Connection

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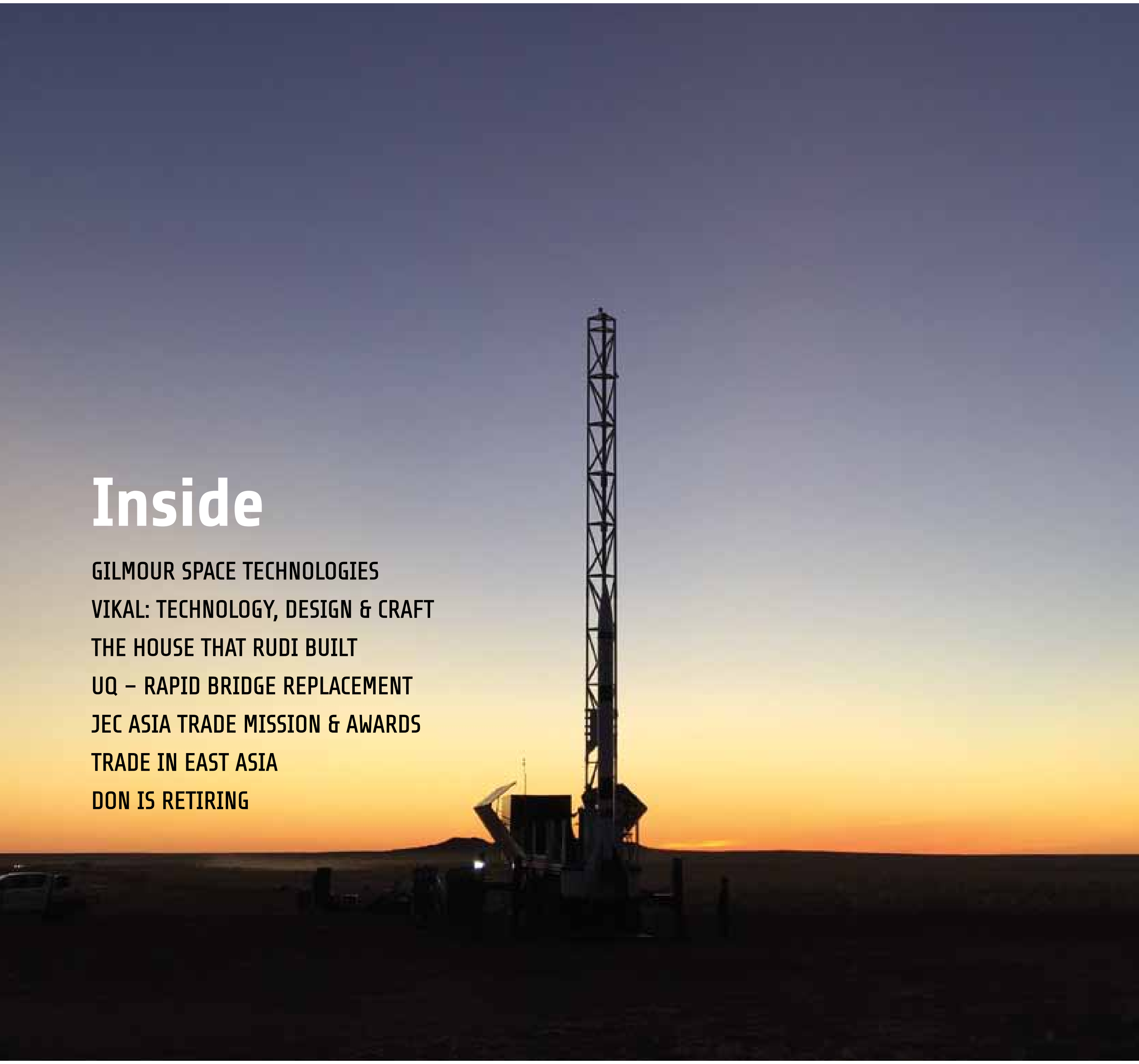
The official magazine of Composites Australia



Inside

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Contents

Issue 51 · December 2019

Front Cover
Far inland, North West of Brisbane, Gilmour Space Technologies attempted to launch its 'One Vision' suborbital rocket to flight test the company's proprietary orbital-class hybrid rocket engine and demonstrate its mobile launch capability.

Feature article

For over 30 years, Vikal International has custom designed, manufactured and supplied tenders to some of the largest and most prestigious Super Yachts in the world from a quiet industrial estate just 20 minutes south of Perth. Lynden Vikingur is convinced that good craftsmanship makes "tech beautiful".

7

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President's letter

From opportunities in East Asia, space technology just north of the Gold Coast, and superyacht tenders south of Perth, this edition features articles on inspirational companies, researchers and international projects.

The venture-funded Australian rocket company Gilmour Space Technologies is developing new capabilities for launching small satellites into space. This heartening story is of a company founded in 2013 by two brothers and demonstrates that space travel is now being driven by private investment and technology interests, with composite technologies making access to space more affordable and more doable.

For over 30 years, from a quiet industrial estate just 20 minutes south of Perth, Vikal International has custom-designed, manufactured and supplied tenders to some of the largest and most prestigious superyachts in the world. This is a great story about a family business, and a value of trade training.

