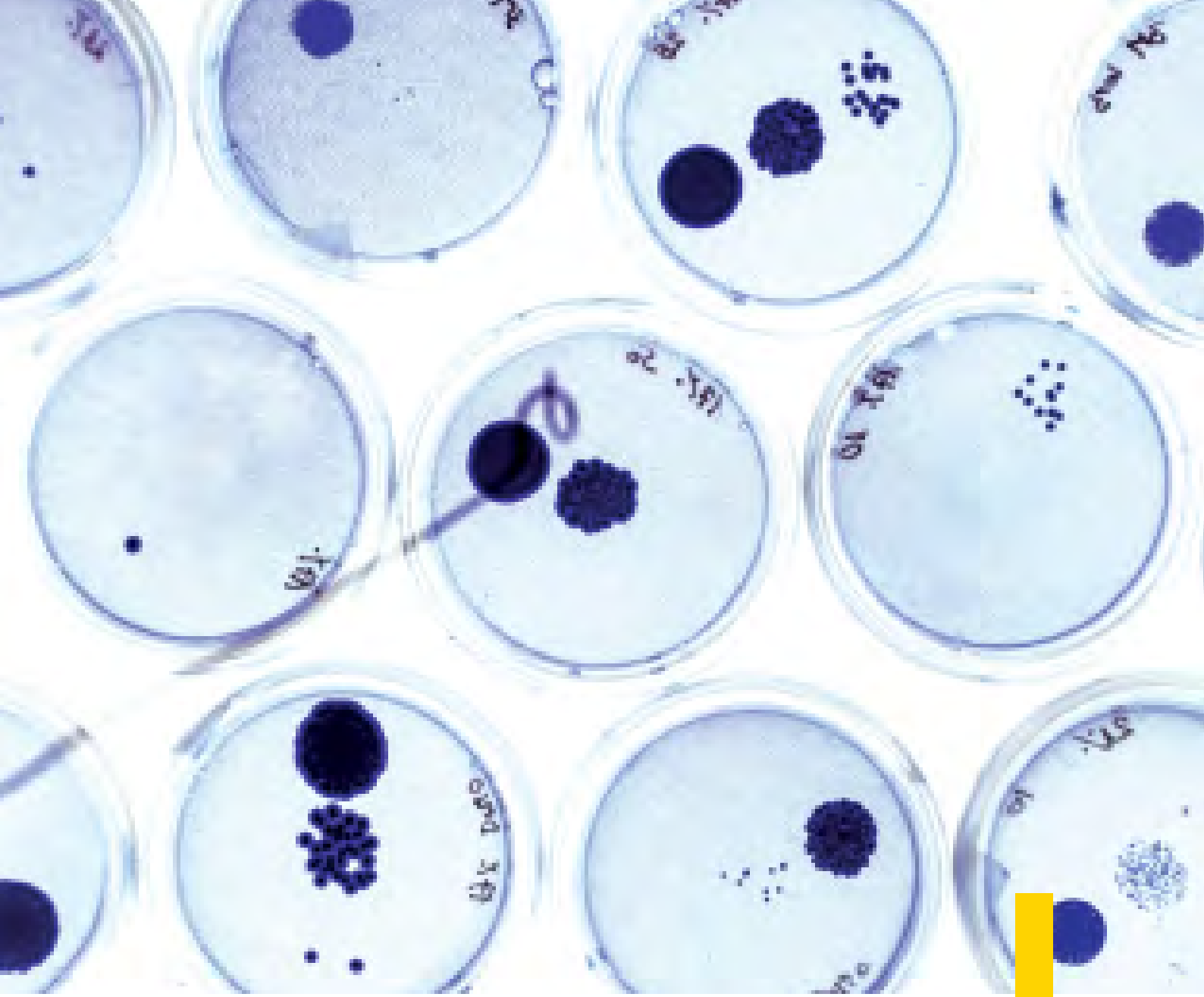

COLLEGE OF SCIENCE AND ENGINEERING

STUDENT RESEARCH EXPERIENCE AWARD 2025-2026

PROJECT BOOKLET

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ABOUT US

At the College of Science and Engineering, we believe in the power of science and engineering to solve real world problems.

We strive to advance fundamental science, to create new technologies, and to work across discipline boundaries. Our interests scale from the sub-atomic through to entire oceans, forests and beyond. We seek to understand the past, but also to create the world of the future.

