STEM HDR Research Day

Tuesday 16th April 2024

9:15am	**Registration desk open (MC Building Foyer)**

9:45am -10:00am	**Welcome (MC-01) Professor Jacqui Ramagge: Executive Dean STEM**

10:05am – 11.20am	**Session 1**
Engineering	**MC1-02 – Session Chair – Dr Sekhar Somenahalli**
	1. Md Nazmul Islam Sarkar 2. Sagun Shrestha 3. Xiao Su 4. Zhiqing Xu 5. Arifuzzaman
Information Technology	**MC1-03 – Session Chair – Dr Solmaz Kahourzade**
	1. Ashwani Malhotra 2. Spencer O'Keeffe 3. Kaining Zhang 4. Bowen Yuan
Project Management/ Mathematics	**MC1-05 – Session Chair – Dr Judy Bunder**
	1. Diane Thompson 2. Maheshi Tennakoon 3. Thomas Miller 4. Heather Smith 5. Maria Kapsis
Sciences	**MC1-21 – Session Chair – Dr Richmond Asamoah**
	1. Rupinder Kaur 2. Sindy Pinero 3. Donna Fitzgerald 4. Matilda Raynes 5. Sushil Kumar KC

11:20am – 11:40am	**Morning break (MC Building Foyer & Courtyard)**

11:45am – 1:00pm	**Session 2**
Engineering	**MC1-02 – Session Chair - Dr Jun-Jie Zeng**
	1. Ankit Shrivastava 2. Hossein Sanaei Ataabadi 3. Md Ahasan Kabir 4. Guangtong Huang 5. Esmat Ebadati
Engineering	**MC1-03 – Session Chair - Professor Haolan Xu**
	1. Bikash Devkota 2. Joshua Davis 3. Yang Cao 4. Vijay Aralappanavar 5. Gertrude Acquah

Information Technology	**MC1-05 – Session Chair – Dr Tung Nguyen**
	1. Umar Memon 2. Corey McKechnie-Martin 3. Dmitry Resnyansky 4. Mahdi Shafiei 5. Naeem Paeedeh
Sciences	**MC1-21 – Session Chair – Dr Zlatko Kopecki**
	1. Kieran Sparkes 2. Ali Nazarizadeh 3. Le Tuong Van Vo 4. Neve Skinner 5. Genine Meredith

1:00pm – 2:00pm	**Lunch** **(MC Building Foyer & Courtyard)**

2:05pm – 3:20pm	**Session 3**
Engineering	**MC1-02 – Session Chair – Dr Reza Hassanli**
	1. Abbas Abbara 2. Abdulrahman Alshahri 3. Rahma Elsebaie 4. Jan Vincent Santos 5. David Willmore 6. Jessica Tejeda
Engineering	**MC1-03 – Session Chair – Dr Subhashini Wella Hewage**
	1. Franke Agenbag 2. Tesi Liu 3. Adam Keith 4. Arieli Tristao Rezio 5. Oluyimide Akinnawonu
Sciences/Construction	**MC1-05 – Session Chair – Associate Professor Craig Styan**
	1. Melody Lau 2. Ivan Gutierrez Agramont 3. Eleonora Allievi 4. Pasindu Karunatilaka 5. Ishara Rathnayake

3:20pm – 3.30pm	**Close by Professor Yan Zhuge: Prof Lead: Research Education (MC1-02)**

Title and Abstract

Session 1

Md Nazmul Islam Sarkar – Dynamic Multimode Fiber Specklegram Sensor Smart Bed Enabled by Deep Learning

Fiber specklegram sensors simplify sensing processes by employing cameras to capture speckle patterns on multimode optical fibers, negating the necessity for intricate optical interrogators. These sensors possess high sensitivity throughout the fiber's length, offering intricate data on external disturbances. Their capacity to cover extensive surface areas and detect movement from any point proves advantageous across various sensing scenarios. Traditionally, static speckle images were utilized for evaluating such disturbances, but scenarios requiring dynamically changing measurements necessitate alternative analytical approaches. In our study, we applied deep learning to dynamic speckle videos for biomechanical sensing, specifically focusing on monitoring respiration rates. This application entails wide-area coverage, exemplified by mattress sensing, alongside dynamic data acquisition. By training convolutional neural networks on speckle videos, captured using a single multimode fiber in an S-configuration, we demonstrate accurate respiration rate classification. This integrated approach holds promise for diverse biomechanical healthcare applications, including pressure sore prevention and fall risk reduction through continuous monitoring.

Sagun Shrestha – Evaluation of pavement performance for three different designs on the expansive subgrade: three case studies

The expansive/reactive subgrade issue has been prevalent in pavement construction throughout Australia, with an estimated 30% of the country's land surface covered by expansive soil. The shrink-swell problem caused by subgrade movement poses a significant challenge, damaging the constructed pavement. Various approaches have been implemented to address this issue, mitigate the detrimental effects, and combat the damage caused by expansive soil. A minimum non-reactive or stabilised cover depth is recommended for low to moderately reactive subgrades. However, in the case of highly reactive subgrades, Austroads and state road agencies advise conducting a comprehensive geotechnical assessment to explore alternative solutions. This article evaluates the potential of geogrid and geotextile in resisting movement caused by reactive soil and assesses their effectiveness in minimising pavement damage. Three road sections were constructed using different configurations. One road section utilised only geogrid, another combined geogrid and geotextile, while the control section had no geogrid or geotextile. The geogrid and geotextile were placed over the expansive subgrade. The design traffic, subgrade CBR (California Bearing Ratio), and reactivity index of the subgrade were consistent across all three road sections to evaluate the performance of pavement configurations. Similar road sections were constructed on three different reactive soils in Adelaide. Over a period of time, road performance surveys were conducted following the guidelines provided by Austroads. The findings revealed that both the geogrid section and the geogrid with geotextile section outperformed the control section in all three locations. This indicates that the inclusion of geogrid and geotextile significantly improved the performance and durability of the road sections constructed on reactive soils.

Xiao Su – Study on Polycarbonate Composites through Compounding with Graphene Nanoplatelets

"Polymers have a significant growth in industrial applications, due to their high specific strength and cost-effectiveness. However, the stiffness, electrical and thermal conductivity are not sufficient, which limits their use in applications such as antistatic coatings, thermoelectric devices, and adhesives. Compounding polymers with high-performance fillers is an effective way to improve polymer properties. Compared with traditional fillers, nanofillers can improve the performance of composites at low ratios. However, nanoscale fillers often stack themselves due to high surface area and incompatibility with polymeric matrices. Therefore, surface modification is necessary for nanofillers when these fillers are compounded with polymers. The graphene nanoplatelets (GNPs) has generated great interest in both academia and industry because their performance exceeds that of traditional fillers such as silica, carbon black, and glass fibres,

and more importantly, its affordable costs make them suitable for mass production. These advantages make it become very promising additive.
The aim of this study is to synthesize GNPs polymer composites with excellent mechanical properties, and electrical/thermal conductivity. This study will explore the modification of graphene to achieve uniform dispersion in the polymer matrix. The polymer material will be manufactured using the twin-screw extrusion method, which is suitable for industrial mass production.

Zhiqing Xu – Deep hierarchical contrastive learning network for bearing prognostics

Asset management plays an important role in industrial organizations as it ensures reliable operation of systems. SA Water spends up to $50 million annually on asset maintenance, which means even small gains in efficiency return large dividends. As a crucial part of asset management, prognostics involves constructing assets' health indicator(HI) and predicting assets' remaining useful life(RUL), two tasks that share the need for learning features from raw data. However, existing methods typically transform raw data into instance-level feature tensors, resulting in the loss of contextual information in raw data. To address this deficiency, this research introduces a deep hierarchical contrastive learning network that can learn timestamp-level feature tensors from raw data. Applying timestamp-level feature tensors can achieve a series of prognostics tasks, including but not limited to HI construction and RUL prediction. Experimental results show that HI has desirable monotonicity, correlation as well as robustness properties, and high RUL prediction accuracy can be achieved by using timestamp-level feature tensors.

Arifuzzaman – Optimisation of Phytocapping technology using engineered growth media and selected native plant species for South Australia

Phytocapping is a promising, eco-friendly, sustainable technology for municipal solid waste (MSW) landfill covers to reduce landfill gas and leachate generation. It comprises a plant growth media layer placed above a compacted low-permeable landfill cap. Vegetation acts as a bio-pump to remove water from the growth media and control the water's deep percolation. Although the success of phytocapping mostly depends on the selection of plant species for particular climatic conditions and suitable growth mediums, there are limited studies on these parameters to establish its effectiveness. This presentation reviews the historical development of landfill technology and phytocapping, the selection criteria of appropriate plants and growth media, challenges, and the importance of new researchers in overcoming these challenges. It also presents the performance, economics, and sustainability of phytocapping technology over ordinary MSW landfills. Keywords: phytocapping; growth media; plant selection; performance; sustainability.

