14-15 will answer your questions.

The story on the Bolwell Corporation's 55 years in operation on pages 5 to 7 is heartening and inspirational. Campbell Bolwell, one of the industry's founding fathers is still passionate about the application possibilities of advanced composites and construction techniques. Page 16 also covers the enduring application of ATL's foam core structural panel technology for lightweight marine solutions. Also inspirational is the collaboration between members Terra Firma Industries, Regina Glass Fibre and allnex Composites to develop a unique fire proofing solution for underground rail tunnels.

The composites industry in Australia is growing in confidence as increased interest in the possibilities of using composites is realised across many sectors. Opportunities in Defence procurement are opening up to Australian manufacturers, so too rail and renewable energy. Positive consumer confidence was evident at the 2018 Sanctuary Cove boat show that was rated (by some) as the best show since before the Global Financial Crisis with local boat manufacturers reporting healthy order books extending out to 12 months. While all good news, members are now reporting a skills shortage to meet increased demand. An article on page 13 on skills and training covers the results our recent member survey on the issue.

With the recent successful event in Perth at Tanks West, and the upcoming event at Compass Pools in August, I urge all members to take advantage of the full range of networking and learning opportunities that the Composites Australia team put such dedication into planning and coordinating for us.

On behalf of the Board, I hope you enjoy this edition of the magazine, and encourage you to take up our invitation to attend our many events cross the nation.

Leona Reif
President

Bolwell Corporation – 55 years on

The Bolwell marque is an acknowledged legend in the Australian automobile industry as much for the advanced composites used in its construction, as for its unique design features. Starting their business initially by building kit cars in the early 1960s, brothers Campbell and Graeme Bolwell moved into full production of the Nagari sports car in 1969. The Nagari earned a unique position in Australian history and the Bolwell marque was an embodiment of the entrepreneurial flair and commitment of a dedicated and inspired group of individuals.

Bolwell's early success led to its prominence as a quality composites manufacturer and laid the foundation for the company's reputation for effective design solutions in the creative application of composite materials. Importantly, this success in car manufacturing led to the formation of the composites industry in Australia, with Campbell Bolwell acknowledged as a founding father.

Fifty-five years on this year, Bolwell is still a family company, headed by Vaughan Bolwell, an Industrial Designer. Co-founders Campbell Bolwell and his high school friend, Linley Hughes, remain company Directors and are still active in the business.

The first Bolwell Nagari was a single piece monocoque construction, the first in the southern hemisphere (and the second in the world) to have such a design quality. Today, this design methodology has been adapted in the Bolwell Edge – the new fully-moulded composites-based touring caravan with lightweight, aerodynamic properties.

According to Vaughan, key to the company's survival over the years has been its flexibility, commitment to continuous improvement and a willingness to reinvent itself at intervals.

An early influence was the automotive and transport industries which led to the adoption of Lean Manufacturing principles, particularly the Toyota Production System (TPS). The company utilises Kanban to schedule work throughout its facilities for efficient and highly visible tracking of orders and it regularly undertakes Kaizen activities to review and optimise its processes and systems. In recent months, Bolwell has installed a specialised, long arm robotic trimmer as well as light scanning technology to its stable of advanced manufacturing capabilities.

Preparing door frames for the early Bolwell Nagari, 1969.

The light scanning technology and associated specialist software are already delivering a step change quality improvement in line with the company's Kaizen ethos. Parts large or small, complex or simple, can now be easily reverse-engineered using the 3D surface measurement digital light projection technology. The systems computational power is also used as a quality control method to verify that the parts produced match the initial CAD data and technical specifications from

Final fitout of the Nagari's composite body.

Campbell Bolwell with dog Bruce outside his first factory, Seaford, 1963

Linley Hughes (2nd from left) and Graeme Bolwell (far right) outside Bolwell sports car factory, Mordialloc, 1972

the customer. Bolwell says that the speed, accuracy, resolution, portability and ease of use is especially useful for PPAP and ISIR requirements where 2D technical specifications are often limited in assessing the complexity of real-world objects.

Adding to its original ISO 9001:2015, the company recently adopted environmental best practice by way vof attaining ISO 14001:2015 accreditation. Bolwell says that the decision to become ISO 14001 accredited was driven by as the company's use of the most challenging raw materials in manufacturing and by the increasing expectations of international client companies. "The ISO framework has also helped us improve our environmental performance through increased plant reliability and process control; efficient use of resources and reduction of waste," says Vaughan.

Structural testing windmill wing, Bolwell Canada, 2001

Spray laminating is one of the processes used in Bolwell's Thailand facility

While he is proud of the company, its legacy, workforce and intellectual property, he is quick to point out that the past 55 years have not been all plain sailing. "We have had our fair share of setbacks, but looking back, the setbacks, although painful at the time, were a catalyst for unity, innovation and advancement. Each time we were forced to assess the company and refresh our values and direction."

An electrical fire started on an early April morning in 2014 and quickly swept through the 2000 square metre factory, exploding resin drums and requiring 80 fire fighters some 90 minutes to bring under control.

Bolwell said that the emotional cost was much higher than the cost of the damage: "But the whole experience was unifying for our team, with everyone coming together to create minimal impact on our customers. Importantly, rebuilding forced us to rethink the way we manufacture, our production flows and equipment."

The company's international ventures in Mexico, Vietnam, Canada and more recently Thailand, have all enjoyed varying degrees of success.

The Canadian wind turbine blades industry is one that owes its origins to the resin infusion process developed by Campbell Bolwell who was called upon in 2000-2005 to relocate to Ontario to set up an industry that still thrives today. For a number of years, the Canadian company Polymarin Bolwell Composites produced blades for 600 kW and 750 kW wind turbine machines as well as large flight simulators for Boeing. Sadly, the company did not survive the catastrophic economic effects on North America and aviation arising from the September 11, 2001 attacks.