Many of us who know Rudi Steinbusch of Lavender Composites here in Brisbane will also be interested in our story on the house he and his wife built from composite materials and technologies. I had the opportunity to visit Rudi at home, and it truly is spectacular with many fascinating features such as the integrated rainwater management and the carbon fibre automated louver system to protect the home from the western sun.

Page 12 also features an article on rapid bridge replacement/repair technology by the team at the University of Queensland (UQ), School of Civil Engineering.

We're now half way through a South East Asia market entry project, which is part funded by the Australian Trade Commission Free Trade Agreement Market Entry Grant Program. Our participation in JEC Asia during mid-November is a key feature of the program and is featured on page 14. From global carbon fibre giants to step-change start-ups, the exhibition had it all.

I joined the mission and was rewarded with a week of informative site visits, gathering knowledge on cutting edge products and fabrication technology, and productive networking opportunities. Our pavilion was a hub of conversations mixed in with a good dose of Aussie fun and drew quite a crowd. The highlight of the event was sharing the celebrations with AMAC UNSW's JEC Innovation award win.

As a manufacturer, I was also thrilled with the opportunity to visit WAIWIS an hour's drive from Seoul. WAIWIS manufactures carbon fibre bikes, the frame of some weighing less than 1 kg. WAIWIS parent company, WIN&WIN, has been developing technology in prepreg heat pressed carbon fibre composites, particularly for high-end bows for archers since the early 90's. WIN&WIN products have enabled archers to achieve gold at multiple Olympics, and top rankings for BMX, road and track riders. A feature wall within the facility displays its 80 patents for Korea as well as global markets, averaging nearly three patents per annum.

The annual Composites Australia conference will be held in Toowoomba from 27th to 29th April 2020. I urge you to join us for the event that will be filled with stimulating presentations from composites practitioners and thought-leaders. Denis Wagner, Non-Executive Chairman and Co-Founder of Wagners will be our keynote speaker. The program will feature more industry speakers and a tour or two. With a focus on cracking composite applications, I have always benefitted from attending. For 2020, I promise a hearty Darling Downs conference dinner.

Best wishes for the holiday season, and I hope you all find time for a well-earned rest when you can settle down and enjoy the magazine, before the New Year is upon us.

Leona Reif
President

Gilmour Space

Just north of the Gold Coast is Gilmour Space Technologies, a venture-funded Australian rocket company developing new capabilities for launching small satellites into space. Founded by two brothers in 2013, this startup is now one of Australia's leading space companies pioneering new and innovative hybrid propulsion technologies with the goal of providing lower cost access to space.

Photo by Gilmour Space Technologies©

The growing Gilmour team of around 45 working in its Gold Coast office are young. They are highly educated, well informed pioneers who are acting on ideas and driving innovation, utilising technology and pushing boundaries they may not even know exist. They are part of the "New Space Economy."

Founding brothers, Adam and James Gilmour invested their own money before attracting venture capital to scale up and sustain the company. Having worked in banking and corporate sales for 20 years, much of it in the midst of Singapore's international financial centre, Adam is more than familiar with analysing business opportunities and the dynamics of successful start-ups. Adam says: "The business case for space no longer has to be made. It is real and our objective is to capitalise on the opportunity."

Space-based technology provides vital services such as communications and defence systems and supports almost every sector of the economy and day-to-day lives. Gilmour Space Technologies was formed off the back of Adam's research forecasting that over 17,000 small satellites (smallsats) would need to be launched into space over the next five years to support our growing reliance on big data and the digital economy. Adam calculates the replacement market for smallsats will be over 2,500 per annum, and a good basis for a sustainable business.

The Federal government recently commissioned and released the Advancing Space - Australian Civil Space Strategy (2019-2028) which forecast the space industry would grow to over $US1.1 trillion by 2040 from of value of US$350 billion today. The Government's goal is to triple the sector's

Founding brothers Adam and James Gilmour.

contribution to GDP to $12 billion and to create an additional 20,000 jobs by 2030.

The government also recognises that the New Space Economy is being driven by private investment in start-ups and private technology interests. To that end, it also aims to stimulate at least a $1 billion pipeline of inbound capitalinvestment in Australia's civil space industry sector between 2019 and 2028. The FederalGovernment's role is to "set a relevant legal and regulatory framework that meets international obligations and facilitates growth in industry while maintaining safe and secure operation in space and on Earth."

Most states in Australia, including Queensland, are now competing to attract the New Space Economy. All have worthy policies to attract investment and boast geographic advantages.

For Gilmour Space, a strategic launch location and associated facilities are vital. Adam says "We're keen to stay in Queensland, which offers the best of both worlds with polar and equatorial orbital launch options. But then again NT could also be good for equatorial launches and South Australia is good for polar launch."

On Monday July 29, far inland north-west of Brisbane, Gilmore Space Technologies attempted to launch its 'One Vision' suborbital rocket to flight test the company's proprietary orbital-class hybrid rocket engine and demonstrate its mobile launch capability.

The 9 metre-long vehicle had a 80 kN of thrust engine and weighed in at close to 2 tonnes. At peak velocity, it was designed to travel at three-and-a-half times the speed of sound and reach an altitude of around 40 km – close to the 'edge' of space. Seconds before launch, however, the test rocket suffered a setback in the oxidiser tank pressurisation system. There was no explosion due to the safer nature of hybrid rocket engines, and no observable damage to the engine or mobile launcher.

