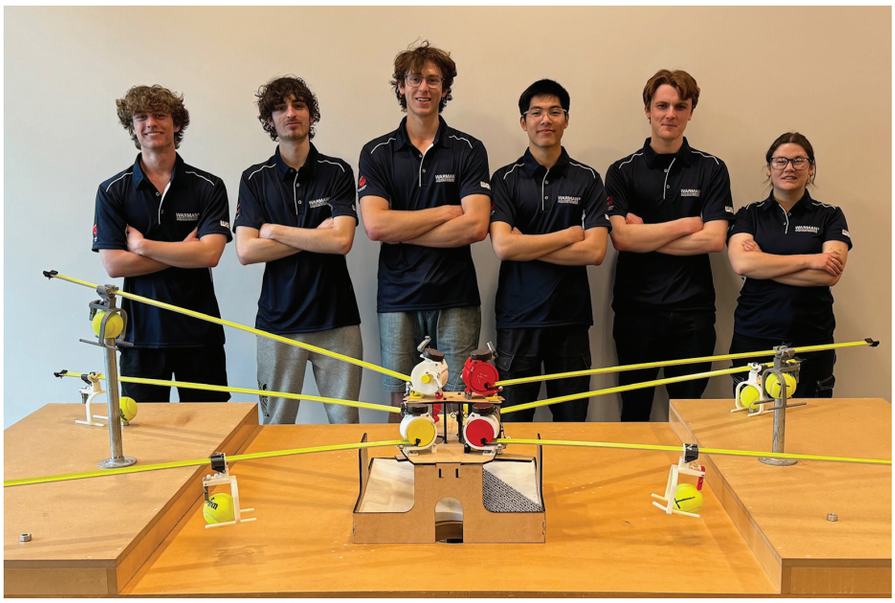
Mech Connect

Department of Mechanical Engineering Annual Report 2024

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND



UNIVERSITY OF CANTERBURY | Engineering Pūhanga

Contents

The department of Mechanical Engineering remains in the top 300 worldwide in the QS ranking. It is ranked second in New Zealand.

Head of Department

Kia ora – Welcome to the 2024 Edition of our Mech Connect Annual Report

We invite you to read our 2024 Edition of the Mech Connect Annual Report and to celebrate with us the many achievements and successes in 2024. We hope you will enjoy reading either selected portions or the whole report. Since the beginning of 2024, the department has been preparing for a leadership transition. We were aware that Mathieu Sellier's term as Head of Department (HOD) would conclude at the end of the year. A very long recruitment process finally culminated in Stefanie Gutschmidt's inauguration as new HOD just before Christmas. The annual report includes two articles—one by Mathieu reflecting on the past five years and the other by Stefanie looking ahead to the future.

Our new student intake (at 200-level) also increased in 2024, with growth of 15% over the previous year. Another record level of interest for our degree programs (mechanical engineering, mechatronics, and the two minors in aerospace and biomedical engineering) was recorded at the UC Open Day, where we welcomed nearly 1,000 students—an ongoing challenging yet fortunate situation. We strongly believe that the high demand for our programs reflects the quality of the degree we offer and the range of rewarding career pathways it provides access to. We are particularly pleased that our Bachelor Honours degrees, including our minors in Aerospace and Biomedical Engineering, have been re-accredited in 2024 with highest commendations by the Engineering NZ Accreditation Committee.

Final year projects remain a critical part of our curriculum, of which this annual report presents a selected few. They provide the pathway for our students to "get used to" the real world and the life of an engineer. We are deeply grateful to our many sponsors in 2024 and would like to thank them for their support and continued impact through their investment to the next generation of engineers.

We remain committed to Research and Innovation. Prime examples of exciting research projects and the success stories of our staff and postgraduate students are also included in this report.

Our department continues to be heavily invested in several student-driven professional clubs because they provide students with unique experiential and peer-to-peer learning. Some of them frequently compete internationally and their successes continue to increase the department's reputation worldwide. For this reason, our clubs will always have their own section in the annual report, where they can present a summary of their activities, achievements and awards.

We would like to take this opportunity to express our gratitude to the staff of the department whose dedication is critical to the student's experience and the quality of our graduates. We also would like to acknowledge the alumni & friends of the department who create many of the opportunities for our students. A special thank also to the members of our Industrial Advisory Board whose input over the years is so valued.

