List of presentations and demos

Presentation streams and codes:

- Industry Stream (Ind.):
  - **Ind.B:** Business Stream
  - **Ind.F:** Fabricators Stream
  - **Ind.M:** Materials Stream
- Demo stream (D)
- Academic Stream (A)
- Workshop (W)

The conference program can be found on the conference website.

Ind.B: Business Stream

Ind.B1: **Outlook for the economy and markets**
David de Garis: Director, Economics, Markets Corporate & Institutional Banking, National Australia Bank

David will present his view on the prospects for the Australian and global economies and financial markets information for which has been derived from a combination of top-down macro data and feedback from clients among the NAB's business franchise.

He will explore how financial markets are responding to events in real time and outline prospects for growth, interest rates and developments in the foreign exchange market, including prospects for the Australian dollar in the near future.

Ind.B2: **Australian Synchrotron: Delivering real life benefits**
Professor Andrew Peele: Director, Australian Synchrotron, ANSTO

The Australian Synchrotron is one of the most significant investments in scientific infrastructure in the 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.

Professor Peele will provide an overview of this extraordinary facility as well as examples of how the characterisation and optimisation of composite materials plays an important role in many of the areas that Synchrotron research.

Ind.B3: How can workforce diversity improve composite productivity (presented jointly with Dr Rik Heslehurst)

Dr Angela Trego: Department Chair, Utah Valley University

Diversity in the workforce has been shown to produce healthier companies and better, more robust products and research. But while women fill half of the jobs in western cultures, they fill less than 30% of STEM jobs.

Angela will first address the current state of women in technical fields and the motivation for growing the percentage of women working in composites companies. She will identify methods for increasing the pipeline for both applied (practical or trades or workshop) and analytical composites applications and how collaboration between industry, universities and trade schools can support and improve the composites industry through the inclusion of more women in its workforce.

Ind.B4: Unlocking unprecedented opportunities for composites to supply renewable infrastructure projects

Andy Balmain: Commercial Manager, Industry Capability Network

The Victorian Government's renewable energy targets of 25% by 2020 and 40% by 2025, offer unprecedented opportunities for local industry to supply into both Wind and Solar projects. Its commitment to local content targets of 64% (construction phase) for these massive projects has resulted in many potential renewable infrastructure operators, EPC's and OEMs searching for capable local suppliers.

Andy will outline the scope of the opportunity and the pathways for local suppliers and subcontractors considering further opportunities in the renewable space, particularly as a result of Government local industry engagement initiatives.

Ind.B5: Improving project performance within a composites business

Mr Fon Hah: Management Consultant, Helmsman International

With some of the best engineers and technical capabilities in the world, there is no doubt that Australian businesses have the 'hard capabilities' to deliver projects. Often undervalued, yet just as important are 'soft capabilities' - communication, engagement, leadership and alignment - that drive project performance.

Fon will outline how the drivers of success in complex projects is the right balance between 'hard' and 'soft' capabilities. He will share research insights from more than 1,000 projects, and the methodology, examples and other approaches used by similar projects to get the balance of capabilities right.

Ind.F: Fabricators Stream

Ind.F1: Thinking and planning like a technology company to adapt IIoT

Mr Ashley Reid: Managing Director, Terra Firma Industries

Imbedding a sensing or responsive ability into a composite product or component provides customers with the classical properties of composites – less weight, stiffness and strength – in addition to creating unprecedented direct customer and stakeholder engagement and interaction.

The Industrial Internet of Things is providing a multitude of new generation of smart devices that can do everything from monitoring water quality and flow to directing trams. Ashley will present on creating connectivity that can track assets and capture data in composite components.

Ind.F2: Courageous fibreglass commissions - the story of 100 skulls

Glen King: Managing Director, King's Fibreglass Pty Ltd

In 2017, Glen King and his team were commissioned by the National Gallery of Victoria to make the most challenging body of work of their careers. Comprising of 100 fibreglass skulls, each 1.2 metre high and designed by Australian-born sculptor Ron Mueck, the installation was titled MASS 2017 and acquired through the Alfred Felton Bequest for the gallery's current NGV Triennial exhibition.

Glen will provide an honest account of collaborating with numerous creative and technical agencies and the challenges of making the moulds and fabricating the skulls that were made up of 20 parts in each two-piece mould, plus dozens of teeth.