Ashwani Malhotra – The impact of misinformation via emerging technologies on digital wellbeing of older workers

In today's fast-paced digital age, emerging technologies have ushered in a remarkable era of connectivity and information exchange. However, with this boundless access to knowledge and communication comes a concerning consequence – the proliferation of misinformation. As misleading information spreads rapidly across various digital platforms, its impact goes far beyond mere inconveniences. Older employees face issues that transcend beyond their professionalism and directly impact their well-being due to workplace transformation over decades and misinformation.
Due to the proliferation of new forms of communication, misinformation has been on the increase. Misinformation refers to the intentional or unintentional dissemination of false or misleading information, typically through digital. Misinformation can spread rapidly and the dissemination of false or misinformation has become a significant social issue when people use new platforms or technologies such as social media, Artificial Intelligence (AI), and fake technologies due to the convenience with which users can share and amplify inaccurate or misleading messages. The prevalence of fake news and its ease of dissemination makes it difficult to distinguish between fact and fiction. New advances in AI and other emerging technologies have worsened this, contributing to the proliferation of misinformation.

This study aims to identify the unique challenges older workers face in the context of emerging technologies and determine technological strategies in mitigating the negative effects of misinformation associated with technology use. To this end, it is necessary to comprehend the fundamental concepts of misinformation, emerging technologies, digital well-being, and the unique circumstances of older workers and to explore possible relationships between these key concepts.

Spencer O'Keeffe – Visualising Multi-dimensional Data in Forestry

Immersive visualisation tools are advantageous for understanding complex 3D datasets. One field with a growing interest in such datasets is Forestry. Modern remote sensing techniques like LiDAR scanners allow enormous quantities of raw data to be captured from forests, but best practice for interpreting and utilising this data is an ongoing area of research. VR displays have the potential to alleviate this problem.
This PhD Project is a collaboration between the University of South Australia (UniSA) Interactive and Virtual Environments Lab (IVE) and local forest operator OneFortyOne (OFO). The focus of the project is to explore the viability of tools and display methodology for remote sensed forestry scans. This has included a study comparing the advantages of VR and Desktop for point cloud analysis, exploration of an automated tree LiDAR analysis pipeline, and the development and assessment of visualisation methodology for forestry analysis in VR.
Subsequent work will explore implementation of forest growth modelling into interactive multidimensional visualisations, with the aim of designing a methodology and open source toolkit for analysing forests in the future.

Kaining Zhang – Identifying Hand-based Input Preference Based on Wearable EEG

Understanding user input preference can improve the user experience, however automatically determining preference can be difficult. In this paper, we designed an EEG-based method for directly evaluating hand-based input preference for touch and mid-air gestures on a smartwatch. We conducted a two-phase experiment, recording EEG data from 18 participants as they performed gestures and captured their ratings (Phase 1) and preference choices (Phase 2) for each gesture. Our analysis uncovered distinct EEG patterns between preferred and non-preferred gestures, including significant differences in Power Spectral Density (PSD), Coherence (Coh), and Sample Entropy (SE) features. When participants engaged with their preferred input gestures, we identified decreased brain activity (PSD) in the central and occipital regions, reduced brain connectivity (Coh) in the delta and alpha bands, and increased brain complexity (SE) in multiple sizes. These insights offer the potential to develop rapid detection of user intent for interactive computing devices by analysing brain signals.

Bowen Yuan – Contextual Views in Augmented Reality: Assessing Line and Radar Guidance for Flexible Task Sequencing

Improving the efficiency of Augmented Reality (AR) task guidance is an important area in education and industry. Most of the current AR guidance techniques provide a fixed sequence of tasks for participants to follow in a training process. We aim to explore the impact of AR task guidance designs when granting participants the ability to freely choose the order of tasks to complete. We conducted a user study with two out-of-view object visualization techniques that have not been previously compared, line guidance and radar guidance. These techniques were compared alongside a baseline condition in situations where participants could freely plan their routes to complete all the tasks. Overall, the line guidance showed better performance regarding completion efficiency, and the participants using line guidance were able to recall the task locations better. Our findings also confirm that these two different visualization methods influence users' route-planning strategies. The findings indicate that Contextual view techniques like line guidance might be a better potential choice for multi-target task guidance interface. We also address the limitations of the study and suggest directions for future work that could overcome these shortcomings.

Diane Thompson – Strategic Management in Australian Construction SMEs – Opportunities in Crisis

Small and medium-sized enterprises (SMEs) make up most of the construction industry in Australia. The recent COVID-19 crisis emphasised the challenges of strategically managing labour, materials, interdependencies, customers, and financial solvency/viability. While existing studies have provided insights into strategic responses taken by construction firms generally, there is a lack of research regarding how and why construction SMEs implement such responses. This paper introduces a novel conceptual framework for analysing strategic management practices and identifying opportunities for adapting to industry conditions. The framework incorporates 10 key strategic response measures identified from extant literature and has been qualitatively tested through a deep-dive case study in the South Australian construction industry incorporating 30 semi-structured interviews of employees together with 13 interviews with external stakeholders. Responses were thematically analysed following general theories of resource allocation and stakeholder management. All 10 measures were verified as pertinent. Four additional strategies were identified as being especially important to SMEs during times of crisis: collaborative culture, promoting corporate values/objectives, succession planning and human resource management. This framework will assist practitioners and policymakers in ensuring a more robust future for construction SMEs.

Maheshi Tennakoon – Enhancing Offsite Construction Supply Chain Resilience via Progressive Procurement Practices: A Systematic Literature Review

Offsite construction (OC) is an effective method to reduce waste generation and improve resource efficiency in the construction industry from a circular economy perspective. However, offsite construction supply chains were severely affected during COVID-19, proving that they were not sufficiently resilient enough to withstand and transform if a disruption happens in the future. Introducing progressive procurement practices could enhance supply chain resilience. Therefore, this study aimed to answer 3 research questions:1) What are the currently used OC project delivery models? 2) What are the limitations of the procurement strategies in current OC project delivery? and 3) What interventions could be implemented through the procurement strategy to promote supply chain resilience? The study was conducted as a systematic literature review (SLR). 41 peer-reviewed research papers published between 2013-2023 were shortlisted through the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A descriptive analysis was conducted, followed by a thematic analysis. The descriptive analysis reveals that the emphasis on digitising offsite construction has shifted to transforming the business model, procurement, and supply chain with a human-centric view. The findings from thematic analysis highlighted design-build, integrated project delivery, negotiated-bid, management contracting, and Engineering–Procurement–Construction (EPC) as commonly used project delivery models in offsite construction. Taking up projects that did not align with the overall business objectives was identified as a limitation in the governance structure. The limitations arising from the specificity of the assets, frequency of the transactions, uncertainties, bounded rationality, and opportunistic behaviours were identified as limitations stemming from procurement practices. The study proposed interventions to promote agility through the organisation's procurement strategy and promote flexibility and visibility through the project's procurement plan. Rewarding collaborative relationships among SC partners and incorporating provisions to postpone the module delivery were some of the interventions proposed to promote flexibility. This study clarifies the current knowledge by thematically expressing the procurement considerations needed to enhance supply chain resilience. Further research was proposed to strategise the proposed interventions by identifying structural relationships among SCR strategies and procurement-related factors from empirical data.

Thomas Miller – Shocks in mathematical models used in population biology

A reaction diffusion equation is a type of mathematical model which is often used to study biological phenomena. For instance, they describe how the density of a population of biological cells or a species varies in space and time. They are made up of two terms: a diffusion term and a reaction term. The diffusion term is usually positive and this leads to the population spreading out, but sometimes aggregation may be the preferred behaviour. For example, a population at low numbers may aggregate for reproduction

purposes. One way to model aggregation is to allow the diffusion term to be negative, and this leads to shock solutions. Shock solutions however are not unique, my project is concerned with analysing the different types of shocks.

Heather Smith – Redesigning the grid with microgrids - what?, why?, how?