Lastly, thank you to all the readers for your interest in our department. We hope you enjoy the read in this annual format. Remember to stay connected and share your stories with us also in 2025.

Mathieu Sellier & Stefanie Gutschmidt
Heads of Department

Five Years of Growth, Challenges, and Achievements

The end of my term as Head of Department has arrived and now is therefore a good time to reflect on this busy but rewarding time.

I went into my HoD tenure, back in 2019, naïve about what the role would entail and ambitious about what could be achieved, and I have to say that I quickly gained renewed respect and admiration for my predecessors when I realized that the role requires a lot.

It requires a skill set which is rarely taught in the long years it takes to train a university academic: organizing, managing, promoting, negotiating, prioritizing, decision making, chairing, strategic thinking, and many more, but above all: people skills!

Dealing with people and making decisions can be stressful and difficult at times, but it has also been a great source of satisfaction because one of the privileges of being HoD is the opportunity to get to know and interact with most staff at some stage and contribute to shaping their journey.

So, my first thanks will go to the staff of the department. I have been incredibly proud and privileged to lead such a team of good, highly competent, and passionate staff. Special thanks also to our many alumni, friends of the department, and members of the Industrial Advisory Board who consistently and generously support the department in many ways including offering final year projects, recruiting our graduates, or simply but crucially being good ambassadors.

We have had a few challenges along the way during my tenure – COVID, of course, and the constrained tertiary education funding - but I am sure that what will remain with me is the successes we have had collectively as a department. I am thinking, for example, of:

- Our recent re-accreditation from Engineering New Zealand is a fantastic demonstration of teamwork and a strong endorsement of the world-class Mechanical Engineering curriculum we are striving to deliver to our students. The many praises I have heard in this context, especially about how staff members in the department are passionate and dedicated, were music to my ears.
- The popularity of our Mechanical Engineering program with a seemingly endlessly growing number of intermediate students choosing to study Mechanical Engineering.
- The Department of Mechanical Engineering is gaining many spots in the discipline QS ranking, evidence of its growing reputation.
- The many successes of our clubs at international competitions such as Formula SAE or Spaceport America

The list goes on and not all achievements are high-profile, but the combination of them all makes the department a great place to work.

Finally, I will conclude by wishing Professor Gutschmidt a term as rewarding as mine was. I have no doubt that our department is in good hands with her at the helm.

I will end on this quote which is a good reflection of what I aspired to as HoD: "A leader is best when people barely know he exists, when his work is done, his aim fulfilled, they will say: we did it ourselves," Laozi.

Prof Mathieu Sellier,
Head of Department — Mechanical Engineering (2019 – 2024)

Looking Ahead: A Vision for the Future

The promising future of our department has always been shaped by its people and leaders. Previous leaders, including the most recent, Mathieu Sellier, understood how to tackle challenges by working together with our people, both in ideas and in action. I first witnessed the remarkable potential of our team during our time in Mandeville after the second major earthquake in 2011 and its series of aftershocks. From constructing temporary lecture theatres (tents) to "searching for" a signal on the rugby field to set up a wireless network, to delivering fully accredited programmes through lecturing and tutoring, to "feeding the 5000" (not nearly 5000, but it surely felt like that when providing food for all student cohorts, including postgraduates), I was truly amazed by the dedication and resilience of the team I was a part of. When I considered putting my name forward for the HOD role, I initially thought the idea was absurd. But then I remembered the power of a team led by a shared vision — a vision that everyone wholeheartedly embraced.

My vision for the Mechanical Engineering Department is one of Transformation. I envision Transformation as in terms of a place that not only facilitates positive change but also nurtures skills that transform individuals and achieves results that make a real impact. I see our department as an influence that extends beyond us, beyond the Canterbury region, and even our nation. Regardless of one's background, education has the power to change lives, and Mechanical and Mechatronics Engineering are uniquely positioned to combine education with practical solutions that strengthen both business and the economy. When I think about transformation, I reflect on our many "Mandeville moments", where I have witnessed "impossible transformations" — through people, through talent, through relationships, and through a shared vision.