Our researchers seek to discover new understandings in fields as diverse as groundwater hydrology, forensic science and medical devices, while our teaching offers training in areas of biological sciences, chemical and physical sciences, computer science, information technology, engineering, mathematics and the environment.

Our college is an exciting place to research, study and work, supported by best practice teaching methods, practical work-related learning and advanced facilities.

RESEARCH SECTIONS

Our talented researchers span across all spheres of science and engineering and bravely pursue solutions to some of the biggest questions of our time. With a broad focus on sustainability, security and health, our research advances knowledge, addresses real world problems, and promotes sustainable development.

Our multidisciplinary research sections provide areas of foci for our research community and encompass the following:

» DATA & INFORMATION SCIENCE

» ECOLOGY, EVOLUTION & ENVIRONMENT

» ENGINEERED SYSTEMS

» MOLECULAR SCIENCES & TECHNOLOGY

DATA & INFORMATION SCIENCE

In today's data driven world, our data and information science, computer science and mathematics researchers are at the forefront of creating practical solutions to real-world challenges. By embracing the rapidly changing technological environment, our research takes fundamental science and applies it to areas including agriculture, healthcare, and defence.

We focus on the integration of cybersecurity, machine learning and advanced data analytics to solving important and wide-reaching industry, government, and defence problems.

Our mathematicians and computer scientists are conducting world-leading research in artificial Intelligence, knowledge discovery, medical image processing, neuroscience, and cybersecurity. Our experts in digital health are making significant contributions to healthcare service delivery world-wide, creating new systems for data security, virtual care and digital infrastructure.

Conducting inter-disciplinary and collaborative research, we translate our research into tangible outcomes with broad impact for the benefit of the professions and the community.

Research Areas:

» Knowledge Discovery, AI & Data Mining
» Digital Health
» Cybersecurity & Networking
» Mathematical Analysis
» HCI, Simulation & Visualisation

ECOLOGY, EVOLUTION & ENVIRONMENT

We do broad and interdisciplinary research in ecology, evolution and the environment and are committed to producing world-class scientists through our Honours and PhD programs. Our work addresses questions at a range of spatial and temporal scales, from microhabitat to global and from generations to millennia. We study a variety of terrestrial and aquatic environments and organisms, ranging from the arid-zone to the deep sea and from bacteria to whales.

We do world-leading research in several areas of biodiversity and environmental sciences, including palaeontology, evolutionary biology, global ecology, molecular ecology, animal behaviour, groundwater and coastal geomorphology. Our research is expanding knowledge about the history of life and the potential of organisms to adapt to environmental change. We are also interested in improving water management and understanding the impact of human activities on the physical environment, biodiversity and natural resources. Our research section consists of around 180 academics, postdocs and research students housed at the leafy surrounds of the Flinders University campus at Bedford Park.

Research Areas:

- Hydrology
- Ecology & Conservation
- Environmental Health
- Evolutionary Biology & Palaeontology
- Marine & Coastal Sciences