The new model of electricity supply in Australia is framed by an urgent energy transition to renewable sources, the abundance of wind and solar and early support for rooftop solar panels. I have modelled 100% renewable electricity to better understand WHAT the new electricity structure should look like, with a focus on making a distinction between localised and centralised electricity systems. I have worked with 3 microgrid projects to establish the details and barriers of local energy systems and to clarify WHY communities are advocating for increased investment in local energy infrastructure. Finally, I have provided a systems view of the regulatory, financial and technical architectures that comprise the electricity system and are intertwined in its redesign. I propose a model for systems change that identifies the stakeholders who need to be collaborating if we are to go beyond solid and rational designs and broadly shared values to truly understand HOW change can be achieved.

Maria Kapsis - Managing peak demand for a fleet of trains

Electric trains are an efficient means of transport but can impose significant power demands on national electricity supply systems. There are regular peaks in demand for relatively short periods of time in the early morning and early evening when public transport usage and household consumption are both high. The cost of electricity increases dramatically when there is a high demand for electricity from consumers. Railway operators are offered financial incentives to reduce their energy consumption during times of high electricity demand.
What is the best way to reduce electricity demand for a fleet of trains during multiple peak demand intervals?

Rupinder Kaur – The influence of surface hydrophobicity on peptide adsorption

Peptide surfactants are novel (and often stimulus-responsive) molecules that can alter the properties of air-water and oil-water interfaces[1]. Significant research exists on their ability to influence the formation of foams and emulsions, but less has been published on their use as targeted adsorbates for metal and mineral surfaces. There is potential for these surfactants to act as surface modifiers in applications such as mineral flotation, but to prove efficacy (both in terms of adsorption strength and adsorption selectivity) there is a requirement for detailed study of their adsorption behaviour onto solid surfaces from solution. In this study, the adsorption behaviour of poly(ethylene glycol)-block-poly(glutamic acid) (PEG-b-PBG) peptide on model thiolated gold surfaces with different hydrophobicities was investigated using quartz crystal microbalance with dissipation monitoring (QCM-D) and bubble-surface collisions. The QCM-D data indicate that PEG-b-PBG peptide adsorbs more onto more hydrophobic surfaces in contrast to lower hydrophobicities. The bubble-surface collisions of the peptide-coated substrates show that the peptide has an increasing ability to lower the contact angle of surfaces with higher initial contact angle, a result which may correlate with the increased adsorbed mass observed with QCM-D

Sindy Licette Pinero – A Novel Bioinformatics Approach Identifies the Genes that Cause Long-COVID

Background: Long-COVID, or post-acute sequelae of COVID-19 (PASC), is a condition that affects 10-20% of individuals who have recovered from COVID-19. It is characterized by a wide range of persistent symptoms influenced by various risk factors. Despite significant research efforts, the specific genes responsible for causing long-COVID remain largely unknown, making it challenging to develop targeted treatments.

Methods: To tackle this problem, we developed a novel computational approach that combines two powerful techniques: Mendelian Randomization (MR) and Controllability Analysis (CA). MR is a statistical

method that uses genetic variants as natural experiments to infer causal relationships between traits, while CA is a mathematical framework that identifies the most influential critical nodes in a complex network. By integrating these methods, we aimed to identify the causal and critical genes that drive long-COVID development.

Results: Our analysis revealed several genes likely to play a causal role in long-COVID, many of which were corroborated by existing literature. These genes are involved in various biological processes relevant to long-COVID, including protein production, viral replication, energy metabolism, inflammation, immune system regulation, and cellular stress responses. We also demonstrated that these identified causal genes can accurately predict the presence of long-COVID and classify patients into different subtypes of the condition.

Conclusion: Our study not only elucidates the genetic basis of long-COVID but also offers a practical tool for its diagnosis and classification. Using techniques from genetics, network science, and machine learning, we have identified key genes likely responsible for developing and persisting long-COVID symptoms.

Donna Fitzgerald – Quantifying dieback of eucalypt forests using remote sensing

In the Mount Lofty Ranges of South Australia, there are three stringybark eucalypt species Eucalyptus baxteri (brown stringybark), Eucalyptus obliqua (messmate stringybark) and Eucalyptus macrorhyncha (red stringybark). All three species have shown signs of dieback, resulting in the reduction of overall forest health with an increase in the death rate of the trees. Possible causes of dieback and forest decline are varied, including biological, climate, topographical location, and anthropogenic changes in the landscape.
Effective management of the conservation efforts for stringybarks within the Mount Lofty Ranges requires accurate knowledge of the amount and extent of the vegetation health changes and how local topography can influence the presence of unhealthy vegetation. Advances in remote sensing techniques using satellite or airborne imagery allow for the assessment of vegetation, including its structure, distribution, health, species information and spatiotemporal dynamics.
In this PhD research, the extent of dieback will be determined, and vegetation health changes over time will be identified in stringybark eucalypt forests using comparative remote sensing techniques to monitor forest health. Findings will be used to develop a Remote Sensing and scenario-based framework for dieback analytics, allowing for determining the extent of dieback and vegetation health changes over time.

Matilda Raynes – Changing the World for Good? Mapping the long-term impacts of adult environmental education programs in South Australia.

The research explores the extent to which adult-orientated Environmental and Sustainability Education (ESE) programs facilitate long-term behavioural outcomes and wider community impact. This research is driven by the current gap in understanding of the impact of these types of programs on fostering lasting change in individuals, households, communities and beyond. Data on long-term outcomes (over three months or more post-program) and systemic impact, are still underrepresented in literature, as they are often unexpected, ambiguous and difficult to quantify and measure. The research addressed this gap by examining a key ESE case study, framed by two research questions. The first question examined long-term outcomes and systemic impact of the case study, including sustainability behaviours, social networks, community action and capacity-building and political engagement and advocacy. The second question explored barriers and enablers that influenced how participants and facilitators continued with making and sustaining changes, post-program. The research approach drew from Roughley & Dart's (2009) 'Performance Story Reporting' evaluation approach and centred on the collection of "stories of change". This approach has been widely used in various evaluation contexts to understand program outcomes and impact. Additionally, mapping techniques were used to highlight systemic impact of programs. Semi-structured interviews, an online survey, an Expert Panel and a Summit Meeting were conducted with program experts, facilitators and past participants. Key findings showed that the highest domains of change reported included behaviour change, increased knowledge and awareness, influencing others, decision-making, household change, increased confidence, social connection and community engagement, across

both the interviews and the survey. The Expert Panel examined the data, unpacked limitations of the study and guided an initial development of recommendations for future program development and research. This research contributes to the understanding of the impacts of ESE programs and the barriers and enablers experienced by individuals in sustaining change. The research offers insight and recommendations for future program development, evaluation and research.

Sushil Kumar KC – Effects of duty cycle on argon plasma jet characteristics and biomedical applications

This work investigates how the duty cycle influences the production of hydrogen peroxide (H2O2) in an alternating current (AC)-driven plasma jet. H2O2 is a major reactive oxygen species produced by plasma jets in medicine and is a biological important molecule because it can intervene in cellular signalling processes important for disease treatment. In this study, duty cycles were varied from 9% to 72%, which correlated with an increase in the plasma's dissipated power and UV photon energy density, and consequently an increase in the production of high energy plasma components important for producing H2O2 through electron collision and UV photolysis reactions. Cell media treated with the plasma jet at higher duty cycles correlated with a decrease in the viability of HaCaT keratinocyte skin cells. The AC-driven plasma jet was shown to be operated optimally at a duty cycle of 34% at a biocompatible gas temperature of 40°C or below whilst still maintaining efficiency in H2O2 production. Overall, the data presented in this study might find use for the future of optimisation of the electrical properties of AC-driven plasma jets in plasma medicine.

Title and Abstract

Session 2

Ankit Shrivastava – Advancing Electron Beam Melting Manufacturing Capabilities for Aerospace Applications

Electron beam melting is an additive manufacturing (3D Printing) technique which fabricates components from 3D design data layer by layer as opposed to traditional subtractive manufacturing. This technique offers unparalleled design flexibility, precision, and the ability to manufacture complex geometries with exceptional mechanical properties, opening new horizons for industries ranging from aerospace and automotive to healthcare and beyond. While titanium alloys are favoured for aerospace use, issues such as undesired microstructure, preferential growth direction, surface and sub-surface defects impede trustworthiness of EBM Ti-alloys for demanding application such as aerospace. The challenge lies in the precise control of specific microstructural features, such as grain size, phase composition, texture, porosity, and surface finish. To address these challenges, a significant portion of EBM components necessitates post-processing treatments, resulting in extended production times and increased costs. This research aims to eliminate the need of thermal post-processing for by utilising intrinsic thermal cycles for microstructural tailoring and eliminating the surface and sub-surface defects. The ability to achieve in-situ microstructural tailoring through EBM positions it as a key player in advancing the state-of-the-art in aerospace applications, offering a pathway towards more efficient and optimized manufacturing processes.