It is now my responsibility to lead us in building strong, long-lasting, and meaningful relationships with industry and the wider community. This will be achieved through our three pillars: world-class education, cutting-edge research, and impactful service/consultancy. Together, we will contribute to the stability of both the local and national economy, serve and benefit our bi-cultural communities, and create a future that is truly desirable. In a world filled with uncertainties, I firmly believe that we have the power to shape our future. Under my leadership, external influences — whether good or bad — and future uncertainties will not pose a threat to us. Instead, they will present new opportunities. Turning challenges into advantages is second nature to our people and discipline.

I would like to extend my sincere gratitude to Prof. Mathieu Sellier for his outstanding leadership over the past five years and for establishing a solid foundation upon which we can continue to build and grow. A successful and promising future is only possible through strong partnerships, and we are fortunate to have an engaged and impactful Industry Advisory Board that plays a key role in supporting us as we pursue our goals. In going forward, I am excited to work with them, as well as with our many industry partners, alumni, and friends of the department.

Prof Stefanie Gutschmidt,
Head of Department — Mechanical Engineering

Who We Are

Staff Members

The Mechanical Engineering Department has 25 academic staff, four administrative staff, three senior tutors, 15 technical and IT staff and four post doctoral and research associates.

Academic staff

Mathieu Sellier
Professor
Head of Department – Mechanical Engineering

Geoff Rodgers
Professor
Deputy Head of Department

Sid Becker
Associate Dean (International, Postgraduate)

Catherine Bishop
Professor
Director of studies 2nd Year Engineering

John Cater
Professor

Geoff Chase
Distinguished Professor
Advisor to Students with Disabilities

Don Clucas
Associate Professor
Practical Work Coordinator

Stephen Daynes
Senior Lecturer
Leader of Minor in Aerospace Engineering

David Denkenberger
Associate Professor
Director of Studies 4th Year Engineering

Paul Docherty
Professor

Tim Giffney
Director of Postgraduate Studies (PhD)

Shayne Gooch
Associate Professor Director of Studies 3rd Year Engineering

Stefanie Gutschmidt
Associate Professor
Chair of Outreach and Marketing

James Hewett
Lecturer

Mark Jermy
Professor
Director of Postgraduate Studies (ME)

Natalia Kabaliuk
Senior Lecturer
International Director of Studies

Deborah Munro
Associate Professor
Leader of Minor in Biomedical Engineering

John Pearse
Associate Professor
Undergraduate Director of Studies

Dirk Pons
Professor

Chris Pretty
Professor
Co-Director of Mechatronics

Mark Staiger
Associate Professor
Director of Studies 4th Year Engineering

Digby Symons
Associate Professor
Director of Final Year Research & Development Projects

Malcolm Taylor
Lecturer

Yilei Zhang
Associate Professor
Director of Master of Engineering Studies

Dan Zhao
Professor

Senior Tutors

Tania Shuker
Senior Tutor

George Stilwell
Senior Tutor

Christine Walker
Senior Tutor

Technical and General Staff

Bruce Robertson
Technical Services Manager
Design Engineer

Tony Doyle
Staff Workshop Team Leader

Rodney Elliott
Technical Officer
Scientific Officer

David Fanner
Workshop Technician

Phil Gadsby
Projects Engineer

Owen Kelly
Projects Engineer

Adam Latham
Systems Administrator
Technical Officer

Dr Shaun Mucalo
Projects Engineer –
Microscopy and Materials

Zac Perston
Projects Engineer

Julian Phillips
Technician
Technical Officer

David Read
Technical Officer

Paul Southward
Programmer Analyst
Systems Analyst / Programmer

Dr Oscar Torres
Project Engineer

Anthony Doyle
Training Workshop Lead Tutor

Julian Murphy
Technician

Administrators

Jess Lagoutte
Administrative Services
Manager

Jess Daly
Administrator

Penny Crudgington
Administrator

Greta Rapalaviciute
Administrator

Post Doctoral and Research Associates

Jake Campbell
Post Doctoral Fellow

Jessica Fitzjohn
Post Doctoral Fellow

Liam Murphy
Post Doctoral Fellow

Steven Su
Post Doctoral Fellow

Retirement/resignation

- Milo Kral (Professor) – January 2024
- Bill Mohs (Project Engineer) – January 2024
- Bradley Boyd (Post Doctoral Fellow) – March 2024
- Garry Cotton (Workshop Training Team Leader) – March 2024
- Emma Buck (Administrative Service Manager) – May 2024
- Anqi Gu (Post Doctoral Fellow) – July 2024
- Nay Lin Oo (Post Doctoral Fellow) – July 2024
- Bushra Anam (Post Doctoral Fellow) – August 2024
- Jennifer Knopp (Post Doctoral Fellow) – August 2024