Assessing the situation, Adam said: "Rocket engineering is all about testing, failing, learning and rebuilding. One Vision was a development and test rocket, and our lessons from here have already informed many of the design features in our next vehicle."

Advanced materials and processes – including GFRP and CFRP – have been fundamental in enabling space travel and have made access to space more affordable and also more doable. Weight and cost-savings are critical for the space industry. Materials that can withstand the harsh conditions of space along with lightening the load for the long journey are essential. According to Adam Gilmour, "Light weighting is vital. Every kilo saved from the upper stage (third stage of the vehicle) represents a $50,000 saving - so carbon fibre is the material of choice at this point."

All of this bodes well for the Australian composites sector. Local manufacturing/fabrication production and materials are readily available, so too R&D, testing and engineering services. "Our original plan was to build our rockets here in our Gold Coast facility, but if there is equipment and knowhow out there we are open to production partnerships," said Adam.

One such partnership is with the University of Southern Queensland. Under the recently developed strategic agreement, the two entities will collaborate on testing new rocket technologies, such as the hybrid propulsion system that Gilmour is developing.

Written by Kerryn Caulfield, Executive Manager of Composites Australia Inc.

Vikal.
A deep heritage of technology, design and craft

Superyachts exceed 24 metres in length. The longest superyacht in the world, the REV Ocean, is a whopping 183 metres long. Launched only recently, it is testament to her owner's wealth. An accessory that many superyachts require is a custom-made tender boat, often more than one. While their prime role is that of a multifunctional workhorse to service the mothership, today's superyacht tenders are expected to transport passengers, pets, equipment and food supplies at high speed, in full comfort and high luxury.

This 12m Cargo Catamaran tender serves as a people mover, dive platform, refueler and cargo supply ferry. In the background is the M/Y A+ (formerly known as Topaz), at 147 metres it is said to be the world's fifth largest private yacht.

For over 30 years, Vikal International has custom-designed, manufactured and supplied tenders to some of the largest and most prestigious superyachts in the world, based out of a quiet industrial estate just 20 minutes south of Perth.

Vikal's global customer base includes the wealthiest families on the planet, and it delivers tenders to superyacht yards such as Lürssen (Germany), Blohm & Voss (Germany), Nobiskrug (Germany), Oceanco (Netherlands), Amels (Netherlands), DeVries (Netherlands) and Royal van Lent (Netherlands).

The company is run by father and son Gunnar and Lynden Vikingur who come from solid Nordic boatbuilding stock. Gunnar was 15 when his father moved the family from Iceland to WA in 1969. On arrival Gunnar joined his boatbuilder father and went to work at a local yard at a time when fibreglass construction was taking over from traditional planking and plywood techniques. He founded Vikal in 1982 to carry out refit and repair work and build the odd sports fishing boat.

Before joining his father's company in 2013, Lynden Vikingur had forged a career in IT and was based in Singapore as a partner in charge of Oil & Gas Commercial Services with Wesvault.

In a radical career change, Lynden made the decision to undertake an apprenticeship in boatbuilding at the local TAFE. "I'd done a double degree in science and economics and had lived a corporate life in WA and Singapore" he says. "Doing my apprenticeship was both humbling and rewarding. While it taught me how to build boats, it also gave me an acute appreciation of the craftsmanship required to build the things that I was surrounded by, as well as the people who built them."

Lynden says, "In the luxury market, precision engineering, sophisticated design, high tech electronics and advanced materials are all symbiotic with a hand crafted concours-style finish."

Every tender is unique and expresses status, personality and personal style. Some follow an open sports boat layout, others are waterborne limousines (covered or enclosed) or special purpose catamaran tenders. All push the boundaries of what is physically and technically possible in a small boat. They are accessory-rich with touchscreens, sensors, electronics, and custom-built interiors made from advanced materials married to traditional quality finishes, such as leather and wood. They are capable of doing speeds of up to 60 knots in the cruising grounds of the Mediterranean, the South Pacific or the Caribbean.

The 9m Hasna Limousine is one of the most technically and aesthetically advanced Tenders on the market.

"Given we're a hemisphere away from most of our clients, service, quality, innovation and luxury are non-negotiable," mused Lynden. "To ensure control of our product and schedule, we've gradually moved most of the trades in-house, including composites, fit out, carpentry, upholstery, engineering and even rapid prototyping via 3D printing and CNC."

Vikal's in-house 4x4m 5-Axis gantry-based CNC machine is said to be one of the largest in Australia. It was an investment that would guarantee hand-crafted luxury, using traditional shipwright techniques, combined with the precision of modern mould-making mechatronics.

Lynden said: "All our marine manufacture is custom, we craft truly one-off products, so we had to build in efficiencies to shape precision GRP moulds, for any component coming our way. A few years back we expanded the service to accept contract pattern mould making, Australia wide, which has rapidly grown as a result of its flexibility and exactness."

All Vikal hulls, decks and GRP components are vacuum infused using epoxy or Vinyl-ester resin systems. We build composite vessels in fiberglass, carbon and occasionally kevlar. Nearly all areas of a build are catered to in-house, from luxurious upholstery to show-finish paint jobs.