But the strategic decision in 2014 to establish Bolwell Holdings (Thailand) Co. Ltd, in which it manufactures advanced composites components and products for its major transport client and the global market has thus far been a success. The facility is centrally located to service both the European and North American markets and, unlike other ventures, is fully owned by Bolwell.

The company's venture into its own recreational vehicle in 2010 was the result of a long evolution in industrial design, composites engineering, tooling, CAD systems, RTM and aerospace bonding technologies for Bolwell Corporation. The Edge caravan rides on an independent trailing arm suspension, making it stable, safe and economical to tow. The body is bonded, creating an extremely strong, one-piece waterproof structure .

The Edge went on to win the Automotive Engineering Excellence Award from the Society of Automotive Engineers, and the JEC Asia Pacific Award for Transport Innovation. The Edge also won the Australian Good Design Award in 2010.

Today Bolwell's advanced manufacturing technologies and world-class designs have been instrumental in creating opportunities both at home and abroad. The company is now known as an advanced composites innovator providing engineering and industrial design services and making and supplying composite components to some of the world's biggest heavy transport manufacturers for over 36 years.

It is difficult to quantify the years of innovation, investment (both human capital and financial) and trial and error in materials and processes. The qualities of persistence, mentoring and determination - from experimenting with chicken wire and early resins in a garage to developing a carbon fibre composite monocoque shell for a supercar – have been part of the Bolwell success story.

Vaughan says: While business can be challenging, I am confident that the company's DNA of raw entrepreneurial spirit, courage, adaptability and resilience will continue.

THE NAGARI – THEN AND NOW

In 1962 Campbell Bolwell and his brother Graeme transformed their hobby of building special sports cars into a business. Utilizing their knowledge and expertise, they produced over 200 Nagaris on a steel backbone chassis, before ceasing production in 1974. The Nagari has a fibreglass body and powerful V8 engine at the heart of the 'Aussie' exotic sports car coupe. During these years of production, Campbell transformed his knowledge of composite fabrication and transport innovation into a diverse global business.

But the pull of the creative process of designing and producing a high performing unique vehicle has never left, and after three years of research and development in its Mordialloc headquarters, the Bolwell Company released a prototype carbon fibre-bodied car, the Mk10 Nagari 300, at the 2008 Melbourne International Motor Show and 2008 Sydney International Motor Show. The Mk II is a mid-engined two-seater coupé with a carbon-fibre tub, front and rear subframes and a carbon-reinforced composite body. Power comes from a fettled 2GR-FE 3.5L V6 engine sourced from the Toyota Aurion. The car was designed to accelerate from 0-100 km/h in 4 seconds due to the extensive use of composite materials.

Unable to quell his creative spirit, Campbell will be releasing a new Nagari within the next 12 months.

Campbell Bolwell discusses prototype performance at Calder Raceway, 1963

Bolwell Mk 5 sales advertisement, 1964

The Mk I0 Nagari 300 Supercar as released in 2008.

"The Nagari has been a passion, a dream and a journey that started in the '60s and progressed and evolved into the breathtaking 2008 and now the 2019 model that is a testament to the extraordinary application of advanced composites and construction techniques," concluded Campbell Bolwell.

Yet another ripper conference!

Held at the unique Australian Synchrotron in Melbourne during perfect autumnal weather, the conference hosted close to 150 delegates from all over Australia and the world who came together to share, learn, leverage and shape new ideas. As one delegate put it, the 2018 Advancing Composites Innovation Conference (ACI-18) was a "ripper with plenty of good stuff"!

The event commenced with a tour of the Australian Synchrotron facilities to see first hand the powerful beams that can be used at individual experimental facilities to examine the atomic and molecular detail of a wide range of materials. An article on the Synchrotron and its ability to assist the composites sector can be found on page 14.

The pre-conference workshop on Composites Design and Manufacturing and delivered by Dr Rik Heslehurst, exceeded expectations with registrants from Australia and internationally.

Rik also delivered papers on the art and science of bonding composite materials and the effect of resin flow additives on the mechanical properties of vacuum infused composites.

The opening presentation by David de Garis, Director for Economics and Markets for the NAB, heartily confirmed that the "the Australian economy by and large is doing well".

Andy Balmain, Commercial Manager, ICN, added to the optimism by outlining the Victorian Government's commitment to local content targets for the renewable energy targets and auction scheme evaluation criteria. This, Andy predicts, is a "boon for local industry with many potential operators searching for capable local suppliers for wind energy components such as hub nose cones, hub spinner shells and nacelle covers."

With the return of practical demonstrations, the event bridged the gap between theory and practical application. The caravan component manufacturer, Tricomposites, together with allnex, performed a live demonstration of the Light Resin Transfer Moulding (LRTM) to validate a DCPD Ortho blend infusion resin developed by allnex for A class auto parts. The blend has been formulated to produce a superior cosmetic finish with less print-through and distortion on finished parts. With all eyes on the infusion, the versatility of the manufacturing method using a closed mould system that features a base mould and counter mould that are sealed using vacuum pressure excelled. We are grateful to the Tricomposite technicians for their time and commitment.

Top to bottom. Dr Rik Heslehurst demonstrating the importance of achieving consistent fibre/resin volume ratio during fabrication.
David de Garis, Director, National Australia Bank.
Damien Bensley, General Manager, Colan Australia.
Delegates for the pre-conference workshop - Composites Design and Manufacturing.
Shammi Sultana Nisha, Swinburne, Kerryn Caulfield and Adrian Orifici, ACSS.