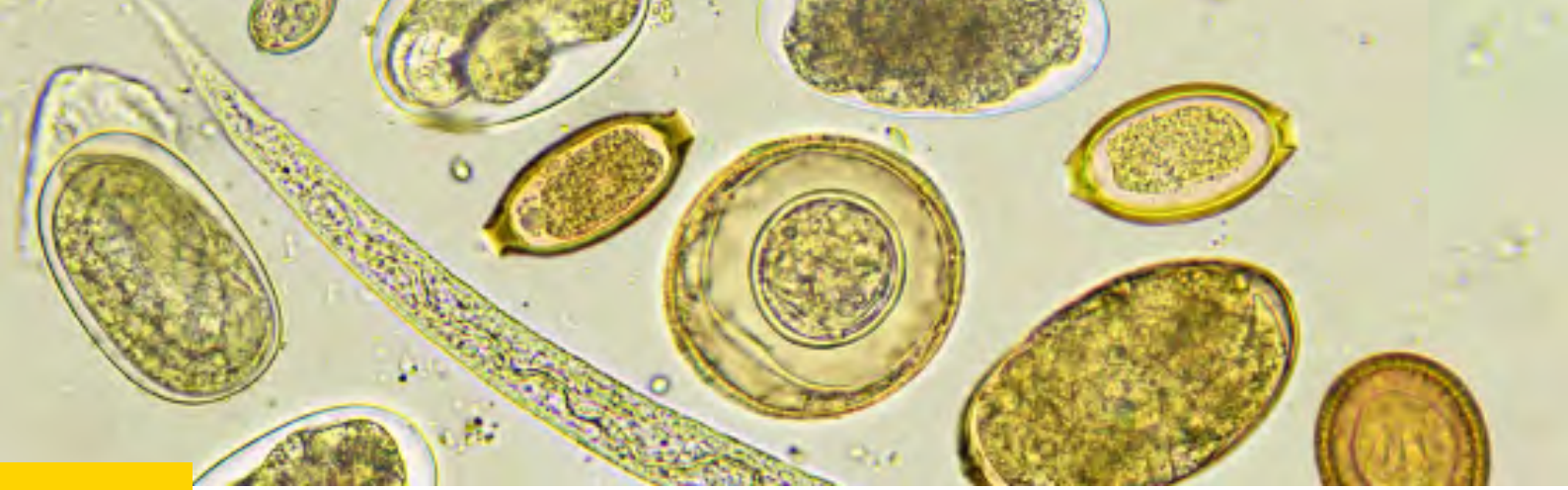
ENGINEERED SYSTEMS

We are dynamic critical thinkers and problem solvers who are undertaking research across diverse fields of engineering, including medical devices, defence and maritime capabilities for the future.

By combining fundamental research with the application of state-of-the-art engineering principles, we are developing new technologies and making new breakthroughs in Biomedical, Civil & Environmental, Electrical & Electronic, Control, Mechatronics & Robotics, and Materials, Mechanical & Manufacturing Engineering. Based at Tonsley, Australia's first Innovation District, our research incorporates strong collaborations with industry, across Australia and internationally.

Research Areas:

- Automation, Control & Robotics Engineering
- Biomedical Engineering
- Civil & Environmental Engineering
- Defence & Maritime
- Electrical & Electronic Engineering
- Materials, Mechanical & Manufacturing Engineering



MOLECULAR SCIENCE & TECHNOLOGY

From the smallest units of matter to the molecular systems of life, we are growing knowledge and developing technology to answer some of the world's biggest challenges.

Our research in physics, chemistry, molecular biology, and plant science is world-leading and dedicated to expanding our understanding of the physical and biological world.

We are also committed to translating this fundamental research into a wide array of real-world applications and impact. Our chemistry and physics discoveries have led to new nanotechnology for environmental remediation, energy production and storage, and advanced materials. Our biochemical research has made an impact on how we view and treat disease. Our forensic science research has provided innovative solutions for fighting crime. Our plant science research has made advances to support the future of food production.

We are forward-thinking and aim for scientific and technological advances for solutions spanning health, development, security and sustainability.

Research Areas:

» Physics
» Chemistry
» Molecular Biosciences
» Plant Biology
» Nanotechnology
» Forensic Science

RESEARCH PROJECTS

PROJECT TITLE	PROJECT SUPERVISOR(S)	RESEARCH SECTION
Multi-Drone Acoustic Swarm Dataset Creation and Classification	Dr Saeed Rehman Dr Shengjian Chen	DIS
Data Atoms for On-Demand Association and Access Control of Sensitive Data	Dr Asara Senaratne	DIS
Multimodal Character Conversations using Generative AI	Dr Matthew Stephenson	DIS
Microbial Dynamics Associated with Harmful Algal Blooms (HABs)	Prof. Elizabeth Dinsdale	EEE
Pygmy Bluetongue Project	Prof. Mike Gardner Ms Dee Trewartha	EEE
Interactions Between Harmful Algal Blooms on Seawater and Kelp Microbiomes	Dr Georgina Wood	EEE
Development and Validation of a Foot Model for Patient-Specific Orthotic Design	Dr Rami Al-Dirini Ms Salindi Herath	ES
Innovative Use of Lithium Mine Waste as a Sustainable Cement Alternative in Concrete Production	Dr Aliakbar Gholampour Mr Mohammad Valizadeh Kiamahalleh	ES
Exams or Experience? What Matters More in Engineering Education	Dr Reza Hashemi	ES
Nano Cluster Based Photocatalysts for Fabrication of Green Hydrogen	Prof. Gunther Andersson	MST
Determining Sea Spray Compositions	Prof. Gunther Andersson	MST
Bioinformatics of Human Gut Phages	Prof. Robert Edwards Dr Vijini Mallawaraachchi	MST
Biomass-Based Rechargeable Batteries	A/Prof. Zhongfan Jia	MST
Astrochemistry	Prof. Colin Raston	MST