New Onboard

- Jess Lagoutte (Administrative Service Manager) – May 2024
- Phil Gadsby (Project Engineer) – December 2024

Erskine visitors

- Professor Edwin Garcia (Purdue University) – ENME452 24S1 Computational Materials Engineering
- Professor Raj Das (RMIT University) – ENME488: Mechanics of Flight and Spaceflight

Mechanical Engineering Industry Advisory Board (IAB)

The IAB provides the department with advice and support, from an industry and alumni perspective. We met with the accreditation review panel as UC's engineering degree programme was successfully re-accredited, and assisted in the development of the Faculty of Engineering's new 10-year strategy.

Other areas the board provided guidance to the department in included the application of AI (tools, threats, opportunities), review of all courses, programme development (aerospace and biomed minors, conjoint degrees and proposed MEngSt), work experience requirements, final year projects (including judging presentations and posters), graduate attributes, staff recruitment (including an interview panel) and marketing and outreach.

Maintaining strong connections to industry and the wider engineering ecosystem is vital as the department strives to ensure the quality and relevance of its teaching and research adequately prepares graduates for industry, including the ability to shape the change needed to meet local and global challenges. The IAB thanks Mathieu Sellier for his service and the way he has actively engaged with the board, and looks forward to serving the new HOD Stefanie Gutschmidt.

Andrew Lamb (chair)
Consultant
Ardio

Ry Collier
Global Manager – Quality
Methanex

Andrew Diehl
Technical Director
Holmes Solutions

Aaron Goldsbury
Chief Engineer
Fonterra

Andrew Hilliard
Product Development Manager
F&P Healthcare

Oliver Hunt
Founder & CEO
Medsalv

Michael Lee
Engineering Manager
Contact Energy

Madeleine Martin
Health Technology Centre Manager
The Arts Centre

Jaclyn Pow
Manager Southern Building Services
Beca

James Powell
Co-Founder
Dawn Aerospace

Craig Price
Chief Operating Officer
Beca

Postgraduate students

Our department is home to a vibrant postgraduate community, with 14 Master's and 84 PhD students as of 31 December 2024. Their research spans diverse fields, including intelligent design and manufacturing, biomedical engineering, robotics, renewable energy, materials science, thermoacoustic and aerospace engineering. We also recognise and celebrate those who have successfully completed their degrees, acknowledging their contributions to engineering advancements. As our students push the boundaries of research and innovation, they continue to shape the future of the field.

Our postgraduate researchers are at the forefront of tackling critical challenges across multiple disciplines. This year, PhD graduates have made significant contributions to areas such as glycaemic modelling, biodegradable implants, UAV control, machine learning in clinical research, combustion systems, and sustainable manufacturing. At the same time, new PhD students have embarked on research in autonomous systems, cryogenic technologies, digital health, and AI-powered engineering solutions, reinforcing the department's strong industry connections and commitment to emerging technologies.

Looking ahead, 2025 promises to be another exciting year as our postgraduate community expands, research continues to advance, and industry engagement creates new opportunities. We encourage students to take part in seminars, interdisciplinary collaborations, and outreach initiatives to broaden their expertise and impact. To further support their academic and professional development, the department partnered with the UC Academic Skills Centre to offer tailored workshops on research writing, academic communication, and career readiness. These initiatives equip students with the skills and confidence to excel in their research and transition seamlessly into academia or industry.

PhD completions

Alex McHugh: *Enhancing Approaches to Glycaemic Modelling and Parameter Identification*. Supervisor: Geoff Chase.

Aditya Avinash Joshi: *Phenomenological modelling of the degradative performance of biodegradable magnesium alloy orthopaedic implants: Applications in craniofacial device design*. Supervisor: Mark Staiger. Associate Supervisor: George Dias.

Daniel Morris: *Adaptive Modelling and Control of Quadrotor Unmanned Aerial Vehicles*. Supervisor: Chris Pretty. Co-supervisor: Adriel Kind. Associate Supervisor: XiaoQi Chen.