The welcome reception and conference dinner are opportunities to network and identify prospects for collaboration. The competitive spirit in many was evident at the Clayton Lawn Bowls Club where delegates enjoyed a great meal, beer on tap and a round of bowls.

Fabricators stream – courageous innovation and diversification

The industry stream featured a number of generous presentations from some of the most knowledgeable manufacturing brains who shared insights into how their companies were manoeuvring through the rapidly-changing Australian manufacturing landscape.

The dynamic duo, Frank Cristiano, GM for Tricomposites and Hugh O'Donnell, Director of the HPC, delivered the 2018 instalment on transforming a manufacturing culture to one of empowerment, ownership and accountability which in turn has delivered efficiencies of 70% for Tricomposites lifting production to 1,800+ parts per month. Central to the transformation is brave and compelling collaboration with peers in other industries, changing mindsets and accessing resources and ideas to improve productivity, quality and delivery performance with minimal capital investment.

Ashley Reid, Managing Director, Terra Firma Industries, inspired the audiences with his examples of imbedding into a composite component, sensing or responsive ability to provide customers with the classical properties of composites – less weight, stiffness and strength – in addition to unique direct customer and stakeholder engagement and interaction. Thinking and planning like a technology company to adapt the Industrial Internet of Things (IIoT) can transform a humble component such as a FRP access cover (aka "manhole cover") into a powerful asset that tracks and stores a multitude of data thereby adding unprecedented value.

Glen King, Managing Director, King's Fibreglass Pty Ltd, impressed the audience with completing the challenge of making 100 fibreglass skulls commissioned by the National Gallery of Victoria. Glen provided an honest account of collaborating with numerous creative and technical agencies including the Australian-born sculptor Ron Mueck and the challenges of making the moulds and fabricating the skulls that comprised of up of 20 parts in each two-piece mould, plus dozens of teeth.

Steve Campbell, Managing Director, Composites Constructions, reasoned that the traditional skills and lateral thinking of a boat builder on issues such as complex shapes and windage are invaluable for a raft of non-traditional applications. His latest public art commission "Convergence" which stands on the ground at over 12 metres high, made from hollow carbon fibre shell with 14mmm thick walls and a 6mm foam core, is a testament to his Master Boat Builder qualifications and collaboration with engineers and artists.

The role of research

Managed by the indomitable Dr Rik Heslehurst, the academic stream is an increasingly important forum for intellectual exchange and an opportunity to share the findings of the diverse global portfolio of research into composites and advanced materials. This year, they showcased the depth and breadth of knowledge and expertise focussed on advancing the composites sector.

Demonstrating the step-change anticipated by (IIoT) and responsive composites, Dr Claire Davis, Defence Science and Technology Group, presented a paper on "In-situ monitoring of fibre reinforced composites using embedded fibre optic sensors", the example for which is incorporating optical sensing fibres into FRP real world structures that often contain geometric complexities. Experimental data was presented comparing the response of the different classes of sensor during resin transfer moulding of hydrofoils and their subsequent curing and demoulding processes.

Another session of interest came from Dr Andrew Phillips from the Defence Science & Technology Group who has analysed the effect on low velocity impact of thick maritime composites - which are designed to withstand high fluid forces - considering laminate thickness, hybridisation with different fibres and fabric architectures, and the influence of internal ply drops

Travelling from Thailand, Chanasit Phongsitthisak of King Mongkut's University of Technology presented his research on harvesting unused energy from a smart Belleville spring composed of composite and piezoelectric materials.

Carbon fibre featured in a number of presentations, namely one on the "Wettability of carbon fibres at tow scale by Jian Wang and another on "Surface energy components of single carbon fibre" by Si Qiu, both from the Harbin Institute of Technology (China).

The annual student prize, which is sponsored by the Advanced Composites Structures Society (ACSS) was graciously accepted by Ms Shammi Sultana Nisha of Swinburne University of Technology for her paper on "Preparation and characterization of a thermos-mechanically stable composite from a fast curing epoxy resin and lignin using a protic ionic liquid as a new medium".

The conference had been a "celebration of knowledge" for manufacturers, suppliers, researchers and educators according to Composites Australia President, Leona Reif. "What brings us together is a faith in making things," she said. The Advancing Composites Innovation Conference (ACI), is Australia's biggest networking and knowledge sharing event for the Australasian composites industry. The level of support for the 2018 conference exceeded expectations and reaffirmed the very strong future for the composites sector in Australia.

We thank those who supported the conference including, allnex, Colan Australia, Pacific Resins, IMCD, Henkel, Gurit, Australian Composite Solutions, SAMPE and the Advanced Composites Structures Society (ACSS), an Engineers Australia technical group that again provided the $500 Best Paper Prize for the presenting author of the outstanding Peer Reviewed paper.

Above. Vacuum Infusion Process Demonstration by allnex Composites and the Tricomposites Team.

Left. Steve Brennen B.I Fibreglass demonstrating his bowling prowess

The Power Of Two

With the announcements made of the winning tenders for the Future Submarine Program (SEA1000) to Naval and the Future Frigate Project (SEA5000) to BAE, Australia will now ready itself for the commencement of the largest recapitalistion of naval capacity in this country's history. The 2016 Defence White Paper, the long-term plan to ensure Australia's national security, has triggered an increase in defence funding which will grow to two per cent of Australia's Gross Domestic Product (GDP) by 2020-21. The Government's vision is to build and develop a robust, resilient and internationally competitive sovereign defence industry that is capable of meeting immediate demands and able to sustain them well into the future.

For the past few years, as the SEA programs have come into sharper focus, the Government has been urging local manufacturers and suppliers to underpin their capabilities and sustainment capacity by seeking out strategic partnerships domestically and internationally.