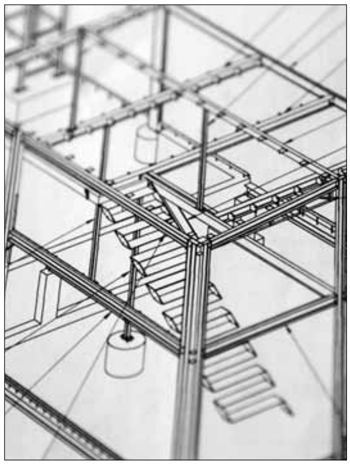
In the world of luxury and high performance, "tech" actually aligns itself far more closely with traditional concepts of shipbuilding craft and skill than we are led to believe. Lynden is convinced that good craftsmanship "makes tech beautiful", and that "Tech-supported manufacture is just another tool in the master tradesman's toolkit".

Written by Kerryn Caulfield, Executive Manager of Composites Australia Inc.

The house that Rudi built

By Kerryn Caulfield and Simon Heading, Technical Sales Consultant for Lavender CE Pty Ltd

We all have a vision of our own dream home. It was not surprising that as a qualified aeronautical engineer, Rudi's dream was a precision engineered home made from lightweight advanced materials that offered superior aesthetic, acoustic and insulating properties.



Rudi Steinbusch during the journey to building his dream home.

Rudi Steinbusch is the owner of Lavender Composites; the Brisbane based firm suppling high-quality composite materials to advanced manufacturers and fabricators. His company has an enviable range of high quality products, composite processing and repair equipment and cutting tools to draw from. The separate engineering division that specialises in the analysis of composite structures and a complete composite tooling design service also came in handy.

Rudi's journey to build his dream home commenced a number of years ago. The house was designed and built around an older partly-preserved house on the rise of a hill. The new house had to be integrated into what was left of the existing structure and designed to take full advantage of the view over the city of Brisbane.

The challenges the block presented were dwarfed by those Rudi encountered from architectural and building services as well as the council and certifiers, all of which had little knowledge of advanced materials and associated processes. He ultimately engaged himself to draw up the plans as one would an aerospace project.

The job dictated bespoke solutions. The walls were made from large-scale, prefabricated lightweight FRP structural panels, made from multiple-density foams forming thermal and acoustic barriers and produced in a one-shot epoxy vacuum infusion process. An exterior-grade epoxy was carefully sprayed onto the table prior to the lay-up of materials which eliminated the need for on-site painting and avoided delays due to bad weather. Metyx E-glass reinforcement and Fire Shield™ veil were laid either side of 50-100mm PET foam and extruded polystyrene foam. These blocks, some pre-cut and others profiled in-house with a hot wire and jig, were combined with pre-sealed EPP strips. Specially made threaded stainless lifting points were countersunk and inserted at vital load-carrying areas. These were rigorously tested at higher loads with an over-exaggerated safety factor due to the high winds and tight working space experienced on-site.

The panels were then finished off with a layer of release film and all vacuumed in position ready for the infusion. The epoxy resin chosen for this infusion was Sicomin SR8100 due to the mechanical properties and flow rate required, as the laminate in some places was up to 150mm thick. Even small gaps in the joining of the foam created vertical 'hot spots' as the resin peaked at exotherm, so it was critical to keep the foam's accuracy throughout each panel. The resin performed extremely well and was cured sufficiently to provide a suitably stiff panel for release and transport off the mould table.

The panels were transported in 'sections' grouped together so that they could be swung into position via a crane, or hand-lifted into position.

Each section was bonded to the steel skeleton with AEC Polymer's Black Mamba, a modified polymer which offered excellent adhesion with enough elongation to handle any thermal expansion. Mechanical fixings were screwed into place to hold

the panel in position while the adhesive cured. Once the walls on both the ground and upper levels were in place, the 'regular' trades could start their rough-in work, as they do with traditional builds. This was a key feature of this build, as it did not overwhelm the tradies who were unfamiliar with composite panels. The windows and doors slotted straight in with minimal adjustment, as they had been checked for square and tolerance when the panels were laid-up. Wiring and plumbing was easily accessible as the internal surface was still exposed right up to the last moment when regular plasterboard was put in place.

Rudi's love and respect for advanced materials can be seen throughout the house in spectacular one-off composite features. The internal stairs are made from wafer-thin prepreg carbon fibre. An overhanging window box is made from carbon fibre and bonded in place with AEC Polymer's SAF methacrylate adhesive. The kitchen benchtop is a precision CNC-machined slab of titanium, featuring a subtle radius and hand-shaped bevel which he had sand-blasted to a luminous satin surface. Summer heat is managed by vertical sun-shade blades made from prepreg spread carbon fibre tow.

One of the main features is the technically intricate and beautiful carbon columns that hold up one corner of the house.

Rudi acknowledges that the journey to build his dream home was a personal one and an outlet for his passion for advanced materials and precision engineering. Rudi says: "We know that composites offer less maintenance and repairs which in turn reduces life cycle costs. Lighter materials are less costly to transport and enable rapid installation. But for my wife and me, composites gave us greater design freedom, enabling the creation of beautifully complex shapes and finishes. In my view, this is the future of residential and multi-storey buildings."

AMAC UNSW wins JEC Innovation Award

Shape Adaptive Marine Propeller with Fibre-Optic Sensing

Frédéric Reux, Media Director & Editor-in-Chief JEC Group; Thomas Lepretre, Sales Director JEC Group; Kerryn Caulfield, CEO Composites Australia; Professor Gangadhara Prusty, Director at AMAC; Eric Pierrejean, CEO JEC Group; Sung-o Cho, Senior Business Development Manager Austrade; Leona Reif, President Composites Australia.