David Muchiri: *Inference of effective rheological laws for shallow lava flow models from free-surface measurements*. Supervisor: Mathieu Sellier. Co-supervisor: James Hewett, Jerome Monnier. Associate Supervisor: Miguel Moyers-Gonzalez.

Hamish Ferguson: *Using field-based power meter data to model track cycling performance*. Supervisor: Geoff Chase. Co-supervisor: Chris Harnish.

He Zhao: *Numerically investigations on combustion characteristics and thermal performance of the micro combustion*. Supervisor: Dan Zhao. Associate Supervisor: Sid Becker.

Honey Gupta: *Bioaerogels derived from canola protein and their use in the delivery of bioactive compounds*. Supervisor: Mark Staiger. Co-supervisor: Steve McNeil. Associate Supervisor: Kate Parker.

Lixian Guo: *Investigations on Nonlinear Acoustic Behaviors of Standing- and Traveling-waves Thermoacoustic Engines and Enhancing Heat-driven Acoustic Power*. Supervisor: Dan Zhao. Co-Supervisor: Sid Becker.

Maria Isabel Andrade Beltran: *A High-Granularity, Non-Invasive, and Low-Cost Method for Quantifying Panel Radiator Operation (Occupant Heating Behaviour) in Single-Occupant Office Spaces*. Supervisor: Sid Becker. Co-supervisor: Susan Krumdieck. Associate Supervisor: Daniel Bishop.

Mohammad Sagor Hosen: *Evaluation of fused particle fabrication additive manufacturing as a recycling method of poly(ethylene terephthalate): Processing-structure-properties relationships*. Supervisor: Mark Staiger.

Rebecca Emanuel: *Development and Evaluation of Machine Learning Tools to Process an Internet Forum for Clinical Research of Polycystic Ovary Syndrome*. Supervisor: Paul Docherty. Co-supervisor: Rua Murray. Associate Supervisor: Helen Lunt.

Salma Rawan: *Heat Transfer Analysis in Pulsed Pressure Mass Transport*. Supervisor: Natalia Kabaliuk. Co-supervisor: Sid Becker. Associate Supervisor: Susan Krumdieck.

Master's completions

Campbell Stevens: *Development of a Sustainable Alternative to Current MBBR Carrier Media*. Supervisor: Hossein Najaf Zadeh. Co-supervisor: Don Clucas.

Ekaterina Lieshout: *Aerodynamic Optimisation of a Sit-Ski*. Supervisor: Natalia Kabaliuk.

Gordon Lay: *Noodle: A compliant, re-configurable 3D serpentine robot*. Supervisor: Chris Pretty. Co-supervisor: Lui Pearson.

Gussy Collet: *Investigating the Efficacy of Subsurface Drip Irrigation for Arable Agriculture in Canterbury, New Zealand*. Supervisor: Paul Docherty. Co-supervisor: Dirk Pons. Associate Supervisors: Mphil Rolston, Nicholas Davies.

James Sinclair: *Development and validation of processing algorithms to delineate individual foot reactions from a single-belt instrumented treadmill to generate synchronised acoustic emission and lower-limb biomechanics data*. Supervisor: Geoff Rodgers. Co-supervisor: Debbie Munro.

Mackenzie Caughey: *Creep Ratchetting of Centralloy® G 4852 Micro-R Reformer Tube Alloy*. Supervisor: Milo Kral.

Matthew Durrant: *Aeroelastic instability of reduced-scale high-altitude pseudo-satellite wings*. Supervisor: Stephen Daynes. Co-Supervisor: Stefanie Gutschmidt.

Olaf Manz: *Stress Corrosion Cracking of Commercial Bronze and Brass*. Supervisor: Milo Kral. Co-supervisor: Catherine Bishop.

Richard Wiley: *The Effect of Thermomechanical Processing Parameters on the Texture of Ti-6Al-4V Forgings as a Precursor to Abnormal Grain Growth*. Supervisor: Milo Kral. Co-Supervisor: Catherine Bishop.