Ind.F3: Tricomposite – The transformation journey continues

Frank Cristiano, General Manager, Tricomposite Australia and Hugh O'Donnell, Director, High Performance Consortium

This brave and compelling story of business transformation was presented at the 2017 conference, when Frank and Hugh described how the Tricomposite team transformed the business to be more reliable, innovative and customer focused in response to intense overseas competition. Central to this change was collaborating with peers in other industries, changing mindsets and accessing resources and ideas to improve productivity, quality and delivery performance with minimal capital investment.

We've brought back this popular team to hear more on the company's transformation journey, one year one. Frank will outline recent achievements, including the journey of changing the culture to one of empowerment, ownership and accountability enabling him as GM to work more on the business.

Ind.F4: Thinking like a boat builder opens opportunities other than marine

Steve Campbell: Managing Director, Composites Constructions Pty Ltd

Over the past few years Composites Constructions has delivered a number of ambitious, beautiful and dynamic public art commissions made from composites.

The latest being “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. The final sections were coated with a textured finish and an applied coat of metallic grey.

Training as a Master Boat Builder to fulfil his love of everything marine, Steve believes that 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. He will outline how realising ambitious creative outcomes requires strategic partnerships and collaboration across many disciplines including working with engineers and artists.

Ind.M: Materials Stream

Ind.M1: XantuLayr technology

Dr Gareth Beckerman: Business Manager, Revolution Fibres Ltd

With a diameter of 100 nanometers or less, Nanofibers have emerged as exciting one-dimensional nanomaterials for a broad spectrum of commercial applications owing to their unique physicochemical properties and characteristics.

XantuLayr nanofibre veils for composite reinforcement have been in the market for more than three years, are now making inroads into automotive, and sports, industrial and military applications. Now aerospace certified, this platform technology is compatible with various carbon fibre processing methods commonly used in the aeronautical industries. Gareth will outline the results of compression after impact, fatigue resistance and Mode I and II delamination.

Ind.M2: An adhesive selection methodology for composites

Dr Rik Heslehurst: Director/Owner, Heslehurst and Associates Pty. Ltd

There are many parameters and design issues to consider when choosing an adhesive to use in a bonded joint. Rik will explain the important selection parameters including consideration for the materials to be joined, adhesive performance and geometric requirements, joint geometric constraints, fundamental joint configuration description, current adhesive stock, installation requirements and capabilities, fabrication and operational conditions, surface preparation requirements and capabilities, failure modes and effects, damage tolerance and durability, maintainability and repairability, design robustness, complexity of the joint and cost of the adhesive system and fabrication equipment.

Ind.M3: A new turn-key core material

Holger Zorn: Business Development Manager, Spheretex GmbH

The function of a stitch-bonded complex is to act as reinforcement of a laminate, a core material for light weighting and a flow medium for a good and steady resin flow while maintaining drapability. Holger will outline how many functional layers can deliver unprecedented functional properties and characteristics within a sandwich laminate.

This presentation will present turn-key solutions for closed mould processes (VIP, RTM and RTM light).

DEMO Stream

Note - Demos are subject to acceptance by the venue once Material Safety Data sheets are submitted

D1: Vacuum Infusion Process Demonstration

allnex composites and Tricomposite

This live demonstration of the Vacuum Infusion Process (from start to finish) will demonstrate the versatility of the manufacturing method using a closed mould system featuring a base mould and counter mould that is sealed using vacuum pressure.

It will feature the fabrication of a **Tricomposite** caravan part using a DCPD Ortho blend infusion resin developed by **allnex** for A class auto parts. Ortho resins offer a cost/performance benefit with good mechanical properties and secondary bonding characteristics. The blend has been formulated to produce a superior cosmetic finish with less print-through and distortion on finished parts.

D2: Composites Adhesives - Bonding to a range of substrates

Mr Kevin Tarrant, Engineering Adhesives Manager – ANZ Region, HB Fuller Engineering

This demonstration will feature the application of the three main adhesives used in bonding and sealing across the composites industry, namely MMA (Methylmethacrylate), MS (Modified Silane) and PU (Polyurethane).

Kevin will demonstrate the application of these adhesives to nine different substrate combinations including fibreglass to aluminium, timber and steel, ABS to fiberglass, steel and timber and carbon fibre to aluminium.

D3: The Importance of achieving consistent fibre/resin volume ratio during fabrication

Dr Rik Heslehurst, Director, Heslehurst and Associates

Dr Rik Heslehurst will demonstrate the effects of pre-mixed resin/fibre weight ratios, and bleed schedules on the structural performance, weight and thickness of composite components through component fabrication, measurement and review of past mechanical testing results.

His demo will wet-out resin cloth, laminate a six ply cloth stack to which he will apply six bleed schedules through a vacuum bag, cured under heat at 80 degC. Rik will then identify failure mode changes, weight, thickness, strength and specific strength variations from pre prepared samples and show the results on a computer projected screen.