Hossein Sanaei Ataabadi – An Innovative Waste-derived Capsule for Self-healing Cementitious Materials

In recent years, concrete with self-healing ability has been proven as a promising solution for repairing defects in concrete without external interventions. Despite the intrinsic autogenous self-healing properties of cementitious material, the incorporation of supplementary composites, such as capsules, has shown higher efficiency in sealing cracks. Capsule-based healing systems work based on the direct release of healing agents into the formed cracks. Hence, once the shell of the capsule is raptured by the pressure inside the crack, the core material is triggered so as to initiate the healing process. Moreover, the

application of waste-based materials represents a reliable and cost-effective approach to enhancing the efficiency of construction materials while mitigating the environmental impacts of organic materials. An innovative and eco-efficient capsule for self-healing cementitious material is proposed utilizing a by-product drinking water treatment sludge (DWTS) as a healing agent. The main elements released from the capsules were Ca, Al, and Si, which would contribute to pozzolanic reactions inside the matrix. Cracks with an initial width of 400 µm were healed in 7 days of curing in water, leading to enhancement in compression and water permeability recovery ratios of the healed samples. The predominant healing products obtained were calcium carbonate in the form of calcite, and some content of aluminium-bearing phases derived from the pozzolanic reaction of DWTS.

Md Ahasan Kabir – Development of Ensemble Learning Algorithm to Detect Aflatoxin B1 Contamination Almonds Using Hyperspectral Image for Inline Application

Almonds are susceptible to aflatoxin B1 in warm and humid environments, produced by the secondary metabolism of Aspergillus flavus and Aspergillus parasiticus fungi. The presence of aflatoxin B1 in almonds poses significant economic and health risks, as it can lead to spoilage of the crop and, more critically, pose health hazards upon consumption. In this study, we evaluated the performance of a developed Ensemble classifier for full spectra and multispectral imaging system in detecting aflatoxin B1 (AFB1) levels in single kernel almonds. The artificially five levels of AFB1 contaminated almonds hyperspectral data are used to develop the classification model. The experimental results demonstrate the developed ensemble model has effectiveness in predicting AFB1 contaminated almonds levels. The classifier achieved high accuracy and minimal error rates for training, testing and cross-validation. Also, the multispectral model achieved higher classification accuracy with high F1-score. These findings underscore the potentiality to detect aflatoxin B1 contaminated almonds using multispectral system for rapid online application.

Guangtong Huang – A framework for designing and optimising LC3 cement considering mechanical, environmental and financial properties

The potential of limestone calcined clay (LC3) cement in reducing CO2 emissions has garnered significant attention, yet the formulation of the LC3 system remains a subject of debate. This study introduces a multi-objective optimization (MOO) framework to design the optimal LC3 system, aiming to maximise compressive strength while minimising environmental and economic costs, simultaneously. The MOO framework integrates a regularised multivariate polynomial regression (MPR) model, achieving an R2 of 0.927 and MSE of 3.445 for mechanical performance prediction. Additionally, life cycle assessment quantifies the environmental impact, and collected market prices contribute to financial considerations of LC3 system. Utilising a dataset of 366 LC3 mortar mixtures, the optimization challenges the conventional 2:1 calcined clay-to-limestone ratio (CC:LS). For high strength (≥ 65 MPa), target a CC:LS ratio of 1:1 to 1.6:1; for lower strength (< 65 MPa), increase calcined clay content, resulting in a CC:LS ratio of 1.6:1 to 2:1. The proposed framework serves as a valuable starting point to enhance the efficiency of LC3 system design and help decision-making to achieve desired mechanical, economic, and environmental objectives.

Esmat Ebadati – In-situ optical method pH sensing towards understanding nutrient availability in the soil

It is well established that plants need nutrients to grow. In farming, these nutrients are added to the soil in the form of fertilisers. However, depending on the soil conditions (such as temperature, water content, pH, soil type, etc) the nutrients may not be in the right form for plant uptake. Determining the availability of nutrients in the soil for plant growth is therefore critical for the yield and productivity of modern farming. A considerable amount of research and knowledge has been developed that shows the importance of the soil pH on the availability (or not) of nutrients. This PhD research aims to understand how to determine in real-time the pH in-situ to the soil in a continuous stable manner in pursuit of informing farmers about nutrient availability. To achieve this, pH sensitive polymer will be investigated via optical sensing techniques.

Bikash Devkota – Numerical investigation of suction profiles under climate extremes

One of the aspects of climate change is climate extremes such as droughts, excessive wet years, and so on. Climate extremes can have various impacts on the socioeconomic setting, ecosystem, and built environment. From a geotechnical perspective, the stability of slopes, the performance of pavement, and other lightweight structures can be affected severely. Most importantly, expansive soils that show greater affinity towards water have substantial potential for moisture-induced volume change. This leads to significant stresses on the foundation of lightweight structures. The atmospheric boundary conditions affect the soil profile along the depth and such profiles can vary with climate change including climate extremes. This study examines the suction profiles under various climate scenarios through a series of numerical simulations. Climate extreme conditions were generated with reference to a long-term data series recorded in the past. Numerical analyses showed the probability of significant changes in suction profiles as per the frequency of expected years of climate extremes.

Joshua Davis – Attack-resillient CubeSat constellations

The space sector is rapidly expanding and with it, constellations of small satellites such as CubeSats. This development has the potential to transform the operations of various industries already dependent on satellite technologies, such as remote communications, earth observations, and financial transactions. Consequently, resulting from this growth the potential cyber threat landscape has broadened, necessitating advancements in Intrusion Detection Systems (IDSs) as threat actors continue to evolve. Machine learning-based IDSs, when trained on terrestrial datasets, inadequately capture the unique dynamics and communication protocols of space systems. This research hence endeavours to bridge this gap through the development of a comprehensive dataset, specifically tailored to the multifaceted aspects of the space sector, thereby enhancing the capabilities of machine learning-based intrusion detection within the domain. By concentrating on the distinctive characteristics of the space, ground, user, and link segments, the aim is to accurately emulate these systems and the cyber threats they face, improving threat recognition and mitigation within the space sector.

Yang Cao – A numerical simulation to assess the effect of saturation degree on sandy soil

Liquefaction could result in serious damage to the infrastructure and cause huge economic losses, therefore, the failure mechanism of it requires intense study. Many Discrete Element Method (DEM) studies have successfully replicated the undrained behaviours of sandy soil under both monotonic and cyclic loadings. However, most of these studies have simulated fully saturated assemblies, achieving undrained conditions based on the constant-volume assumption. Note that quasi-saturated sandy soil is prevalent in practice, in which compressible pore air is generally believed to constrain the rapid increase of pore water pressure and mitigate liquefaction. Nevertheless, some laboratory studies have indicated that quasi-saturated sand can still experience liquefaction under cyclic loading. This study aims to investigate the liquefaction resistance of both saturated and quasi-saturated sandy soil under undrained triaxial shearing. The traditional DEM with a constant-volume approach assumption is not suitable because the presence of pore air can significantly increase the compressibility of the assembly. To address this, a novel DEM software, DEMPLA, has been adopted for the simulations.

Vijay Aralappanavar – Development of a Diffusion Gradients in Thin Films (DGT) methodology to assess bioavailability of herbicide residues

Imidazolinone herbicides have been widely used to control broadleaf and grassy weeds in Clearfield® cropping system. However, repeated application over the years had led to their residual development and carryover effect on subsequent sensitive crops. The conventional methods for measuring these herbicide residues only quantify the total herbicide concentration in soil without determining the concentration to which crops are truly exposed (i.e., the bioavailable fraction). Diffusion gradients in thin films (DGT) is an in situ passive sampling technique has been designed and tested for measuring the potential plant availability of various organic pollutants but with less focus to date on soil pesticide residues. The study aimed to develop a DGT

methodology to measure the bioavailable concentration of two commonly used imidazolinone herbicide (imazamox and imazapyr) residues from the soil system. Twelve different materials were tested to select promising binding phases for DGT development. Of all the tested materials, biochar and SepraZT-WAX showed high adsorption and elution efficiency and their performance were independent of the following: pH in the range of 4.1–9.0; electrical conductivity from 0.01–0.5 M; sulfate concentration 0-600 mg L-1. The developed DGT performed exceptionally in the pure solvents but their performance to predict herbicide bioavailability in soils needs further testing.