NEW PhD students enrolled in 2024

Ali Akbari: *Low-cycle fatigue, strain-ageing, and residual-capacity testing of reinforcing steels*

Ben Robertson: *Therapeutic Optimization and Targeted Applications for Levelling Blood Sugar (in the ICU)*

Chuan Tian: *Enhancing Autonomous Engineering Solutions through Collaborative Large Language Model Techniques*

Conor Papple: *A model-based investigation of the distinction between phenotypes of polycystic ovary syndrome (PCOS)*

Filip Soukup: *Thermal Engineering and cryocoolers on Small Satellites*

Harvey Morison: *Monitoring and Management of Fatigue for use in Exoskeleton Stroke Rehabilitation*

Jessica Sewell: *Development of a modelized approach to monitoring and preventing ACL tears in women's football*

Jiaming Gao: *Research in progress*

Jinshen Tong: *Investigating the Chemical, Combustion, and Emission Characteristics of Premixed Combustion Chamber Fuelled with Renewable-Sourced Ammonia*

Jordan Hill: *Non-invasive Optical Oxygen Extraction Estimation*

Kshitij Thapa: *Blueprint for Creating an Artificial Insect Egg: Understanding the Morphological and Mechanochemical Properties of Insect Egg Structure*

Marvin Miclosa: *Research in progress*

Ryan O'Sullivan: *Model Based Control of Agitation Management in Critical Care Patients*

Samantha Couper: *Imaging technology and automated diagnostic developments for the Digital Imaging Elasto Tomography breast cancer screening device*

Tianyuan (Daniel) Wu: *Symmetry Engineering Novel Domain Structures in Barium Titanate Thin Films*

Yadian Zhao: *Research in progress*

Yuwei Sun: *Research in progress*

PhD students enrolled in 2024

Adam Cox: *Optimal control of flow over a hydrofoil using suction/blowing to mitigate cavitation*

Alexandra Mckendry: *Resonant MEMS for in-sensor reservoir computing*

Ana Luisa Monteiro: *Production of plant-based resilient foods in case of catastrophe*

Andres Carlos Guiguet: *Sustainable and resilient supply chains: A New Zealand simulation-based design*

Andrew Lange: *Modelling collisions of milk droplets*

Annette Swale: *Investigating the Efficacy of Innovative Design Approaches for Softshell Headgear to Minimise the Intensity of Head Impacts in Youth Rugby Players*

Baxter Williams: *Market-Based Management of Electricity Demand for Sustainable Electrification of Vehicles, Homes, and Businesses in Aotearoa New Zealand*

Briana Steven: *In Vitro Particle Image Velocimetry Analysis of Aneurysms and their Surgical Remedies*

Caleb Barr: *How can the RoC*RoI model be adapted to advance predictive power and fairness*

Christopher Cameron: *Direct nerve interface for control of assistive devices, using sieve electrodes*

Congyu Xu: *Development of TPMS structures suitable for rugby headgear*

Connor Melton: *Optimising Plantar Heel Pain Comfort with User Adjustable Home Footwear*

Dael Summerhays-Sunnex: *Mechatronics based virtualisation of ASD emotion recognition therapy*

Dale Cusack: *An experimental investigation of lava rheology using analogue fluids and numerical methods*

Danyon Stitt*: Concussion in rugby: investigating the biomechanics and means of reducing mTBI in rugby players*

Di Guan: *Attenuating Self-Excited Thermoacoustic Instability in Rijke-Type Combustors by Implementing Bias Flow Perforated Liners*

Ella Guy: *Rehabilitation of Continuous Positive Airway Pressure (CPAP) Ventilation*

Emily Young: *Point-of-Care Biomolecule Sensor Technology Platform for Measuring Insulin*

Finn Birchall: *Accelerating Alloy Discovery through Gradient Microstructures*

Finn McIntyr: *Spin-Coating on Curved Surfaces*

Francis Pooke: *Low-cost mechanical insulin pump design and validation*

Han Qiao: *Empowering Enterprise Product Emotional Design with AI: Integrating Kansei Engineering and Large Language Models for Human Emotion Recognition*

Haoyu Cheng: *Numerical investigation on trapped vortex combustion*

Hui Rong: *Portable fuel cells are attracting more attention in the development and application of emergency power generator system*

Isaac Flett: *Quantifying Agitation in Intensive Care Patients Using Wearable Devices*

Jaimey Clifton: *Classification and predictive monitoring of respiratory disease*

James Cushway: *Model-Based Fluid Resuscitation in the Intensive Care Unit*

Jessica Rocio Montoya Meja*: 3D Printing of Piezoelectric Transducers*

Josie Dixon: *Narrow-Band Optical Methods for Blood Analyte Detection*

Junfeng Wu: *Construction of a novel probiotics encapsulated delivery pathways with prebiotic materials*