D4: Acrylic 1 technology demo

Mani Sampaio: Managing Director, Australian Composite Solutions

This demonstration will feature A1 or Acrylic One which is a two component system consisting of a mineral powder and an acrylic water-based resin which creates a very durable product. The product is increasingly being used for replica building materials including panelling, facades and concrete lookalike. Creative applications also include architectural sculptures and decorative building and frameworks.

Its user friendly characteristics include a lack of solvents and therefore few, if any odours; no special equipment is required during use or personal protective clothing and there is no shrinkage. End products are UV stabilized and resistant to fire (certification Fire Classification B-s1, d 0) and weathering.

Academic Stream

A1: Low velocity impact of thick maritime composites

Dr Andrew Phillips: Organisation: Defence Science & Technology Group

The ocean and waterways of the world contain many objects that can deleteriously damage a vessel on impact. These impactors include ice, wood (e.g. pallets, lumber, trees), metal (e.g. shipping containers, cables, other vessels) as well as large marine animals. Polymer composites used in structural marine applications are typically thick and solid so that they can withstand the high fluid forces, and also can be highly curved for improved hydrodynamic performance. While collision performance of thinner aerospace composites has been extensively analyzed, little is known about the performance of these thicker complex shaped composite structures.

The first part of the paper briefly reviews key features of impact in the marine environment including potential impact locations, possible impactors and their range of velocities. The second part of the paper summarises results from recent preliminary experimental studies which aimed to investigate the out-of-plane low velocity impact behaviour of a number of flat composite laminates. The effect of laminate thickness, hybridisation with different fibres and fabric architectures, and the influence of internal ply drops will be discussed.

A2: Analysis of electrical energy harvesting using a piezoelectric laminated Belleville springs

Mr Chanasit Phongsitthisak, King Mongkut's University of Technology

Energy harvesting is a process of transforming environmental unused energy to beneficial electrical energy. This research presents a study of a novel energy harvester from smart Belleville spring composed of composite and piezoelectric materials. The electrical energy can be generated by employing piezoelectric effect in the piezoelectric elements bonded on or embedded in the spring. Mathematical models are developed to calculate the spring characteristics when a mechanical force/energy is applied, such as deflection, stresses, and strains. In addition, electromechanical performance, i.e. amount of electrical energy can be predicted under quasistatic analysis.

The study focuses on the variables involving the snap-through buckling of the composite spring, which the behavior is a key mechanism to enhance the harvested electrical energy. Furthermore, an optimal condition of piezoelectric element installation for example, their location, amounts, and sizes of the piezoelectric patches has been analyzed. Results showed geometries of spring effect to energy generated, while the most effective area of piezoelectric patches is area around the inner circumference of springs from the stress most occurring. The final outcomes lead to the design guideline of smart composite Belleville springs under various applications, for example, their utilizations as a speed bump to collect energy from moving vehicles.

A3: In-situ monitoring of fibre reinforced composites using embedded fibre optic sensors

Dr Claire Davis, Defence Science and Technology Group

The incorporation of optical sensing fibres into fibre reinforced composite structure offers huge potential to deliver both an enhanced understanding of the manufacturing process and provide material state awareness in the manufactured product. However, the transition of this capability into main-stream composites manufacture has been slow, in large part due to the practical challenges associated with integration of these fibres into real world structures that often contain geometric complexities. Furthermore, reliable interpretation of the resultant optical response measurements is critical if the results obtained are to be relied upon for decision making.

This paper provides a comparative evaluation of the three main classes of fibre optic sensor which are suitable for composites embedment (fibre Bragg gratings, continuous fibre gratings and Rayleigh scattering). These fibres are embedded in nominally identical composite hydrofoils that contain many of the geometric features that can present challenges for integration in real world applications. Experimental data is presented comparing the response of the different classes of sensor during resin transfer moulding of the hydrofoils and their subsequent curing and demoulding processes. Finally, experimental results will be presented of the performance of the fibre optic sensors in the finished hydrofoils under quasistatic cantilevered loading.