At the recent JEC Asia exhibition that was held in Seoul Korea, the Australian Research Council Training Centre for Automated Manufacture of Advanced Composites (AMAC) was awarded the prestigious JEC Innovation Award in the maritime category for their research, testing and prototyping of a "Shape Adaptive Marine Propeller with Fibre-Optic Sensing".

Increasingly, polymeric composite materials are disrupting the use of traditional alloys for lightweight marine structures. In this novel application, the propeller blade shape is automatically adjusted by fluidic forces, resulting in decreased vibration and optimised cavitation which reduces noise.

The shape adaptive marine propeller, a research program between the University of New South Wales (UNSW) and the Australian Defence Science and Technology Group (DST), involved the manufacture of a prototype of the composite propeller using AMAC's Automated Fibre Placement (AFP) technology. The structure also includes embedded fibre-optic sensors to verify manufacturing performance and service. The precise control offered by AFP in laying the carbon/epoxy prepreg tows at specific fibre orientations accurately allowed for the introduction of tailored stiffness distribution into the passive shape-adaptive structure.

Professor Gangadhara Prusty, Director of AMAC, who leads the research program, along with Drs. Nigel St John and Andrew Phillips of DST says this is a significant breakthrough in demonstrating sensor-embedded automated manufacture of adaptive structures using advanced composites.

Kerryn Caulfield, CEO of Composites Australia Inc., says "this shape adaptive advanced composite technology for marine vessels is an important step change for our nation girt by sea".

The program is progressing legacy research by the Cooperative Research Centre for Advanced Composite Structures (CRC-ACS – now ACS Australia), that validated the novel optimised methodology for the design of passive shape adaptive structures.

AMAC was established under the Industrial Transformation Research Program (ITRP) of the Australian Government and started its operations in 2017. This UNSW led Centre is a collaboration with the Australian National University (ANU), Technical University of Munich (TUM), national research institutions and several industry partners from start-ups to OEMs, and is an incubator for automated composite manufacturing innovations and innovators.

Professor Gangadhara Prusty says, "We are grateful for the award, particularly the opportunity to participate in JEC Asia and Austrade's support for Australian organisations entering the East Asian market."

Professor Gangadhara Prusty, Director at ARC Training Centre for Automated Manufacture of Advanced Composites (AMAC).

Phil Aitchison, VP R&D at Imagine Intelligent Materials (Imagine IM), was awarded Bronze in the JEC Startup Booster. Imagine IM will be heading to JEC World in 2020 to join the Startup Hub in Paris.

A double-skin tubular arch bridge system

According to the 'National State of the Assets 2018 Roads & Community Infrastructure Report' commissioned by the Australian Local Government Association, the need for investment in infrastructure today exceeds $30 billion and roughly one in five local timber bridges are in poor condition.

Dilum Fernando working on his double-skin tubular arch bridge system at The University of Queensland.

The direct costs of replacing bridges including materials, labour and equipment are apparent. But the cost and safety risks of closing roads, often for months, as well as associated traffic disruptions are just as considerable in urban, regional and remote locations alike. Formwork, a site presence of months or years, and labour-intensive processes all add to the costs for stakeholders.

Rapid bridge replacement using pre-fabricated components is a worthy solution to the disruption and cost of traditional bridge repair. The team at the University of Queensland (UQ), School of Civil Engineering is tackling the challenge with an innovative composite construction technique for building lightweight bridge components. The design team included Brisbane-based company RocketC, global engineering consultancy Arup and the Hong Kong Polytechnic University under the stewardship of Dr Dilum Fernando, Associate Professor, UQ.

The novel double-skin tubular arch (DSTA) bridge system, including double-skin tubular (DST) beams, columns and arches was designed around an inner steel tube, an outer fibre-reinforced polymer (FRP) tube, and a concrete layer between the two tubes. It's this strong compressed layer of concrete that allows the bridge to bear such heavy loads, while the tensile forces are carried through the steel. The tubes can be placed concentrically or eccentrically, depending on the specific needs of stiffness and strength. They also serve as stay-in-place formwork to eliminate the use of temporary formwork.

A single-lane railway overpass bridge prototype was designed and fabricated at the UQ Structures Laboratory. The length and mass of the DSTA bridge were constrained to 12.5m and 23 tonnes respectively, to allow easy transportation to site on a standard heavy vehicle (National Heavy Vehicle Regulator, 2016) and lifting with a mobile crane. The width of the bridge was selected to be equal to the standard railway track gauge used in Australia, which is 1.435m. Advanced numerical modelling approaches, as well as simplified design approaches, were developed to design the systems.

Construction was carried out in five phases:
(a) fabrication of steel and GFRP segments,
(b) assembly of GFRP segments around steel of arch and columns and welding, (c) sealing of GFRP tubes and concrete casting for the arch and columns,
(d) assembly of GFRP segments around steel of beam segments and welding, and
(e) sealing of GFRP tubes and concrete casting for the beams.

The GFRP tubes were filament-wound (with 8 layers of GFRP, having fibre angles of ±82° C to the tube axis) and then cut to size.