DIS = Digital & Information Science
ES = Engineered Systems
EEE = Ecology, Evolution & Environment
MST = Molecular Science & Technology

MULTI-DRONE ACOUSTIC SWARM DATASET CREATION AND CLASSIFICATION

Background & Motivation: Drone swarms pose new security and safety challenges. Incidents like the 2018 Gatwick Airport disruption—where more than 50 drones spotted over a 15-hour period resulted in 30 hours of flight disruption and a significant financial loss—highlight the threat of simultaneous UAVs. Acoustic sensing (microphones) is a promising countermeasure: it is low-cost and drone propellers have unique audio signatures. However, most prior work and datasets assume single drones. In practice, multiple drones can fly together (civilian formation flights or hostile swarms), so we need detection methods that handle overlapping propeller noise. Recent reviews emphasize that the threatening potential of drones especially in security contexts sharpens the need for automatic detection and location of drone swarms.

This project will create and evaluate a synthetic multi-drone acoustic dataset by mixing existing single-drone recordings with environmental background sounds.

Project 1: Dataset Creation

» Source Selection: An open-source drone audio clips dataset will be provided.
» Audio Mixing: Combine two or more drone recordings with varied start times, amplitude scaling, and spatial simulation to represent different distances and movement patterns.
» Environmental Augmentation: Add realistic background noise (traffic, birds, urban sounds) and apply effects such as reverberation, propagation loss, and Doppler shifts.
» Scenario Design: Produce dataset representing civilian, mixed-type, and high-noise environments.
» Metadata Annotation: Document the number, type, and configuration of drones in each file for reproducibility.

Project 2: Classification & Detection

» Feature Extraction: Generate spectrograms and Mel-frequency cepstral coefficients (MFCCs) from the audio files.
» Model Development: Train simple classification models (e.g., CNNs, RNNs) for tasks such as binary detection (drone vs. no drone), drone count estimation, and multi-class identification.
» Evaluation: Assess models using accuracy, precision, recall, and confusion matrices.

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DATA ATOMS FOR ON-DEMAND ASSOCIATION AND ACCESS CONTROL OF SENSITIVE DATA

This project focuses on building a “Data Atom”, a self-contained, secure digital package that holds sensitive data along with essential descriptive information for controlled discovery and access. The goal is to allow data to travel independently of traditional databases while preserving both privacy and context-awareness.

A Data Atom contains two parts:

» Nucleus: the actual sensitive data (text, numbers, files, or multimedia).
» Wrapper: openly visible metadata describing the data’s context, purpose, and access rights, without revealing the sensitive content.

During the project time, you will develop a prototype that can:

» Accept raw input data from a defined real-world interaction scenario (such as a medical note, transaction record, or research observation).
» Extract relevant descriptive keywords and associate them with knowledge categories to create the nucleus (using natural language processing).
» Encrypt the nucleus using a hybrid encryption method.
» Build a wrapper containing metadata such as origin, knowledge category, and access rules.
» Store the resulting Data Atom in a document-oriented database for later retrieval.

By the end of the project, you will deliver a Data Atom generated from sample datasets, demonstrating how sensitive data can remain secure while still being searchable and shareable under context-based rules.

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MULTIMODAL CHARACTER CONVERSATIONS USING GENERATIVE AI

Generative language models such as ChatGPT, Gemini and Claude are revolutionising the way that humans interact with AI on a regular basis. Beyond being used as personal assistants, tutors, editors and technical support, this cutting-edge AI technology can also provide new creative opportunities. Several prominent entertainment companies (Nvidia, Ubisoft, Electronic Arts, Xbox, Sony, etc.) alongside a suite of high-profile academic researchers, are already exploring the potential for generative AI to create dynamic characters that respond authentically to users.

This project will focus on developing an interactive character conversation demonstrator, able to interpret a variety of input modalities. This demonstrator will utilise existing Generative AI technology, such as the GPT-4, GPT-vision and Whisper models provided by OpenAI, to produce a virtual character capable of taking both audio and visual inputs (from microphones and cameras) and producing its own generated speech and visuals in response. These functions can then be combined with real-time animation and lip-syncing software to create a fully realised virtual character, able to seamlessly interact with human users.