Wanting to be fully prepared to capitalise on the escalation, RPC Technologies, a long-time supplier to the Defence sector, and Australia's leading maritime Composite manufacturer, sought out a strategic partner with the required criteria; an existing relationship with the SEA5000 bid proponents, parallel experience in complex composite manufacturing and a similar culture. The best match came in the form of UK's Tods Defence who, in the late 1980's, were the original manufacturer of the Acoustic Sonar Windows for the Collins Class submarines. In the early 1990's, with the Australian government wanting to increase Australian Industry Content, Transfield RPC, the forerunner to RPC Technologies, took over manufacturing the domes at their Newcastle facility. "We had never manufactured anything like the Windows before, so it was a significant technical challenge. But that has always been our strength – we have always had a culture of innovation, and no job was too big or too small. This attitude has been the driving force of the company vision," says Tony Caristo who engineered the management buyout with Transfield in 2002 and remains managing director of RPC today.

Fast forward to the present, Tods Defence Managing Director Pete Eckersall said the support provided by BAE Systems' Global Access Program enabled them to bring two great companies together. The partnership will leverage the strengths, capabilities and deep experience of the two respected industry leaders.

"Not only will this relationship allow us to transfer technology enabling the local manufacture and

Collins Class Submarine

"RPC offers Tods Defence the opportunity for a single relationship into Australia, where RPC will use its local supply chain to provide the entire Sonar Dome solution for maritime contracts."
– Pete Eckers, Tods Defence Managing Director.

ongoing support of our Sonar Dome technology for the SEA5000 project, but it also allows our companies to collaborate on other opportunities on a larger scale," he said.

"RPC offers Tods Defence the opportunity for a single relationship into Australia, where RPC will use its local supply chain to provide the entire Sonar Dome solution for maritime contracts."

The agreement also opens the path for Tods Defence and RPC to exchange technology and offer Sonar Dome solutions to other maritime programs in Australia.

The companies recently celebrated their partnership by exhibiting together at the Undersea Defence Technology Conference in Glasgow. James Zegir, Business Development Manager, Defence, for RPC said several other SEA5000 opportunities emerged at the conference with further talks to take place.

"In many major sectors in recent times, manufacturing in Australia has been marginalised due to competition from overseas. It is exciting that these contracts have changed the paradigm. Organisations are now looking to capitalise on our experience and track record in the Australian and South East Asian market and talking to us about collaboration and the sharing of technology and innovation," said James.

For Defence, RPC works in both Advanced Composites and specialty metal fabrication. Along with Acoustic Sonar Domes and Windows, flag bins, composite yardarms and handrails for the Maritime sector, RPC also has a strong track record in Land Forces and is currently delivering the contracts for Land 155 – Single support Contract for bridging, Land 121 Phase 3B –design and manufacture for the Bridge-to-Boat Interface (BBI) and Land 121 Phase 4 to manufacture and support the Hawkei Dashboards. RPC also supplies ballistic protection spall curtains and liners for the Bushmaster vehicle and the M113 and M113A armoured personnel carrier.

"Advanced Composites are perfect for Defence purposes. They are strong, lightweight, have superior corrosive resistance and exceptional asset life. They can be moulded into almost any shape and can be adapted to a vast range of purposes. RPC is constantly looking to provide the best engineering solutions for our customers but we are also keen to advance our global footprint by sharing innovation and collaboration with other organisations," said Tony Caristo.

L to R. Pierre Gouhier – Engineering Manager, RPC, Tony Caristo – Managing Director, RPC, Pete Eckersall – Managing Director & Vice President, TODS, Steve Burton – Business Development Director, TODS at UDT.

Whilst shared knowledge, value creation and transparency can be counter-intuitive for competitive companies, successful global partnerships are formed from an alignment of commercial interests and mutual goals. They provide added capability to grow a company's technology portfolio and to develop export opportunities. There are shared benefits as well as pain, but for those courageous enough to invest and trust in long term global partnerships, the opportunities for supplying defence contracts is more promising than ever.

Composite Engineer's Viewpoint
By Rik Heslehurst PhD, MEng, BEng (Aero) FIEAust, FRAeS, CPEng

Part 12– Quality Control & Assurance Measures

In this article we review from a manufacturing perspective, the Quality Control and Assurance Measures that will help produce high quality sandwich panels.

The term "quality control" can be separated into two distinct and independent elements, both of which play an important role in the total product quality, as follows:

1: The **material and process quality control** element of sandwich structure manufacturing deals principally with the actual materials used in the fabrication of the sandwich panel, in addition to the process by which sandwich structure fabrication takes place; and

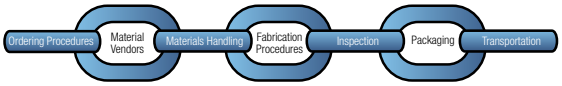
2: **Product quality assurance testing** is the physical testing of a completed product/component to demonstrate that it meets an acceptable set of standards.

The initial materials and process control phase is to ensure that constituent materials are of the highest quality and that the manufacturing facility is set up as an appropriate working environment with adequate quality control procedures and guidelines, including but not limited to:

- **a.** Material quality checks from suppliers;
- **b.** Materials handling procedures and storage facilities for materials with a shelf life;
- **c.** Clean room for composite and bonded structure fabrication;
- **d.** A grinding area with suitable dust extraction equipment;
- **e.** Humidity and temperature controls in the clean room, including positive pressure for dust control;
- **f.** Controlled access to the clean room;
- **g.** Consumables, environmental controls and fabrication procedure documentation; and
- **h.** Appropriately trained technical staff, with required skill levels and ongoing training programs.