For the fabrication of joints, two different processes (namely the wet-layup and pre-preg processes) were used. The quality of the joints formed using pre-preg GFRP was found to be better than that of joints made using wet-layup GFRP. However, both types of joints showed no signs of damage during the loading test. While the pre-preg process gave better quality, it required heating for curing of the pre-preg, and the process was found to be more demanding than the wet-layup process. However, with better design of a heating box, the construction efforts could be greatly reduced. The concrete mix design used was found to be suitable for casting of concrete in DSTA bridge sections, and no air voids were observed.

The hybrid DST members have the benefit of excellent corrosion resistance, ductility and strength/weight ratio. During testing, the joints showed excellent performance against static and dynamic loading. Advanced numerical modelling approaches, as well as simplified design approaches, were developed to design the systems.

Ease of construction and reduction of embodied energy make the DST option an attractive alternative to traditional bridge members. An economic feasibility study using a typical example of an urban level crossing found that by reducing the time spent onsite to the order of a few days, instead of months or years, substantial cost savings could be made. The study concluded that material costs would be higher than those incurred for a traditional pre-stressed concrete bridge, but the total cost of the DSTA bridge would be in the order of $80million as opposed to $200million for the traditional design.

Dr Fernando, from the School of Civil Engineering, said: "The bridge is three times as strong as conventional reinforced concrete bridges, yet only a third of the weight. It can be pre-fabricated and transported on a semi-trailer and erected without the need for specialised heavy lifting equipment in about 72 hours. This means bridge building projects that previously caused up to six months of disruption can now be completed in just three days."

For this reason and the science involved, the research team received the inaugural World Innovation in Bridge Engineering Award in Portugal last year. "The award recognises our design as a game-changer, coming in ahead of designs involving more than 200 authors from 50 countries," said Dr Fernando.

The $50,000 prize was announced and sponsored by the Faculty of Engineering at the University of Porto (FEUP) and BERD, a project, research and engineering firm specialising in bridges.

Written by Kerryn Caulfield, Executive Manager of Composites Australia Inc.

Composites Australia Trade Mission to JEC Asia 2019

Seoul, Republic of Korea. 13–15th November, 2019

Above. JEC Asia Industry Tour to Win & Win co. Kerryn Caulfield, CEO Composites Australia; Leona Reif, President Composites Australia.

Right. Danu Chotikapanich, CEO COBRA; Kerryn Caulfield, CEO Composites Australia.

Above. Henry Stonham, International Sales Manager JEC Asia; Eric Pierrejean, CEO JEC Group; Kerryn Caulfield, CEO Composites Australia; Leona Reif, President Composites Australia, Nelly Baron, Marketing & Communication Director JEC Group.

The Australian Pavilion hosted by Composites Australia at the three-day JEC Asia 2019 event was a busy meeting hub that showcased Australian companies, a leading educational institution and award-winning products and fabrication technology, as well as engineering and R&D services.

The Australian presence amongst 200+ exhibiting companies from 49 countries included delegates from ACS Australia, Envirospheres, FDP Composites, GMS Composites, Quin Global, Regina Glass Fibre, and finally the ARC Training Centre for Automated Manufacture of Advanced Composites (AMAC) at UNSW Sydney.

The event also featured a parallel conference program where industry experts provided their insights on the latest developments in high-performance composite technologies and applications. Electric mobility and self-driving vehicles were key themes of the conference which explored resolving urban transportation problems with intelligent lightweight design concepts and using composite technology to develop solutions for next generation mobility. The existing integrated supply chain spread across South East Asia's automotive-producing countries is seen to be the main industry enabler.

But the real action was on the floor of the exhibition, particularly the Australian Pavilion where the atmosphere was lively, with constant visitors, meetings in the dedicated meeting space, and the occasional sound of an Aussie 'g'day'.

Conversations rich with manufacturing and technology observations flowed for three days. Language proved to be no barrier, as demonstrated by Manny Samano, Business Development Manager for Envirospheres as he expertly navigated a three-language business meeting with translations across four people.

The B2B meeting platform proved to be an efficient online system through which over 550 meetings were scheduled during the event.

Australian participation was amplified by a JEC Innovation Award as well as the Startup Booster Bronze Award, both of which are covered on page 11.

For Sam Weller, Managing Director of GMS Composites; "There is a growing market across the whole of Asia for the high performance custom composite prepregs in specialty fibres and nanotechnology - the area in which we specialise. The Free Trade Agreements across the region have freed up what were once closed markets - and the reduced tariffs, while not huge, provide the opportunity to discuss price."

Mark Pontil, General Manager for Regina Glass Fibre, said; "We're grateful for the opportunity to exhibit amongst fellow Australians. Export development is a long game and this JEC was a chance to better understand the South East Asian market and to energise our penetration. We came away with a heartening list of interested end users."

Andre Duarte, Business Development Manager for Advanced Composites Structures Australia, said of the event: "Specialising in design, manufacture and delivery of advanced composite structures and assemblies, conducted under ISO 9001 certification, ACS-A has all the credentials to service the East Asian market and beyond."

The event was a timely opportunity for Composites Australia (CA) to catch up with Eric Pierrejean, JEC Group CEO, and Jeong-hee Bai, Project Management Director for the Victorian Government Trade & Investment, to discuss and evaluate regional strategies. As CA Executive Director Kerryn Caulfield said: "The mission has provided a chance to refresh old relationships and establish new ones that we can continue to build on in future for the mutual benefit of the Australian and East Asian composite sectors."