Gertrude Acquah – Advanced recovery of critical battery metals from complex low grade ores and wastes

The rise in demand for sustainable energy solutions due to energy security, rising fossil fuel costs and the impact of climate change has led to an increased interest in alternative options with reduced CO2 emissions. This has resulted in a growing demand for electric vehicles and smart devices powered by battery, with expectations of continuous growth in the future. The growing demand coupled with the current depletion of high-grade ores has necessitated the processing of economically less attractive, refractory, mineralogically complex and chemically variable low-grade ores (< 1.5 wt%). It is presented that hydrometallurgical methods such as agitated tank and heap leaching, provide economical approaches for extracting metals from low-grade ores. However due to their major drawbacks (e.g., poor selectivity towards Ni-Co, higher acid residual consumption and long processing times), much improvement is needed for eco-efficient processing of value metals. This research project aims at determining and developing eco-efficient novel methods of upgrading and extracting nickel and cobalt from lateritic ores and wastes.
In the present study, the effect of mechanical activation as a pre-treatment method on pulp acid leaching behaviour of cobalt and nickel from low-grade goethitic nickel laterite ore was studied at 70°C. Mechanical activation was achieved by stirred milling of the feed ore for different times in the range 1 to 60 min. The results showed that nickel and cobalt extraction increased by a maximum factor of ~ 5 and 9, respectively, after 4 h of atmospheric acid (H2SO4) leaching for 60 min milled feeds. Mechanical activation led to reduction in the average particle size and increased surface area. The slow kinetics of the atmospheric stirred tank leaching of nickel and cobalt from complex, low grade laterite ores at low to moderate temperatures could be ascribed to the inherent refractory iron oxides. Further studies to improve the extraction efficiency of Co and Ni is ongoing.

Umar Memon – Enhancing Interoperability and Adaptability in Composite Digital Twins: A Novel Architectural Framework

Research on Digital Twins (DTs) has proven useful to provide new insights into predictive maintenance and real-time monitoring of machines and to support decision-making. However, leveraging the full potential of DTs necessitates an understanding of their capabilities in multi-DT environments, a facet yet to be extensively investigated. Current frameworks often lack interoperability, hindering seamless interactions between DTs. This research presents an architectural framework for composite digital twins, aiming to facilitate interoperability, integration, and self-adaptation.
Our proposed framework enriches existing approach by integrating the MAPE-K (Monitor, Analyze, Plan, Execute, and Knowledge) paradigm and ontological structures to realise self-adaptive composite digital twins. This incorporating MAPE-K into the model library enables dynamic adaptation of any changes that may occur in real-time by determining the optimal combination of models at any given time, to effectively delivery the functionality required for a composite digital twin. It enhances self-adaptivity in models and improves interoperability in a case where multiple models are involved as each individual property will be considered and evaluated during composition. This work also proposes to develop a conceptual meta model to define the inputs and outputs, relationships between the models. This meta model is defined to transfer information between DTs and is done through defining ontological structure by using a model library that also allows scalability. This meta model offers a comprehensive approach to interoperability while accommodating multiple related domains Validation and evaluation of the solution will be carried out by using the case study.

This presentation will introduce the architectural Framework and discuss practical implications of our research, advancing the capabilities of composite digital twins in diverse industrial contexts.

Corey McKechnie-Martin – The Spheres of Player Motivation: Understanding the Dimensionality of Players in Digital Games

It is widely stated that people play games to have "fun". But "fun" is a complex emotional state that can be impacted by many other fundamental wants. The question of what makes something fun for an individual is quite complex. These questions are difficult to explore due to the nuanced and subjective nature of the topic. While numerous Models have been proposed in the past to quantify the motivations felt by players, the pursuit of novelty creates an environment where the games industry is ever-evolving. Technological advancement leads to new ways to engage with games, and in turn, leads to new reasons why a game is "fun".

A mixed-methods approach was applied to gain a rich insight into player motivations, combining qualitative and quantitative measures through the four studies presented in this work: a meta-ethnography; a card sort; expert interviews; and player surveys. Using a combination of analysis techniques to explore the relationships between motivations and identify recurring themes within player and developer narratives to understand the nuances of their experience with games.

A novel model for interpreting player motivations is proposed, called "The Spheres of Player Motivation". By synthesising and expanding upon existing interdisciplinary player motivation research, this dissertation provides valuable insights for game developers and game researchers seeking to understand the diverse and nuanced reasons people play games.

Overall, this dissertation advances the current body of knowledge, contributing to improved theoretical understanding and the practical connotations of motivation within the game development domain. The findings have implications for academia, industry, and society at large. Offering a unique contrast against how player motivations have been modelled in the past by examining it through a multi-disciplinary lens.

Dmitry Resnyansky – Tangible Augmented Reality For Text-Based Programming Education

Innovative technologies such as Augmented Reality (AR) and Virtual Reality, tangible user interfaces (TUIs), computer games, robotics and microprocessors have seen an interest within educational research due to their potential for fostering active learning in and outside the classroom. This paper aims to explore the affordances of AR and TUIs as mediums of instruction to address the problem of teaching and learning text-based computer languages, computer science concepts, and programming skills such as debugging. It presents parallels between the technology-supported learning and the active, scaffolded narrative entertainment experience in videogames, and suggests a conceptual framework for the design of learning environments for programming and debugging by using AR and tangible interaction to support scaffolding.

Mahdi Shafiei – Authorship Attribution in Social Media: A focus on binary n-gram analysis

Authorship attribution is a key process in text mining with numerous applications, particularly in the field of social networks. It is defined as identifying an author based on the extracted patterns from the same author in the past. In this research, we continue the trend of narrowing the scope of the features, which has been trending from sentences to characters in the literature and focus on the binary representation of the text. We develop a method to extract binary n-gram features from the text and then train a classification model to predict the author based on the provided set of the features. Our approach can use either short or medium-size texts or their mixture without separating them. We evaluate our approach using a number of various data sets including comments and reviews on social platforms

Naeem Paeedeh – Handling Dynamic Environments with Extremely Few Examples

Despite the impressive successes of Deep Neural Networks, they have some weaknesses. Firstly, they require many samples for training. Collecting and labeling many samples can be expensive, time-consuming,

and error-prone. It is sometimes impossible to store data such as medical images due to privacy concerns. Second, they quickly forget their knowledge by learning new concepts. By contrast, humans learn new concepts daily by observing one or a few examples, accumulating abstract knowledge during their lifetime, and generalizing their past knowledge to significantly different domains or tasks without forgetting prior knowledge. In dynamic environments, the neural networks must quickly learn from only a few available samples, be ready to learn new concepts and patterns when encountering drastically different environments and objects, and continually learn without forgetting. Considering the importance of few-show learning, any improvement can impact many aspects of our lives, such as healthcare, autonomous driving, recommendation systems, manufacturing, agriculture, and commerce.

Kieran Sparkes – Non-Invasive Prenatal Testing Using Extracellular Vesicle Derived Fetal DNA.

Non-invasive prenatal testing (NIPT) provides genetic insights on an unborn fetus from a simple maternal blood sample. It has revolutionised prenatal screening due to its ability to accurately confirm the absence of chromosomal disorders. However, NIPT is limited to a testing a handful of chromosomal disorders, disregarding other severely debilitating conditions, and it remains a screening test requiring follow up invasive testing due to false positive results.

The challenges faced by NIPT primarily stem from the small amount of fetal DNA available in the mother's blood for testing and an inability to perfectly distinguish fetal DNA from maternal DNA. My PhD research focuses on investigating a novel NIPT based on fetal DNA specifically associated with extracellular vesicles (EVs). EVs are tiny bubble-like structures released by all cell types, and placental EVs are released into the mother's blood. I hypothesised that specifically enriching DNA associated with EVs substantially increases the proportion of fetal DNA relative to maternal DNA and improves testing performance. I aim to answer both basic questions about the origin of fetal DNA in maternal blood and its association with EVs and provide a proof of concept of a clinically useful next generation NIPT. To this end, I will be presenting the current confusion about the origin of fetal DNA in maternal blood, its relevance to NIPT, and the approaches I will be using to answer these basic and clinical questions.

Ali Nazarizadeh – Comparative study of radiosensitizing effects of gold and aluminum nanoparticles; does atomic number matter?

Heavy metal-based nanoparticles are being investigated as radiosensitizers to enhance radiotherapy. Although a couple of nano-radiosensitizers have progressed to the clinic, their mechanisms of action are yet to be elucidated 1. While the conventional theory emphasizes the physical interactions between the nanoparticles and X-rays; we have recently shown that gold nanoparticles (AuNPs) downregulate the enzyme required for DNA damage repair, following radiotherapy 2. This discovery spurred us to further investigate the radiosensitizing mechanisms of AuNPs compared to immunogenic aluminum nanoparticles (AlNPs) 3.