In effect, material quality assurance is pre-fabrication testing of constituent materials. Such testing is used to screen incoming materials to ensure that they conform to the manufacturer's documented standards, and that re-lifing of time expired materials can be checked against that standard. For prepreg composites and adhesives (or any resin material) suggested tests include the composite prepreg tack test and the adhesives flow test.

Process quality assurance: During the actual fabrication of the sandwich structure, it is advised to



undertake co-fabrication quality assurance testing. Simple and inexpensive tests can have a large effect on the structural integrity of the final product. The testing procedure ensures that all fabrication steps are completed and that critical steps are independently inspected prior to continuing to the next process step.

Quality assurance testing: The completed component quality assurance tests are a post-fabrication test procedure. Physical tests for adequate material properties on the completed component include:

- **a.** short beam shear test,
- **b.** tension and compression tests,
- **c.** beam bending tests,
- **d.** lap-shear test, and
- **e.** wedge test.

Additionally, a comparative coupon test can be conducted to provide an indication of compliance.

Post-fabrication non-destructive inspection. The final assurance of structural integrity for sandwich structure components is a process of non-destructive inspection (NDI), which is conducted post-fabrication. NDI is conducted to determine the presence of any non-conformity, particularly debonds and delamination, porosity, voids and foreign objects and can range from very simple visual inspection to an extensive through-the-thickness non-destructive interrogation.

The process of quality control, including the quality of materials and the manufacturing facility through to the fabrication process and quality assurance testing, is an integral part of the entire sandwich structure manufacturing process and ensures the integrity of the finished product. This is important so as to assure current and future customers of the product's integrity.

In the next article we will discuss, "Testing for Performance of Sandwich Structures". What testing is required and what are you testing for will be addressed.

All articles published in Engineer's Viewpoint are available on the Composites Australia website (www.compositesaustralia.com.au/industry). Rik welcomes questions, comments and your point of view by email to rikheslehurst@gmail.com

Composites trade skills shortage looms

In a recent labour supply survey conducted by Composites Australia, one respondent stated they were seeking to employ "anyone with a pulse"! We have interpreted that to mean skills shortage is high on the agenda of Australian composites businesses. The association looks closely at emerging needs of the composites sector to inform the industry about workforce skills to meet operating challenges and to capitalise on the upswings. The challenge is to ensure that the sector has an appropriate labour pool to draw from, integral to successful operation of any business.

Our industry survey confirmed a national skills shortage, with 70% of respondents reporting that they are currently unable to find employees with the right skills set. It was evident that fabricating skills are in short supply with over 50% of respondent actively looking for composites technicians including laminators and gel coaters. Over 25% reported that they were seeking Composite Designers and/or Engineers.

While only 30% of firms that responded to the survey are currently training composite technicians/workers by way of an apprenticeship or traineeship, 73% responded positively to considering training new and existing employees in the near future.

The most relevant manufacturing qualifications for the composites sector are:

1. Certificate III in Engineering - Composites Trade MEM31112
2. Certificate III in Marine Craft Construction MEM30705
3. Certificate III in Polymer Processing (Composites) PMB30116

Bucking the national trend that has seen a continuing decline in apprenticeships and traineeships across Australia, enrolments for the above qualifications are increasing.

Ben Switzer, Project Manager for Hart Marine reported that the company is "sitting on 26 apprentices, half a dozen of which were taken on this year." The practical training is delivered on site by GO TAFE.

Enrolments for Composites Technician Apprentices at the Queensland based Composites Training Centre at the PARTEC Institute have increased by 30%. "There are now over 350 graduates with the composites qualification from PARTEC" says Roger Cater, PARTEC General Manager.

FDP Composites in Brisbane has doubled its apprentice intake, with 25% of their manufacturing team currently enrolled in the Cert III in Polymer Processing (Composites) at PARTEC, utilising both on and off site training to fast track learning.

By all accounts, the recent Sanctuary Cove Boat was the best show since before the Global Financial Crisis with local boat manufacturers reporting healthy order books extending out to 12 months. "We've doubled our efforts in acquiring the right young people to meet demand. We approach high schools and set up a career pathway early and bridge the gap between school life and a career in composites for young people. Our apprentices are supervised by the industry's best operators. We put a chopper gun in their hand in the first week, not a broom;" says Adam Houlahan, Optimisation, Safety & Training Manager for Riviera Australia.

Training in regional areas is particularly onerous. Alan Steber, General Manager of Steber International in Taree on the Mid North Coast of New South Wales has six apprentices that undertake Marine Craft Construction by distance learning from Sydney.

Co funded by the Victorian Government, Gordon TAFE has invested in a "fully equipped composites training centre" that will be operational in October with an intake of around 15 students in the first group. "The centre will primarily service the emerging carbon fibre companies in Geelong including Quickstep Technologies, Sykes, Carbon Revolution and RPC Technologies" says Rory McNamara, Program Manager for Advanced Manufacturing Technologies for the Gordon. The apprenticeship will include "carbon fibre" units (developed separately) and also some units from the qualification 22470VIC Certificate II in Engineering Studies.

Photo supplied by Vaughan Bolwell

The overwhelming attitude of industry to education and training is pragmatic; qualifications will be supported if much of the training can be delivered in the workplace on existing equipment. "Our system is to deliver relevant training" says Brett Ambrozio, Commercial Manager for GO TAFE. "We develop a training plan to the business need which may require theory units to be done off site, and the practical learning onsite."

In an attempt to combat the trades drought, the New South Wales Government announced earlier this year that they would scrap TAFE fees for 100,000 apprentices saving students about $2,000 per course. The Victoria Government also made the decision to provide free TAFE courses in over 50 qualifications. The Queensland government offers rebates on WorkCover premiums and state payroll tax on apprentice wages.