A4: Wettability of carbon fibres at tow scale

Mr Jian Wang, Harbin Institute of Technology

In composites, the physical adhesion between Carbon Fibres (CFs) and polymer matrices as well as the formation of voids at the interface between these two materials are mostly controlled by the wetting properties of the fibres. Due to the hierarchical structure of CF reinforcements, it is essential to study their wetting behavior at different scales: from the single fiber (microscale) to the fabric (macroscale) via the tow scale (mesoscale). Whereas a direct measurement of the contact angle of single CFs by tensiometric means is well established, a direct measurement of the wettability of CF tows is hampered by their porous structure due to densification and liquid take up phenomena. In this work, we first developed a new methodology combining a tensiometric method and a synchronized in-situ optical observation technique to better characterize the wettability of CFs at tow scale. The wettability of single CFs and CF tows composed of unsized and sized CFs were measured. By comparing their wettability at the micro- and mesoscale, we

could quantify how the modification of the surface chemistry at the microscale is transferred to the mesoscale.

A5: Preparation and characterization of a thermomechanically stable composite from a fast curing epoxy resin and lignin using a protic ionic liquid as a new medium

Ms Shammi Sultana Nisha, Swinburne University of Technology

A bio-composite of ionic liquid lignin (ILL)–epoxy was prepared from lignin microparticles and a fast curing thermoset epoxy resin (FCTER). A low cost protic ionic liquid (Triethylammonium Hydrogen Sulfate) was used as a new carrier for introducing lignin into the matrix. The aim of this work is to study the thermal and mechanical effect of ILL as an additive for a fast curing DGEBA pre-polymer, a bisphenol A - based epoxy hardened with an anhydride based curing agent. Surface properties and surface composition of the designed IL-epoxy resin were investigated by the contact angle and X-ray photoelectron spectroscopy (XPS). The degradation mechanisms and the influence of the ionic liquid lignin on the thermal stability of ILL- epoxy networks has been evaluated by thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC). Addition of ILL led to a significant improvement of the thermal behavior of the epoxy networks, by increasing the glass transition temperature from ~40°C to 50°C. The mechanical testing showed that the flexural toughness of the matrix was increased by 23.50%.

A6: Surface energy components of single carbon fibre

Mr Si Qiu, Harbin Institute of Technology

Carbon fibers (CFs) have received much attention lately for their multiple potential applications when combined with matrix materials owing to their excellent mechanical properties. They are usually coated with an organic layer (sizing) to increase their adhesion to polymer matrices. Despite the importance of CFs in the composite field, studies dedicated to the wetting dynamics of single carbon fibres have been poorly documented. In this study, dynamic contact angles of diiodomethane, formamide, and ethylene glycol, on T300 CFs were measured using the methodology that permits us to measure dynamic contact angles by taking into consideration both the intrinsic variability of the carbon fiber diameter and the extremely small amplitude of the capillary forces. Advancing and receding contact angles were calculated at various test velocities. The experimental dynamic contact angle values were then fitted by the MKT and HD approaches which allowed to model the wetting dynamics and to establish static contact angles values and finally the SEC of single CFs.

A7: Modelling of low-velocity impact on shear thickening fluids

Mr Xiaoyu Cui, University of Sydney

Shear thickening fluids (STFs) have been regarded as energy absorption materials due to their remarkable rise in viscosity at high strain rate. This study aimed to develop a three-dimensional finite element (FE) model to simulate low-velocity impact process of the STFs. Based on the impact-activated solidification theory (Waitukaitis and Jaeger, 2012), the STFs were divided into two parts during impact, a solid-like cylindrical part underneath an impact striker surrounded by a liquid part. The solid-like part was simulated using a Johnson-Cook model

measured from split Hopkinson bar tests, while the properties of the liquid part were derived from steady-state rheological and confined compressional measurements. It was found that the jamming front propagation is not neglected in our numerical model, although the impact load-penetration relation is comparable to the experimental one when full densification of the STFs is achieved. Then, we refined our model by further dividing the solid part into a liquid part on top of a solid-like part. The refined numerical FE model can reproduce the whole impact process of the STFs, and the impact load-penetration curve by the FE model was consistent with the experimental result.

Workshop (preconference)

W1: Composites design and manufacturing

Dr Rik Heslehurst: Director/Owner, Heslehurst and Associates Pty. Ltd

This half day workshop will commence with top-end view of the design process for composite structures and components and the unknown parameters that the composites design engineer is required to consider; namely:

- fibre type and form selection,
- resin system selection,
- manufacturing process required/available,
- the number of plies required or component thickness,
- the orientation of each ply; and,
- the stacking sequence of each ply or the ply lay-up configuration.

The needs of the selected manufacturing process will be addressed based on cost, production run numbers, part quality and material property consistency, followed by an analysis of the material property data scatter.

Participants will also be stepped through available options in the case that the manufactured composite part is unable to meet the design performance requirements and will be provided with recommendations to overcome design and manufacturing shortfalls.

ENDS