Leona Reif, CA President said: "We are grateful for the support of the Australia Trade Commission which enabled our participation through the Free Trade Agreement Market Entry Grant Program. It was a particular honour to welcome Sung-o Cho, Senior Business Development Manager for the Austrade Korean office to our pavilion"

The JEC Group has positioned itself as the top composites network in the world, with 250,000 engaged industry professionals through its Paris headquarters, exhibition and conference. The foundational JEC Asia events were held in Singapore, though Korea's commitment to advanced manufacturing has motivated the relocation to Seoul for the foreseeable future.

The views expressed herein are not necessarily the views of the Commonwealth of Australia, and the Commonwealth does not accept responsibility for any information or advice contained herein.

Members of the Composites Australia Trade Mission to JEC Asia 2019.

Composite Engineer's Viewpoint
By Rik Heslehurst PhD, MEng, BEng (Aero) FIEAust, FRAeS, FSAMPE, CPEng
Composites Australia (Honorary Member)

Part 15–Sandwich Structure Repairability

In the last article we considered non-destructive inspection of sandwich structures. Now the damage has been identified we look at the most appropriate restoration approach for the sandwich structure.

Prior to the implementation of a repair scheme a sound set of repair design, development, fabrication and installation criteria must be developed. Thus, the basis of composite and sandwich structure repair design follows a logical set of repair parameters which are outlined below:

Static Strength & Stability: Any repair must be capable of supporting the design loads that are applied to the original structure through either a strength or stability restoration focus.

Repair Durability: Any repair scheme that is designed to restore the structure to operational conditions is generally expected to remain an integral part of the structure for the remaining service life. Considerations include fatigue loading, corrosion, and environmental degradation during the design/ development phase of restitution.

Stiffness Requirements. With light weight structures stiffness is often more critical than strength. Consideration should therefore be given to the repair scheme maintaining the integrity of structural stiffness via deflection limitations, flutter and vibration, and load path changes.

Surface Smoothness: Surface smoothness is an important consideration when maximum speed or fuel efficiency is required. You should always ask yourself is a flush repair required?

Weight & Balance: The size of the repair and the local changes in weight can be insignificant to the total component weight, but in weight sensitive structures, such as aerodynamic or hydrodynamic control surfaces, the effect to the mass balance can be highly significant.

Operational Temperature: The operating temperature influences the selection of repair materials particularly adhesives and composite resins. A combination of extreme temperatures with environmental exposure (the hot/wet condition) is often the critical condition for which the repair must be designed. Materials that develop adequate strength within the required operational temperature range must be selected.

Environmental Effects: Composite and adhesive bondlines are prone to degradation when exposed to various environments, in particular fluids and thermal cycling. The influence of moisture absorption can affect the durability of the repair design and should be considered in the repair scheme design.

Costs & Scheduling: It is well established that it is cheaper to repair than replace, given availability of appropriate facilities and adequate personnel skilled. Repair and their design costs in terms of platform downtime and operating expenses are a consideration.

Operational Performance & Appearance: Consideration should be given ow whether the repair adversely affect operational performance, in particular radar cross section characteristics. The repair should not be visible.

Facility Capabilities. Does your facility have the appropriate workshop equipment and facilities to undertake the repair? This will include the occupational health and safety of repair personnel.

Repair Staff: Consideration should be given to whether repair technicians and engineering staff are trained in the repair of composite sandwich structures; including whether they have been trained in damage inspection, damage characterization, damage removal, repair scheme fabrication, repair scheme installation (particularly surface preparation) and post-repair quality assessment.

This is the final article on sandwich structures. In the next article we will discuss the differences between a nested and a stacked composite laminated structure. This article will not consider the details and specific types of repair and how to develop such repairs. For such detail the reader is directed to the following book on composite repair design: Engineered Repairs for Composite Structures, Rikard Benton Heslehurst, ISBN 9781498726269, 2019 CRC Press

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.

Free Trade Agreements – Korea

High tariffs and other trade barriers were once standard defensive trade mechanisms used by countries around the world to protect their domestic markets. Governments imposed tariffs to raise revenue, protect domestic industries, or exert political leverage over another country. Up until 1986, the effective tariff rate on items of clothing being imported into Australia was as high as 178%.

Movement towards trade liberalisation in Australia began over 40 years ago and is today based on a series of unilateral, bilateral and multilateral trade agreements. The outcome of this reform agenda has been Australia's successful integration into the global economy, particularly in Asia.

Shared prosperity through trade in Asia matters to Australia. According to the Department of Foreign Affairs and Trade (DFAT), Australia's $105 billion two-way trade with ASEAN exceeds our trade with Japan and the United States, our second and third largest trading partners.

Trade with Korea has been enabled by the Australia-Korea Free Trade Agreement (KAFTA) which came into force at the end of 2014. It is a comprehensive agreement that reduces both tariff and non-tariff trade barriers, with the exception of some agricultural products that have special phasing arrangements. According to the DFAT, more than 99% of Australia's goods exports to Korea are eligible to enter duty-free or with preferential access. The agreement extends to Australian services suppliers as well. A mutual recognition arrangement signed between Engineers Australia and the Korean Ministry of Science in 2015 guarantees market access in Korea.