The bespoke AlNPs and AuNPs were synthesized and characterized in our laboratories. Next, their toxicity to 4T1 murine breast cancer cells was assessed, to identify biologically relevant concentrations at which the NPs induce minimal, moderate, and maximal toxicity. Next, their ability to attract RAW264.7 murine macrophages to 4T1 cells using a dual-chamber transwell system as well as induce phenotypic changes to the macrophages was studied. Their effects on the invasiveness of the 4T1 cells were also quantified using Matrigel® invasion assay. Finally, their radiosensitizing effects to 4T1 cells was investigated using the clonogenic assay following irradiation with 160 keV X-radiation.
Both nanoparticle types significantly increased the migration of RAW264.7 cells and induced morphological changes characterized by enlarged and hypervacuolized cells. While AuNPs significantly reduced the invasion of 4T1 cells with a dose-dependent trend, AlNPs surprisingly increased the invasiveness at the minimally toxic concentration and reduced at the other two concentrations. Finally, both NPs significantly increased the number of aborted colonies and reduced colony sizes compared to the untreated 4T1 cells with or without the lowest radiation dose (Figure 1).

These findings suggest that biological interactions between NPs and cells also plays an important role in radiosensitization, as well as the physical interactions between x-rays and nanoparticles. Therefore, high atomic number of a nanoparticle may not be essential for it to act as a radiosensitizer which has been validated in vivo, as well.

Le Tuong Van Vo – Development of The Next-Generation Antimicrobial Dermal Matrix for The Management of Deep Burn Injury

Infection is the most frequent and inevitable complication in burn injuries, especially in severe deep burns where the invasion of bacteria and biofilm formation can lead to systemic inflammatory response, possible sepsis, and multi-organ dysfunction. Although several artificial dermal substitutes and wound dressings have been commercialized, to date, none of the currently available products are able to address clinically challenging wounds with limited capacity to stimulate healing, prevent infection and reduce scarring. In the field of wound healing and tissue engineering, a critical knowledge gap exists in the endeavor to converge dermal substitutes with antimicrobial and wound healing agents, representing a promising avenue for more effective and customized treatments. To address the clinical issue of infection in deep burn injuries, this study proposes an investigation of a safe and effective dermal substitute in combination with antimicrobial peptides. This will achieve dual action, promoting wound regeneration and preventing infection.

Neve Skinner – Going South: establishment of invasive, tropical pearl oysters in the Upper Spencer Gulf of South Australia

Marine introduced species are a global problem, and in many places affect ecosystem functioning and cause economic loss. However, not every introduced species establishes long term or has a major impact on how a receiving ecosystem functions. One such introduced species local to South Australia is the pearl oyster Pinctada albina, which's introduction has caused concerns for locals of the Upper Spencer Gulf. The particular concerns of P. albina's introduction to the Upper Spencer Gulf is the possible 'invasive' capabilities that they are having by competing with the native bivalve razorfish (Pinna bicolor). To fully comprehend the effect that introduced pearl oysters are having to the Spencer Gulf ecosystem, it is important to understand the demographic processes that may have facilitated their establishment here and the effect they are having on native biodiversity.

Genine Meredith – Geospatial literacy expectations in the transition from secondary to tertiary education

Geospatial literacy is an individual's capability to understand and critically evaluate information within a geospatial context. Currently no pre-requisite criteria of geospatial literacy in Australia exists when students move from secondary into tertiary education. Incorporating several stages, this study characterised and established a tool for benchmarking geospatial literacy (GeLDA) for students entering geospatially relevant undergraduate degrees. This presentation focuses on the stage that explored what a cohort of tertiary academics in Australia considered to be essential geospatial literacy. Research was accomplished through interviews and questionnaires. Results suggested that although all geospatial literacy concepts put forward were applicable to the tertiary courses, consensus (over 70% agreement) on the level of capability expected for each concept was not achieved. Most academics recognised that they did not know the specific achievement standards of senior secondary school leavers, instead providing additional support to make the tertiary course content accessible. The data gathered provided further refinement of GeLDA and an argument for a more formalised communication pathway between the secondary and tertiary education sectors.

Title and Abstract

Session 3

Abbas Abbara – Effect of Length on the Compression Behavior of Radiata Pine Solid Sawn Timber.

The demand for solid sawn timber in engineering applications has increased in the last 20 years, as timber is one of the most renewable materials for construction, with attractive properties including low specific gravity, high strength, and stiffness. However, timber is heterogeneous material. At macro-scale, the material properties vary in the longitudinal direction due to presence of defects such as knots, spiral grain, and density variation resulting in phenomena called length effect. Length effect can be divided into statistical and deterministic length effect. The literature lacks information about the variation of compression behavior of solid sawn timber with respect to length resulting in limited application of solid sawn timber as compression members, and unclear characterization of compression properties of timber boards. Accordingly, studying the variability of compression properties of timber board will improve the understanding of timber behavior for structural application and increase the reliability of this material. Therefore, the aim of this research is to study and predict the effect of length on compression strength, elastic modulus, fracture energy and stress-strain relationship of solid sawn timber using experimental and statistical methods. Compression test includes two matched datasets of timber boards with grade MGP10, cross-section of 35 x 90 mm. 50 timber board with length of 2720 mm, each timber board will be divided to 8 short segments with length of 340 mm resulting in 400 test pieces (Dataset A, short test piece). 50 laterally restrained timber boards with length of 2720 mm (Dataset B, long test piece). Dataset A will be used to determine the compression variability within timber boards (statistical length effect), While the deterministic length effect will be determined by statistical comparison between Dataset A and Dataset B.

Abdulrahman Alshahri – Retrofitting of Eccentrically Loaded Slender Concrete Column with Textile Reinforced Engineered Cementitious Composite

This study addresses gaps in research regarding Textile-Reinforced Engineered Cementitious Composite (TRE) concrete column retrofitting. TRE retrofitting exhibits superior performance compared to Textile-Reinforced Mortar (TRM), primarily due to its optimized utilization of textiles, which facilitate efficient stress distribution through strain-hardening characteristics. TRE also outperforms Fiber-Reinforced Polymer (FRP) retrofitting, where FRP is characterized by the susceptibility to adhesive degradation when subjected to high temperatures and reduction of confining pressure when undergoing freeze/thaw cycles. Additionally, the brittleness inherent in FRP wrapping contrasts with the desirable ductility of TRE retrofitting. While existing studies have primarily focused on short and concentric loaded concrete columns, the behavior of eccentrically loaded slender concrete columns retrofitted with TRE remains unexplored. In practical structural cases, columns are subjected to a combination of axial load and moment, moment can be developed due to, construction imperfections, lateral loads, and initial eccentricities induced by supported beams. Therefore, the behavior of beam-column elements retrofitted with TRE requires investigation. The research objectives encompass investigating load-carrying enhancement, lateral rigidity enhancement, and axial load-flexural moment interaction. The impact of multiple factors including the number of textile mesh layers, and column slenderness ratio on the behavior of retrofitted slender concrete columns will be comprehensively examined through both experimental and analytical methods. The experimental results will culminate in developing an analytical methodology to predict the performance of retrofitted slender concrete columns under eccentric compression. Throughout this research, carbon fiber textiles will be employed in the retrofitting TRE layer. The finding of this study will potentially enhance understanding of TRE's efficacy in retrofitting slender concrete columns and provide valuable insights for the design of such columns.

Rahma Elsebaie – Developing High-Quality Optical Coatings for Rare-Earth Doped Fluoride Glass Lasers

High-quality optical components are in demand in industries like manufacturing, telecommunications, and medical, as they are crucial for controlling high-powered lasers.

This research project will develop multilayer coatings for near-infrared (NIR) laser wavelengths by depositing dielectric materials, such as Ta2O5, HfO2, TiO2, and SiO2. The coatings will be deposited using physical vapour deposition (PVD) techniques, and their optical properties will be analysed.
The project aims to investigate, design, and develop multilayer thin film coatings for ZBLAN (ZrF4-BaF2 -LaF3 -AlF3-NaF) glass, NIR laser gain medium. The expected enhancement in the optical properties of the optical interfaces in such lasers includes improved efficiency, beam quality, and stability.