Looking towards future needs, the industry requires a rising number of skilled workers who are able to cover broad areas of employment with the support of flexible training. A responsive educational and training system is crucial to all manufacturing industry sectors, as is ongoing dialogue between industry and training providers.

Australian Synchrotron: Enabling step change in advanced materials

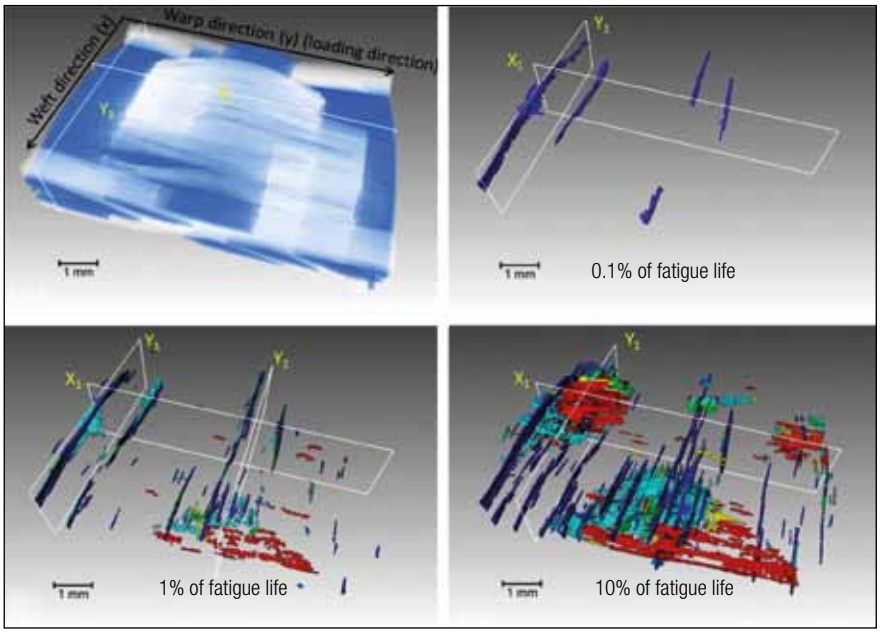
The Australian Synchrotron is one of the most significant investments in scientific infrastructure in our nations' history. Operational now for over a decade the facility has over 6,000 registered research users and has supported thousands of experiments. Research performed at the facility has delivered benefits to our economy and the way we live ranging from world-leading results in: medical and life sciences, including key insights into diseases such as malaria and diabetes; advanced materials and engineering, including lightweight polymers and composites; and earth and environmental sciences including hydrogen storage materials and reduced CO2 emissions in cement manufacture.

There are more than 50 synchrotron light sources in the world carrying out a range of experiments with applications in engineering, biology, materials science, cultural heritage, chemistry, environmental science and many more. The largest is the Large Hadron Collider in Switzerland which is the worlds largest and most powerful particle collider, and the most complex experimental facility ever built and the largest single machine in the world.[1]

The Australian synchrotron is a large machine (about the size of a football field) that accelerates electrons to almost the speed of light. As the electrons are deflected through magnetic fields they create thin beams of X-Rays which are directed toward end-stations next to the accelerator and used to characterize materials. This 'Synchrotron Light' covers wavelengths including microwaves, infra-red, visible light, ultraviolet light and X-Rays. However, it is mainly X-Rays that are used for materials characterization.

While Synchrotron Light is a well-known tool for fundamental and applied research in the physical and biological sciences, it is increasingly being used to provide engineering information to manufacturers and to solve materials and process challenges. Conventional x-rays can only be used to look at hard tissue, such as bones or teeth, while penetrating through flesh for example. Synchrotron x-ray images have much higher resolution that can efficiently detect flaws such as voids, discontinuities and cracks in composite materials and bring unique insight into improving composite structure mechanical properties.

In its simplest form, 3D computed tomography (CT) is a non-destructive scanning technology that allows you to view and inspect the external and internal structures of an object in 3D space. CT works by taking hundreds or thousands of 2D Digital Radiography



Resin crack	B/B debond	B/R debond
Transverse crack	W/R debond	W/B debond

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projects around a 360 degree rotation of an object. Algorithms are then used to reconstruct the 2D projections into a 3D CT volume which allows you to view, and slice the part at any angle. The technology virtually eliminates interpretation errors and opens the door to capabilities often not available with other technologies .

In terms of the 3D tomography tools, the synchrotron light enables inspection of whole components of engineering interest and with sufficient resolution to see microstructural interactions. The extreme brightness and control of the X-Rays enables the rapid collection of successive high spatial resolution 3D images to create 3D movies such as tracking crack propagation or damage accumulation under constant or cycling loads using time-lapse 3D imaging.

Using Synchrotron light to map the failure of fibres in carbon fibre reinforced epoxy composites researchers generated information by placing the composite to tensile stress while taking X-Ray images of the area under stress. They unlocked some of the challenges by observing a fibre failure mechanism via this relatively simple experiment. The information can be used to predict the tensile strength and related performance of continuous carbon-fibre composite materials .

Fatigue damage: Time-lapse interrupted fatigue tests were performed at around 40% of the materials' tensile strength on 3D woven glass fibre angle interlocked samples. The matrix crack evolution was made visible using a contrast agent. Four regimes through the fatigue life were identified dominated by transverse cracking, de-bonding and fibre failure. Using this tool, one can visualize the progression of defects with fatigue. The picture shows binder/binder (B/B), weft/resin (W/R), binder/resin (B/R) and weft/binder (W/B) debonding. This information can be used to modify the design in terms of fibre amount/ architecture, mould pressure, binder/ resin ratio etc.