This project will provide the following student learning experiences:

- Research into the capabilities of Large Multimodal Models (LMMs) capable of interpreting both text and image inputs.
- Development of skills working with the OpenAI API, including utilisation of GPT-4 models for text generation and image analysis (GPT-vision), as well as Text-to-Speech and Speech-to-Text capabilities.
- Utilising prompt engineering techniques to craft believable virtual characters that seamlessly integrate visual and audio inputs.

Pre-requisites:

- A basic knowledge of Python (as covered in ENGR1721 or COMP2712) or equivalent understanding of an alternative programming language such as Java or C#.

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MICROBIAL DYNAMICS ASSOCIATED WITH HARMFUL ALGAL BLOOMS (HABS)

A Harmful Algal Bloom (HAB) is currently occurring of South Australia and having significant ecological, economic, and public health impacts. While the algal species driving these blooms are often well-characterised, the surrounding microbial communities—and their role in bloom development, persistence, and decline—are less understood.

This project will investigate microbial community dynamics during a HAB event by combining molecular and environmental measurements. Water samples will be collected from bloom and non-bloom sites and filtered to capture microbial biomass. DNA will be extracted from filters and used for 16S rRNA gene amplicon sequencing, allowing taxonomic profiling of bacterial and archaeal communities. Flow cytometry measurements will be taken to quantify microbial cell abundance and community shifts in real time. By integrating sequencing data with flow-based cell counts, the project will identify key microbial taxa associated with different bloom stages, providing insights into microbial–algal interactions and potential bloom mitigation strategies.

Project Supervisor

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PYGMY BLUETONGUE PROJECT

Pygmy bluetongue lizards are an endangered species that lives in grasslands in the Mid North of South Australia. They were thought to be extinct until they were rediscovered in Burra in 1992. Flinders University Lab of Evolutionary Genetics, Conservation and Sociality (LEGCS) has an active research program on this species exploring how to undertake translocations effectively, as well as a new program exploring the potential impact of windfarms on these lizards and the spiders whose burrows the lizards use.

Project 1: During drought there is potential for diurnal species to seek water resources at night. No one has reported this for pygmy bluetongue lizards. We set out nine cameras across two sites to film pygmy bluetongue burrows overnight and capture any possible activity. The candidate would examine pre-recorded footage and record behaviours. This is computer work only, with potential to volunteer for fieldwork within the active research program.

Project 2: This study aims to determine how pygmy bluetongues' activity level and body condition are affected under drought conditions. Data loggers have been placed at one site to record temperature during the drought in April 2025. Nine lizards have been filmed at two sites recording behaviour during 2024-2025 field season during the drought over a four-month period. This footage is to be compared to baseline behaviours in previous years. The candidate would score video footage, recording behaviours seen. This is computer work only, with potential to volunteer for fieldwork within the active research program.

Project 3: In 2020 the lab set up a translocation experiment of the pygmy bluetongue at the southern edge of the species range. The site consists of a number of 25 x 25 m enclosures (small 25cm walls) with lizards from three different populations. The translocation has been a great success and we need to start thinking about what we do next. As part of this, we need to understand the number of available burrows just outside the walls of the enclosure. To do this the candidate would go to the translocation site and help with marking, measuring and checking the contents of these burrows. Ultimately, we want to know if there are enough burrows for the lizards to occupy if we remove the walls.

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INTERACTIONS BETWEEN HARMFUL ALGAL BLOOMS ON SEAWATER AND KELP MICROBI-

Harmful Algal Blooms (HABs) are increasing in frequency and severity worldwide, posing serious risks to marine ecosystems. While HAB impacts on water chemistry and planktonic communities are well documented, little is known about how they affect the microbiomes of habitat-forming seaweeds such as kelps. These microbial communities play important roles in kelp health, nutrient cycling, and resilience to stress, and may even include bacteria capable of mitigating HAB effects.

In this project, the student will process samples collected from coastal sites affected by a recent HAB event, including surface seawater, benthic seawater, and kelp surface swabs. DNA will be extracted from each sample and prepared for high-throughput sequencing to characterise microbial community composition. Analyses will explore how HABs alter microbial diversity and structure across habitats, and will search for bacterial taxa on kelp surfaces with potential allelopathic properties that could inhibit harmful algae. Findings will contribute to understanding kelp reef resilience and inform restoration strategies under increasing HAB pressure.