Jan Vincent Santos – Influence of shot peening and ball burnishing on the long-term immersion of magnesium AZ31 in in vitro conditions

Temporary fixators that facilitate bone fracture recovery have materials with stiffnesses too high compared to the surrounding bone which results in stress shielding and gradual bone density loss. Alternatively, there has been a rapid increase in magnesium studies due to its biocompatibility, low elastic modulus and gradual degradation in in vivo conditions. Prolonged fixator mechanical integrity is required to ensure proper bone fracture recovery while enabling the eventual fixator dissolution in situ. By utilising mechanical surface treatment on magnesium, the corrosion rates and biomechicanical stability can be customised for the fracture and fixator combination. The shot peening (SP) and ball burnishing (BB) will be applied on the AZ31 Mg alloy on 4 intensities based on a previous study; UNT (untreated control) SP (240 kPa), BB (88 bar) and their combination. To assess the long-term corrosion performance of each sample was submerged in simulated body fluid for 2, 4 and 7 days. The mass loss, hydrogen gas released, pH levels and surface composition were measured. Both the UNT and BB 88 bar samples had low corrosion rates based on the H2 gas evolution and mass loss measured. However, while under high magnification, the BB 88bar samples' surface compressive residual stresses resulted in narrower and less frequent cracking at the grain boundaries compared to the UNT sample. Based on all data collected, the SP 240 kPa and SP+BB 240kPa/88bar degraded substantially more than, as pitting corrosion, either the UNT or BB 88bar samples. The crystallographic defects and the high surface roughness produced in the manufacture of the SP 240kPa and the SP+BB 240kPa/88bar have made it vulnerable to rapid Mg corrosion. While the combination SP+BB 240kPa/88bar sample had more surface structure retained after the 7 days, the fewer cavitated site were similar in size to the SP only sample. Further research into optimising ball burnishing intensity levels could yield customisable corrosion rates for in vitro conditions while shot peening is too detrimental even with the help of ball burnishing.

David Willmore – Understanding the effects of pressurised vessel failures on hydrogen fires

The feasibility of hydrogen as a fuel source is heavily dependent on efficient storage. However, the high-pressure required to achieve the target storage efficiencies presents a significant risk of autoignition if the tanks were to fail. The sudden, supersonic release of hydrogen and the formation of high-energy shock-waves may combine to produce the necessary conditions for autoignition. The likelihood of an autoignition event occurring when a pressurised hydrogen tank fails can be increased by nearby objects, through either increasing mixing, or introducing surfaces from which shock-waves can form and reflect. The use of hydrogen will see a network of pipes surrounding the tanks which can lie in the path of a hydrogen jet formed upon failure. Numerical simulations have been conducted to analyse the release of high-pressure hydrogen into a confined space, both with an impinging cylinder and without, mirroring two possible failure scenarios. The results show that upon sudden release, a supersonic jet of hydrogen forms, along with a leading shock-wave. When obstructed, the impingement with the cylinder impedes the flow, resulting in a localised heating and stagnation, allowing for ignition to occur. A wake forms behind the cylinder and draws the heated hydrogen into this region, rapidly mixing with the air and forming a rapidly expanding flame. When free of obstruction, the leading shock-wave propagates downstream and is reflected by the walls of the confined space. The reflected shock-wave intersects with the leading shock-wave and causes a significant increase in energy, leading to ignition. The wake of the impinging cylinder mixes the hydrogen and air, forming a region of premixture, which the flame rapidly accelerates through, experiencing the phenomenon of deflagration-to-detonation transition. The absence of an impinging cylinder limits the amount of mixing that occurs, preventing the flame from transitioning into a detonation

Jessica Tejeda – WSUD in Semi-Arid Regions: Assessing the Performance of Emerging Infiltration Systems in Relation to Regional Planning Policy and Environmental Needs

This research focuses on a recently developed kerb side stormwater infiltration system with 275 L of storage and a media material known as stone-wool. The main objective is to investigate how can these systems be implemented strategically in a regional catchment to reduce peak flows, runoff volume and improve water quality for receiving waters. Additionally, a socio-technical component has been added to understand the power of influence that each stakeholder plays in applying this new technology.

Franke Agenbag – An Automated Method of Detecting, Characterising, and Responding to Radiation Events in Space

The barrier to entry into the small satellite industry is lowering considerably in terms of manufacturing cost, time for construction, and cost to launch, enabling rapid experimentation and large constellations. Space has been listed as a Sovereign Industry Capability Priority (SICP) and there is a wide range of space applications that Australian Defence can undertake to achieve its goals in the harsh environment of space. With the shift in the space industry to small satellites using commercial-off-the-shelf products, this has reduced standards around space resiliency, and recent results have shown that approximately 40% of all small satellites launched in the last two decades experienced total or partial mission failure (Jacklin, 2018). However, reduction in mission assurance has not reduced the operational mission expectation. In order to ensure a resilient spacecraft that meets the demand for Australian Defence capability, a spacecraft must be designed to survive in its environment and characterise and respond to threats in this changing environment. It is commonly known that space radiation has detrimental effects on electronic components in low-earth orbit. Currently spacecraft attempt to pre-emptively mitigate radiation events by using earth-based space weather forecasting. Gaining understanding and characterising radiation induced effects will be essential to real-time on-orbit mitigation. Single event effects (SEEs) arise from strikes of cosmic rays, protons or neutrons and they cause significant damage to electronics on board spacecraft. Characterising SEEs will be essential for outlining a procedure for the design and validation of radiation-tolerant electronic systems.

The system being proposed will measure and characterise the types/intensity of radiation experienced in space through sensor instrumentation which can be implemented on-board spacecraft, and it will respond to measured results in real-time. Implementing a real-time response in space, using characterised radiation data, is a novel concept.

Tesi Liu – New radiobiological insights using a microphysiological device enabling long-term culture of patient-derived brain tumour tissue slices and cerebral organoid slices

Glioblastoma (GBM) is the most aggressive and prevalent form of primary malignant brain tumour with by a dismal 5-year survival rate of 5.8%. Conformal adjuvant radiation therapy is the current standard of care for GBM patients following surgical resections but remains limited by frequent neurotoxicity. Towards improving survivors' quality of life and based on the specific physical characteristics of proton beam, proton therapy is increasingly used to treat locally advanced cancer. However, to date only limited evidence supports its clinical benefits for GBM patients. My PhD project aims to address critical radiobiological knowledge gaps and to foster proton therapy's clinical utility in GBM. Specifically, the radiobiological knowledge that will be gained will support the design of precision proton treatment plans aimed at improving patient treatment outcomes. To deliver the anticipated outcomes, our approach relies on the integration of micro-physiological perfusion/culture technology with patient-derived organotypic tumour (to preserve the tumour microenvironment) and cerebral organoid slices. The unique feature of this design enables us to culture tumour/cerebral organoid slices for long period of time, this enabling more systematic assessment of brain tissue radiobiological responses. We anticipate that the outcomes of the project will contribute to better radiobiological knowledge for not only brain tumour but also healthy brain parenchyma, with the potential to assist in the selection of an optimal radiation protocol for each patient.

Adam Keith – Assessment of PFAS exposure from produce grown in contaminated media

Per- and poly- fluorinated alkyl substances (PFAS), also known as 'forever chemicals', are a group of stable, environmentally and biologically persistent organic compounds that present a significant potential health risk to humans. Ingestion is a main pathway for human intake, with my literature review finding that consumption of food plants alone potentially introduces PFAS to the body in quantities that exceed minimum risk levels advised by some regulatory bodies. My research is investigating factors that impact uptake of PFAS by some food plants, which is hoped to subsequently be used to inform strategies to reduce potential human health risk from PFAS.

Arieli Tristao Rezio – Developing analytical methods to analyse neodymium isotopes in marine animal tissues: a novel marker for tracking the movement and origins of marine species

Neodymium isotopes are a highly novel and promising tool for tracking the origins of marine animals and their products (i.e. seafood). They are influenced by continental geology and are thus spatially distinct in the seawater. However, Neodymium (Nd) is a rare earth element and is found in relatively low concentrations in both seawater and marine animal tissues and can be challenging to extract with minimal contamination. Currently, known methods for extracting Nd from living marine animal tissues are restricted to bivalve molluscs, with limited details regarding sample digestion and preparing the sample solution prior to Nd purification. This exploratory research tests different methods for better extraction of Nd in different types of animal tissues in a variety of taxa, including both soft and biomineralized hard tissues. I will also discuss our upcoming field research on Nd isotopes, where I will be exploring the incorporation and uptake of Nd isotopes in different marine animals. I hope that this study will help researchers who are analysing Nd isotopes in marine animals for the first time and encourage the uptake of this potentially powerful tool in marine ecology.