Porosity with manufacture time/temp: The application of X-Ray computed tomography to composite design and manufacture: using time lapse imaging during the pre-preg consolidation process, porosity was eliminated as shown in the image. This information can be used to adjust the materials inputs as well as the time to manufacture the item.

Porosity with manufacture pressure: Similarly, tomography was used to examine samples from sheet moulding compound – glass fibre bundles in thermoset matrix before and after compression moulding. The porosity was found to be significantly reduced after compression moulding and it decreased with mould closing pressure. The CT reconstructed images of the non-deformed and compressed sample is shown. The effect of compression is clear in terms of the reduction of observed voids (a→b); and the more ordered form of the glass fibre (c→d).This information was used to change the pressure regime of the process, optimising cost, time and materials use.

[1] https://xrayinspectionservice.com/markets/aerospace

[2] *Mapping fibre failure in situ in carbon fibre reinforced polymers by fast synchrotron X-ray computed tomography*. SC Garcea.

Located in the Melbourne suburb of Clayton, the Australian Synchrotron is landmark infrastructure, managed by ANSTO. This extraordinary facility is the only one of its kind in the Southern Hemisphere, and is available to anyone who wishes to use it. It is home to Australia's own team of synchrotron scientists, who along with the Synchrotron Industry Engagement Team are available to advise and assist clients with scoping and costing synchrotron tests to enable cost effective outcomes. The team can also assist with accommodation and travel during the testing and ensure access to the facility within around six weeks of initial contact.
By all accounts, the Australian Synchrotron is viable cost-effective enabling technology for composite solutions.

ATL's sandwich composite technology still delivering

The name Barcoo Drift conjures the sense of a fresh breeze to refresh the mind, breathtaking landscapes and the quiet, laid back way of fishing on the Barcoo River in the North Qld interior. But the Barcoo Drift, launched in April, is a Roger Hill custom designed 14 metre sports fishing catamaran built by Julian Griffiths and his team in Noosa Marine. Notably, it is a perfect example of Australian sandwich composite technology

Typical applications for foam-cored structural panels include marine hulls, decks, superstructures and bulkheads; road and rail floors, walls, roof and body panels, front end and side skirts; automotive floors and truck bodies; and long span roofing and partitions.

The Barcoo Drift is constructed with a combination of ATL's proprietary DuFLEX® Composite Panels cored with DIAB's Divinycell H80 and HM100 structural foam cores. Some panels were laminated with unidirectional laminates so they could be strip-planked to conform to the more compound sections of the outer topsides and wing-deck areas.

ATL Composites engineered the HM100 into the hull bottoms and lower topsides to provide extra strength to absorb high dynamic impacts and slamming loads while ensuring a light, yet strong structure.

Designed to keep weight to a minimum and to provide a very comfortable stylish vessel for cruising the North Queensland coastline, all other structural sections including bulkheads, hull soles, cabin sides, side decks, etc, were supplied in CNC-routed Component Packs cored with Divinycell H80 in a variety of thicknesses and E-fibreglass reinforcements to meet design and engineering requirements. Divinycell H has been used worldwide and has a proven track record in marine sandwich composite construction.

The interior fit-out on Barcoo Drift was also supplied by ATL as a CNC-routed Component Pack in FEATHERLIGHT® FF1015X6 Marine Grade panels. Cored with 15mm Divinycell H60, a low density unique combination of polyuren and PVC core, the Featherlight panels will provide valuable thermal/acoustic insulation and will provide superior stiffness and ultra-light weight to increase overall performance.

The Barcoo Drift hull in construction at Noosa Marine, demonstrating the foam-cored structural panels.

Noosa Marine used Techniglue R60 adhesive in conjunction with the proprietary DuFLEX® Z-Press for the panel joining. Packed in self-mixing cartridge packs, the R60 makes mixing and application quick and mess free. A thin bead of epoxy can be applied quickly to the scarf joins on the panels and using the heated Z-Press allows the joint to be cured in approximately 12 minutes, as opposed to manual joining which requires an overnight cure time.

DuFLEX® and Featherlight® Component packs ensure weight consistency and build time is highly efficient. To complement the system, ATL's 900 FRP Bonding Angles provide a quick and effective means for making right angle joints between the panels. These pre-cured angles reduce wet-lay-up in tight corners and overhead applications and also assist to speed up assembly.

Built in just 12 months, using Australian technology Barcoo Drift is a strong, low maintenance, practical and comfortable vessel that promises to satisfy all future cruising and fishing adventures

The Barcoo Drift, launched in April, is a Roger Hill custom designed 14 metre sports fishing catamaran built by Julian Griffiths and his team in Noosa Marine featuring ATL's sandwich composite technology.

Collaboration – fireproofing underground tunnels

Fire is one of the key safety challenges in communities, workplaces and public space. Fires in transport networks, particularly tunnels can have catastrophic consequences. Needless to say, the prevention of fire is probably the single most important safety measure for tunnels, and the best way to prevent fires is to control the type of combustible material permitted into a tunnel in the first place.

Rail Projects Victoria (RPV, formerly Melbourne Metro Rail Authority) is currently constructing additional tunnels to expand the network, and already has several underground stations being reconditioned. Melbourne's Parliament underground railway station is one of the busiest stations on the metropolitan network, with around 50,000 weekday commuter entries. Ease and speed of access to critical cabling and other infrastructure housed beneath station platforms through access (manhole) covers is essential for the huge and complex task of safely maintaining the station with minimal disruption to passengers.