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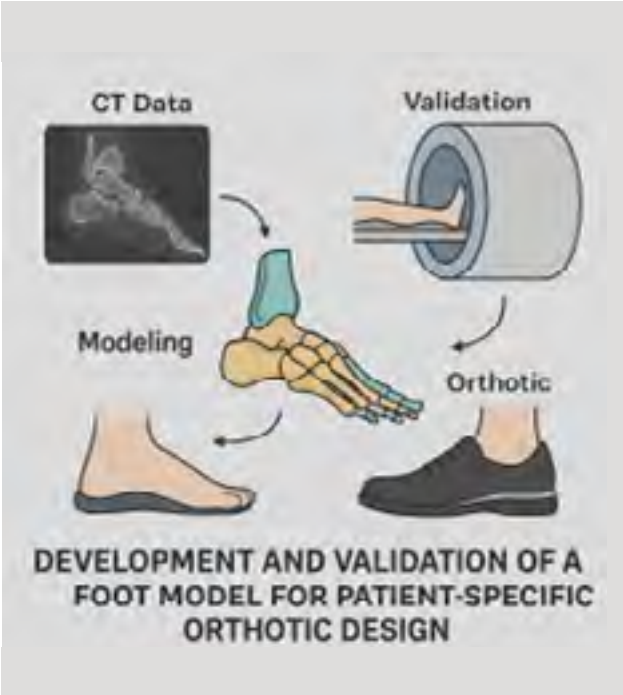
DEVELOPMENT AND VALIDATION OF A FOOT MODEL FOR PATIENT-SPECIFIC ORTHOTIC DESIGN

This project will be part of a larger project that aims to predict the internal skeletal geometry of the foot from sparse data and validate the prediction using clinical data. The final model of the foot can be used to improve design of an orthotic by quantifying offloading following prescription of the insole.



To address the first aim, a statistical shape model of the foot will be developed using computed tomography (CT) data obtained from the New Mexico Database. First, this project will require manual segmentation of the foot bones which will be utilised to create surface models. These surface models will then be utilized to create a statistical shape model based on principal component analysis by another researcher.

The second stage of this project will be validation of the predicted foot model using clinical data. A clinical study will be designed that will request participants to obtain a CT and magnetic resonance imaging (MRI) scan of their feet (non-weightbearing and weightbearing). Both CT and MRI scans will be conducted in a supine position which will require the development of a method to simulate weightbearing. This project will require the student researcher to design an MRI compatible apparatus that can position the feet similarly between participants and apply a load to each foot equal to half of the participants' bodyweight.

Completion of this project will provide the student with experience in segmentation, an introduction to statistical shape modelling, and implementation of an engineering design.

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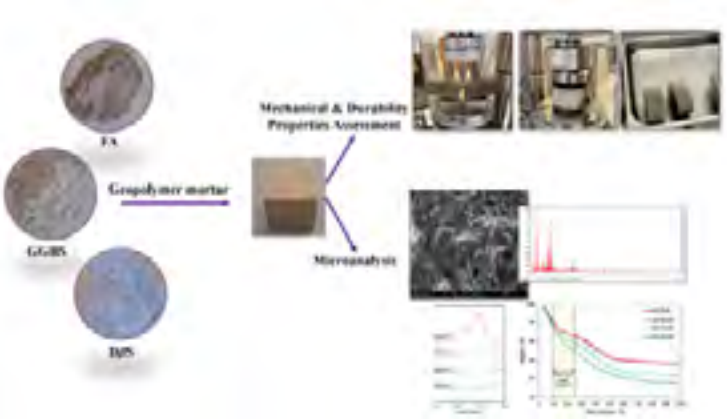
INNOVATIVE USE OF LITHIUM MINE WASTE AS A SUSTAINABLE CEMENT ALTERNATIVE IN CONCRETE PRODUCTION

This research project looks at how we can use a waste material from lithium mining—called delithiated beta spodumene—as a new ingredient in concrete. Normally, concrete is made using Portland cement, which produces a lot of carbon dioxide and harms the environment. But delithiated beta spodumene, which is left over after lithium is removed from spodumene ore, might work like cement and help make concrete more sustainable.



We will test how well this material works in concrete by checking its strength, durability, and how it reacts with other ingredients. Students will learn how to prepare concrete samples, run lab tests, and analyse results. The goal is to see if this waste material can reduce the environmental impact of concrete while still keeping it strong and safe to use.

This is a great opportunity to work on a real-world problem that combines engineering, sustainability, and chemistry. Students will gain hands-on experience and contribute to research that could help make construction more eco-friendly.