Korea is the fourth largest economy in Asia and the 13th largest in the world. It is a global industrial giant with an advanced manufacturing economy, a highly educated workforce and democratic government.

In pursuit of economic growth, the Korean government prioritised manufacturing development through policy initiatives, tax incentives and investment.

The race for technology has seen the formation and growth of R&D centres working on composite materials in universities (KAIST, Seoul National Univ., Postech, Gyeongsang National Univ.), research institutes (KIMM, KARI), and companies (Hankuk Fiber, DACC). Their activities cover a broad range of research and development in composite materials: design and fabrication; processing technology; structural analysis; characterisation of composite materials; NDE; fibre optic structures; damage detection; health monitoring; smart structures and so on. These technologies will be increasingly used in various fields and play an important role in future industries.

Like Australia, the Korean government has joined with the Korean industrial conglomerate Hyosung Corporation to invest in a "Carbon Valley" in its Jeollabuk-do Province to nurture the country's capability in carbon fibres, artificial graphite, and carbon polymers.

KCTECH (Korea Institute of Carbon Convergence Technology), located in the centre of the Carbon Valley, specialises in carbon technology and has a global network of 13 institutes in eight countries. KCTECH's aim is to become a global research institute for composites industry, most notably through its key fundamental technologies and commercial applications.

In August this year, Hyosung announced it will invest A$1.2 billion by 2028 to expand its carbon fibre production capacity, in a quest to become the third largest carbon fibre producer in the world.

The investment should be seen through the lens of the trade war between the US and China that intensified last year. There are mixed perspectives on what Korea stands to gain or lose from the trade war, but there is no doubt that global companies with manufacturing and trade interests in China and the U.S. are hedging exposure by relocating some manufacturing and assembly processes to other parts of Asia.

The synergies between Australia and Korea are encouraging. Across Australia are a number of sister city relationships. According to the Department of Education, Korea is one of Australia's priority countries for science and innovation collaboration and Australia is one of the top 10 collaboration countries for Korea. Furthermore, Australia's international student enrolments from Korea of around 23,000 annually are creating a strong alumni in Korea that will sustain our nations' ongoing relationships into the future.

Written by Kerryn Caulfield, Executive Manager of Composites Australia Inc.

Don Elliot is retiring...

Don Elliot accepting the VCAL Teacher Achievement Award for Excellence in Program Development for the Victorian Curriculum by the Hon. James Merlino, Deputy Premier & Minister for Education.

It is almost 50 years since Don Elliot picked up a brush and roller but, as the year 2020 approaches, he's made the defining decision to hang up the safety goggles to retire.

Don's career in the composites sector spans manufacturing, composites repair, teaching and consulting, commencing with early composite manufacturing adapters such as Bolwell Cars.

His contribution to the sector includes a significant body of work co-writing and teaching a number of composites teaching programs, short courses and traineeships including, but not limited to, Certificate II in Plastics – Composites, Certificate IV in Polymer Technology and the Victorian Certificate of Applied Learning (VCAL). His best estimate is that he has trained over 2,200 students across five TAFE colleges, two Universities and a number of secondary institutions.

His involvement in the composites sector includes many years as an active committee member for the Victorian chapter of what was the Composites Institute of Australia as well as presenting workshops and at conferences.

"I have a lot of great memories over my career manufacturing automotive, marine and primary production components. I've met some wonderful like-minded people who enjoy making things as much as I do," said Don. "The last 10 years have been particularly rewarding running the TAFE VCAL student program to build energy efficient vehicles - made from composite materials – to compete in the annual Energy Breakthrough Event in Maryborough, Victoria."

In a well-earned acknowledgment of his decades of commitment to education, Don was recently presented with the VCAL Teacher Achievement Award for Excellence in Program Development for the Victorian Curriculum by the Hon. James Merlino, Deputy Premier, and Minister for Education and Emergency Services.

Don Elliot early in his career.

NDT Equipment

Non-Destructive Testing (NDT) of composites components is a responsible method of determining the consistency of complex composite materials and identifying and monitoring internal damage including delamination and occurrence of voids or splits/cracks. Within the aerospace industry NDT plays a vital role in the design, manufacture and maintenance of aircraft. NDT has also become indispensable technology for all other composites including marine craft, defence equipment, tanks and pools.

One of the leading international manufacturers and suppliers of NDT equipment is Testia, a company formed from the R&D department of Airbus in France to ensure aircraft structural reliability and to facilitate the maintenance operations of Airbus aircrafts.

The range developed by Testia is now available through the Sydney based firm, NDT Equipment Sales. The range includes the D-lamTool that was specifically developed to detect delamination after impact on multilayered components made of carbon or glass fibre composites.

Rod Martin, Managing Director of NDT Equipment Sales says, "Through our partnership with Testia, our company is now able to offer the Australian market this unique range of testing equipment and augmented reality software for accurate analysis of composite components for aerospace and other applications. The D-lamTool is a Go-NoGo NDT tool that provides an automatic diagnosis and acoustic coupling monitoring that is not influenced by thickness change in structures. An added benefit is that can be operated efficiently by a non-certified operator."

Contact Rod Martin, NDT Equipment Sales.
Tel: 02 9524-0558 or email: ndt@ndt.com.au

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