Cast iron and concrete are heavy and cumbersome, with the latter prone to cracking and causing a trip hazard under certain conditions, particularly under the weight of maintenance machinery. RPV chose to replace the concrete covers which were installed in 1983 with a strong, lightweight lid, which is non-skid, lockable, and resistant to corrosion and fire. Due to safety requirements, the fire tests for materials used in tunnels are particularly stringent.

Composite members Terra Firma Industries, Regina Glass Fibre and allnex Composites collaborated on the development of a unique composites solution using fire retardant resin and the tissue product FireShield®. The resulting "Class C" access cover weighs 23kilos and can withstand the weight and vibration of equipment such as scissor lifts. Importantly, the tests results were in excess of the minimum required standard with the smoke intumescence levels significantly better than required.

Melbourne's Parliament underground railway station is one of the busiest stations on the metropolitan network, with around 50,000 weekday commuter entries.

The network operator Metro Trains Melbourne (MTM) determined the lids should be tested in accordance with the flooring material fire requirements of the NCC (National Construction Code), the testing regime for which is AS ISO 9239-1 which measures the performance of the "total flooring system" in the horizontal plane. The sample was heated along its length (~1m) using an inclined radiant panel and received about 11kW/m of heat energy at one end and about 1kW/m at the other end and ignited at the hot end. The sample is allowed to burn until the flame goes out (extinction).

The heat energy measured at the point of extinction is the Critical Heat Flux (CHF), also called the Critical Radiant Flux (CRF), which is the lowest amount of energy a fire requires to keep burning - hence the higher the CHF value the better the result. Smoke is also measured over the duration of the test. The total amount of light extinction (measured as a percentage) due to the smoke obscuring a light beam in the flue is multiplied by the duration of the test to give the result (in percent minutes).

Regina Glass Fibre Pty Ltd produces FireShield® under licence from Advanced Composite Structures Australia. This unique tissue product, originally developed to meet aerospace industry fire standards, provides composite structures with the capability to withstand fire attack by simply integrating the FireShield product on the composite surface. Mark Pontil, Regina's General Manager: "The ten years of R&D behind our product gave us confidence that FireShield® could meet the stringent flame and smoke toxicity requirements within the highly regulated rail environment. We are looking forward to extending the product's use throughout the Metro network in the future."

Inspiring site tour of Tanks West WA

Distance and remoteness are the unforgiving geographical realities of Western Australia's rural and industrial sectors. Liquid storage tanks have long held stewardship of containing life preserving water in addition to the most corrosive materials while protecting sensitive resources in harsh environments throughout the vast countryside.

Composite practitioners and suppliers recently gathered at the Perth company Tanks West, to witness a remarkable production facility that featured two tank making production methods and exceptional equipment in action. Steve Thompson, General Manager and Alan (Alby) Green, Production Manager, along with team members, proudly shared some insights into the company's journey since 1992.

Steve outlined how they developed bespoke chemical compatible FRP storage solutions considering area specific hazards including temperature, UV exposure and cyclonic events and long term transportation. Its moulded fibreglass storage and cartage tanks are designed to meet the Australian Standard AS4020 for potable (drinking) water and a range of corrosive liquids used in the agricultural, mining and industrial sectors.

Steve also outlined how a major fire destroyed one of the production buildings on the Canning Vale site in 2014. "While devastating, the setback forced us to refocus on productivity and energy efficiency which resulted major capital investments in equipment and systems including resin technology controls" said Steve. Thinking outside the box also involved providing solutions for their customers including designing out unproductive downtime during the busy cropping and spraying season. The 4.8 diameter mechanised construction technique – dubbed "Stargate" and pictured below – now produces a massive FRP tank. The Super 60 is a heavy duty tank with a superior chemical resistance together with impact resistance and tensile strength. It can handle liquids as heavy as 1.5kg/litre, providing a generous safety margin when storing liquid fertiliser which weighs 1.33kg/litre.This super large volume capacity tank of 60,000 litres has immense benefits for storing on farm Liquid Fertiliser.

Delegates are standing in front of "Stargate" technology used for 60,000litre tanks.

Events Schedule 2018 – 2019

2018

August

July 29–August 1
Cairns, QLD

11th Asian-Australian Conference on Composite Materials
The Asian-Australasian Association for Composite Materials Committee invites composite practitioners to its three-day conference that features a comprehensive program of composite presentations on research currently being conducted across Asia.

Thursday 30
Tomago, NSW

Compass Pools site visit and tour
By travelling to Tomago in the Hunter Region of New South Wales, you will hear the story behind one of the most innovative and successful pool manufacturers in Australia and enjoy a guided tour of the manufacturing facility.

October

Wednesday 10
VIC

Knowledge forum on Intellectual Property and its role in protecting the value of companies.

Monday 8
Hawthorn, VIC

Graphene+ 2018 conference, the Australian Graphene Industry Association.

December

Wednesday 5
Brisbane, QLD

Fibre-reinforced polymer (FRP) bars technology clinic and end of year networking function. Technology workshop on latest developments in FRP reinforced concrete structures followed by end of year networking function.

2019

April

Tuesday 2–Thursday 4
Sydney, NSW

Composites Australia annual conference – Advancing Composites Innovation
Featuring composites practitioners presenting on the latest developments in composite material technologies, processes and systems.

August

Sunday 11–Friday 16
Melbourne, VIC

22nd International Conference on Composite Materials 2019
The International Conference on Composite Materials (ICCM) is an international scientific conference devoted to all aspects of composite materials.

For full details and to register go to. www.compositesaustralia.com.au/events

Disclaimer: This schedule was current at time of going to print but is subject to change. Composites Australia is not liable for any loss or expenses incurred due to changes in the program.

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