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EXAMS OR EXPERIENCE? WHAT MATTERS MORE IN ENGINEERING EDUCATION

This research project investigates whether final exams are the most effective method to assess students in upper-level engineering courses, or if alternative assessment strategies such as project-based learning may offer a more meaningful evaluation of engineering competencies. The study will explore whether traditional exams reflect the skills and knowledge needed in real-world engineering practice and how academic assessments can better align with professional expectations.

The project aims to address the following questions: Do final exams adequately measure the skills required for success in engineering practice? How do engineering stakeholders (students, educators, and industry professionals) perceive the value of exams vs. experience-based assessment? What alternative assessment strategies are currently used, and what impact do they have on student learning and professional preparedness? How can assessment methods in engineering education be improved to better align with professional outcomes?

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NANO CLUSTER BASED PHOTOCATALYSTS FOR FABRICATION OF GREEN HYDROGEN

Hydrogen (H2) has been identified as an important future energy resource. Green H2 (GH2) can be generated via solar energy to meet the demand of reducing the use of fossil energy resources. Photocatalytic water splitting uses sunlight directly to split H2O into H2 and O2. The process requires an efficient photocatalyst. We are working on two aspects to facilitate this process: a) a protective overlayer to avoid the recombination of H2 and O2 to H2O to improve the overall efficiency, and b) efficient co-catalyst facilitating the H2O splitting reaction. For b), we use small metal clusters containing only 4 – 100 metal atoms. Each cluster type used consists of a specific number of atoms with atomic precision. The project is a collaboration between Flinders University, the University of Adelaide, Michigan University (USA), Imperial College London (GB) and the University of Tokyo (Japan).

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DETERMINING SEA SPRAY COMPOSITIONS

Sea spray aerosols alter climate and the environment in remarkable ways. Marine aerosol particles are created by breaking ocean waves. This top region of the ocean is rich in organic molecules. The breaking waves transfer this biological soup into the droplets as they are jettisoned from the ocean surface. Water droplets can act as miniature catalytic converters for interfacial reactions. The aim of this project is to determine the composition of water droplets directly. For determining the composition of the outer surface of water, we are using a unique depth profiling method in our laboratory: neutral impact collision ion scattering spectroscopy (NICISS). Our depth profiling method will be applied in collaboration with Dr Bernd Winter (Fritz Haber Institute, Germany), the University of Newcastle and the Australian National University.

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BIOINFORMATICS OF HUMAN GUT PHAGES

This project will explore the fascinating world of viruses that infect bacteria, known as phages. We have recently obtained genome sequences of several Microviridae phages from the gut of people with inflammatory bowel disease (IBD). These tiny viruses are abundant in nature but remain poorly understood, especially in relation to human health. In this project, you will use bioinformatics tools to study their genomes in detail. This includes identifying genes, comparing them with known phages, predicting their bacterial hosts, and exploring how they might influence the gut microbiome. You will gain experience in genome annotation, evolutionary analysis, and microbial ecology, while contributing to new insights into the role of phages in disease. The project is ideal for students interested in virology, microbiology, or computational biology, and offers the chance to develop practical bioinformatics skills while addressing exciting questions at the frontier of microbiome research.

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BIOMASS-BASED RECHARGEABLE BATTERIES

Solutions for sustainable energy storage require developing a new rechargeable battery technology that exclusively uses renewable resources to create recyclable or biodegradable materials for all parts of the batteries, specifically sustainable polymer batteries. Ideally, all components and manufacturing processes are derived from biomass. Building on our successful demonstration of a biomass-based rechargeable battery in the laboratory, this project aims to address the challenges of scaling up electroactive materials, increasing energy density, and establishing assembling techniques in prototyping, with the ultimate goal of producing the first sustainable biomass-based rechargeable battery.

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ASTROCHEMISTRY

Understanding chemistry in the environment and the solar system is fundamental for future space exploration. The Vortex Fluidic Device (VFD) generates a thin film of liquid with high shear topological flow regimes of submicron dimensions, with localised temperatures of at least 630oC and 20 MPa pressure. These hostile conditions can mimic processes on Earth and on planets, moons, asteroids, comets and dwarf planets within the solar system and beyond.

Research will focus on processing water in the VFD where the mechanical energy decomposes water to hydrogen gas and hydrogen peroxide, and how this relates to processes in the solar system, under the umbrella of astrochemistry.

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