Ishara Rathnayake – Building the future: Fostering circularity through the new dawn of sharing economy practices in the construction industry

The sharing economy (SE) concept emerges as a transformative shift in resource utilisation, offering a promising path towards a more circular future. The SE is an economic system where individuals or organisations share underutilised resources using digital platforms. Despite increasing interest in this concept, limited studies focus on SE practices in the construction industry (CI). This research provides the first insights into the potential shareable resources in the CI through a systematic literature review (SLR) and a website analysis on digital platforms. Results revealed a notable lack of research on the SE within the CI compared to other industries. Potential shareable resources were categorised into 14 types. Among them, 'equipment/tools/machines/devices' sharing was highly practised in the CI, alongside 'space/storage', 'energy', and 'human resource' sharing. The Business-to-Consumer (B2C) model emerged as the prominent business approach. The research underscored deficiencies in construction-related SE digital platforms, namely, 'service coverage', 'information availability', and 'language support' and highlights the need for a user-friendly and feature-rich platform to facilitate SE practices in the CI.

Oluyimide Akinnawonu – Managing Timber's Moisture Content in the Supply Chain

The use of timber and other natural building materials in civil construction has significantly increased. Various studies have established a relationship between timber and environmental factors, such as moisture content and temperature. Wood mechanical properties depend on moisture content, on temperature and on their variations. Environmental impacts in the timber supply chain, from sawmills to final products, are major sources of concern. The moisture content of timber can undergo significant changes as it moves through the supply chain, from the mill to its eventual in-service location. Failure to manage these changes effectively can lead to unexpected issues affecting both appearance and structural integrity. It is important to understand the moisture content (MC) of timber and wood products in the timber supply chain and develop guidance that allows timber industry members to limit unacceptable MC variation and improve

customer confidence. Moisture Content issues in timber can occur in various stages, including transport from the mill to storage facilities, within these facilities, in fabricator workshops, on building sites, and during service.
As part of the research methodology, this study conducted semi-structured interviews with stakeholders in the timber supply chain, including timber mill workers, timber processors, timber suppliers and builders. These industry members shared their experiences with moisture content issues in timber products along the supply chain through an interview. It was observed that seasonal variations in temperature and humidity can significantly impact timber and wood products, leading to challenges throughout the supply chain. Results indicate that the timber supply chain will experience periods of different environmental conditions, from manufacturing through transport to in-service use, resulting in a broad spectrum of moisture content fluctuations. Understanding and managing these changes are essential for ensuring the quality and performance of timber and wood products. Wood have been used since ancient times in building construction and monitoring the moisture content (MC) of wood and avoiding large MC variation is a crucial task as a large moisture spread after drying can significantly devalues the product.

Melody Lau - Modernising Microbial Risk Assessment: Innovative Strategies for Contaminant Detection

Access to safe drinking water, a fundamental human right vital for public health, is guided by the Australian Drinking Water Guidelines (ADWG). These guidelines provide clear direction to water regulators and suppliers on monitoring and managing drinking water quality. Central to this approach is the utilization of E. coli as a key water quality indicator, with health-based targets enhancing its significance in determining treatment requirements for source waters. However, recent research challenges the conventional belief that the presence of E. coli in water always indicates faecal contamination.

The assumption that all faecal E. coli poses an equal risk is a significant limitation in current water quality assessment. Certain hosts, such as humans and cattle, carry a higher risk due to potential pathogens they may harbor. To address this, markers like Bacteroides 16S and mitochondrial 12S RNA have demonstrated their suitability in catchment screening, providing additional risk discrimination when E. coli monitoring falls short. Challenges, including low target concentrations and intensive sampling efforts, have arisen in implementing these alternative markers.

In this project, we explore the potential of passive sampling devices, known for high sensitivity in detecting low-level contaminants like SARS-CoV-2 in wastewater. Simultaneously, efforts are made to enhance current filtration methods to concentrate microbial templates in water samples. If successful, passive sampling could revolutionize microbial source tracking, precisely identifying sources of faecal contamination from humans, livestock, and wildlife. This information holds the promise of guiding tailored pollution control measures, effectively reducing associated health risks within communities.

Ivan Gutierrez Agramont – Sensitivity analysis of Data Driven Machine Learning algorithms for Laser Induced Breakdown Spectroscopy data.

In the evolving landscape of geochemical analysis, the accuracy of Laser-Induced Breakdown Spectroscopy (LIBS) data interpretation through Data-Driven Machine Learning (DDML) models is paramount. This study presents a sensitivity analysis of DDML algorithms, evaluating their performance in predicting elemental compositions of powdered materials. Through this analysis, we explored the nuances vital for creating resilient DDML models and their implications for predicting geochemical compositions.
A prototype LIBS instrument for geochemical analysis in a drillhole in a mineral exploration scenario, being developed within MinEx CRC, was used to collect spectral data from MgO and NaCl powder mixtures. Training datasets comprising variable subsets of the complete analytical dataset were used to evaluate the influence of training data volume, variance, and representativity on DDML algorithm efficiency. Results were correlated with XRF analysis of the same samples to ensure accuracy.

The study showed that the accuracy of DDML models in predicting elemental compositions relies heavily on the representativity of the training data. Denser datasets resulted in improved model performance. However, the sensitivity of the model predictions varied for each element depending on how well the training data represented them, with Mg exhibiting higher sensitivity.
This sensitivity analysis contributes to understanding how machine learning algorithms can be optimised for complex geochemical data, providing a pathway towards developing in-situ, laser-based geochemical analysis tools for real-time applications in mineral exploration. The results indicate a direct correlation between the number of training data and the model's predictive accuracy, with denser sampling leading to lower prediction errors and higher accuracy. The study highlights the importance of careful dataset preparation and the potential for DDML to innovate LIBS-based geochemical analysis methods.

Eleonora Vittoria Allievi – Defining the role of granzyme K in inflammation and chronic itch

Itch refers to the involuntary action of scratching in response to a fastidious stimulus. Itch is often considered a benign response, aimed at expelling noxious material or pathogens from the skin, but is also associated as a chronic symptom of inflammatory skin diseases, burns and cancer. At least 7% of the population suffers from chronic itch, defined as itch lasting for longer than 6 weeks, and it is a reported symptom by 87-100% of dermatitis patients and 79% of psoriasis patients. Itch is considered a very prevalent and challenging problem in clinical dermatology practice, treatments are primarily limited to targeting inflammation, rather than specifically the pathways of itch induction. The neurobiological mechanisms of itch are not well understood and a better knowledge of the pathways involved in inducing this response might reveal new targets and therefore better and more specific therapeutic options. Recent studies have identified a naturally expressed proteases called granzyme K is elevated in multiple inflammatory skin diseases characterised by itch, including atopic dermatitis, and psoriasis. Mechanistically, granzyme K was identified to be involved in a key step of the chronic itch pathway. We therefore hypothesise that granzyme K is involved in chronic itch. Using animal models of chronic itch in skin, we assessed a granzyme K inhibitory drug for its capacity to mitigate itch. Using a topical delivery strategy, a single drug administration led to >80% reduction in scratching behaviour, reduced skin damage and overall improvement of skin health. The drug displayed efficacy for at least 5 hours. This drug may therefore be a valuavle treatment for itch. Based on the data collected this far, we are further investigating this drug as a potential therapeutic approach to treat chronic itch.

Pasindu Karunatilaka – Estimating plantation water use in the South East of South Australia

Plantation forests were created to supply a variety of ecosystem services, mostly timber and other wood products, and make up close to 4% of the world's forests. However, compared to non-irrigated agricultural land covers like pasture, wheat, and other crops, plantations use more water. In South Australia, plantation forestry is currently a significant land use in the higher rainfall areas of the Lower South East, Kangaroo Island and the Mount Lofty Ranges. Plantation forest water use is licenced in the South East of South Australia based on the requirements of the Lower Limestone Coast Water Allocation Plan (LLCWAP). If the depth to the groundwater table is greater than 6 m, the model assumes that groundwater is not extracted. However, there is some evidence that Pinus radiata can extract water from the unconfined aquifer at depths of 6 to 9 m. Additionally, there is evidence that access to the water table can be affected by the geology, terrain, and hydrogeology of the region. Clay soils are known to generally hold more water than sandy soil but the movement of water through clays is restricted. Therefore, in this study Pinus radiata plantations will be assessed to identify whether groundwater extraction occurs at depths greater than 6 m, focussing on between 6 to 9 m from the surface. Eucalyptus globulus plantations with varying clay thicknesses will be observed to compare the water use behaviour with variation in clay layer thickness. Also, based on some concerns over the accuracy of the existing water use model in the LLCWAP for estimating forest water use, a new model will be developed and compared with current approaches to determine the water licence requirements of plantation managers and discuss any implications of the findings on the LLCWAP.