Kaleb McGillivray-Seaton: *Wireless Power Transfer and Communication Development for High-Depth Miniaturised Biocompatible Implants*

Kamean ali Ahmed: *Towards lower costs and reduced waste in 3D printing using functionally graded lattice structures*

Kaspar Soltero: *Acoustic Resolution of Animal Dynamics for Informing Biosecurity in*

Kathryn Ford: *High Temperature Molten Oxide Electrolysis to Produce Metals*

Kong Ting Lee: *Smart agriculture decision support system*

Kritika Khanal: *Interface Phase Transition and Degradation in Pb-free Ferroelectric Ceramics*

Lachie Crawford: *An Autonomous Monocopter for Fighting Fires*

Lev Chernyshev: Improving real-time hydrodynamic models of foiling yachts in dynamic simulation

Linghui (Jeff) Meng: *EMG-EEG hybrid system to improve recognition accuracy of hand gestures based on deep learning*

Mariah McDonald: *Extending predictive pulmonary models to a wider demographic*

Matthew Payne: *A low cost, open source insulin pump and non invasive CGM, controllable via any bluetooth enabled smartphone, for the improvement of diabetes care*

Molly Evans: *Numerical and Experimental Investigations on Thermoacoustic Instability in Ammonia-Fired Gas Turbine Combustors*

Nicholas Lam: *Advancing numerical evaluation of model identifiability in noisy data*

Nicolas Davey: *Predictive Cardiovascular Modelling using Support Vector Machines*

Nina Pernus: *Research in Instrumented Sport Climbing Holds*

Paul (Pavlo) Kyselvo: *Non-destructive testing of products made of polymer composite materials: Research and development of control technology*

Pavithran Devananthan: *Response of brain tissue to cyclic loading that mimics rTBIs*

Phillippe Bruneau: *Development Of A Method For Evaluating The Sustainability Of Energy Systems*

Prospero Uybarreta: *A Limited Study to Develop a Piloted Aircraft Comprehensive Operability Rating System*

Ramesha Soysa: *Micro-fabricated Sensor System to Measure and Monitor Stress Fractures in Racehorses*

Richard Ellingham: *Novel dielectric elastomer actuators for biomedical rehabilitation applications*

Sam Dougherty: *Investigations into the unsteady aerodynamic performance of low Reynolds number multirotor UAVs: theoretical, experimental and numerical*

Samaneh Dashti Ghalehjogh: *Application of Energy Dissipation Devices to Steel Jacket Structures*

Seigan Hayashi: *Extending Control-Based Continuation Methods for Dynamical System Analysis*

Simon Blue: *Novel Long-Term Packaging Material for Wireless Implantable Devices*

Tambwe Gregoire Mbangu: *Application of systems dynamics to determine manufacturing scenarios for transition to Environment 4.0 and Industry 4.0*

Theo Nankivell: *Cavitation Mitigation on Hydrofoils by Surface Distributed Mass Flux*

Thomas Bell: *Research and Development of On-Orbit Servicing Capability for Dawn Aerospace Propulsion Systems*

Thomas Maslin: *Active, coupled micro-oscillators for totally implantable*

Tong Jinshen: *Using numerical simulations to characterize the combustion instabilities occurred in cavity-stabilized scramjet combustors, in order to get insights on the origins and control mechanisms of combustion oscillations*

Trudy Calje-van der Klei: *Computational lung mechanics virtual patient modeling*

Widhanalage Ramesha Indeewarie (Ramesha) Soysa: *Sensor System to Measure and Monitor Stress Fractures in Racehorses*

Xinyu Zhao: *Theoretical and Numerical Studies on Combustion Instability and its Control*

Xiran Liu: *Study of the Efficient Use of Small-Scale Wind Harvesters under Different Conditions and the Properties of Wake Flow*

Yiheng (Gwen) Guan: *Numerical and Theoretical Investigations on Nonlinear Thermoacoustic Instabilities in a Bifurcating Combustor and Flame Transfer Function*

Yufeng Lin: *3D printing of complex food structure*

Ziqi Dai: *Design of highly swept propeller blades*

NEW Master's students enrolled in 2024

Hammad Mohsin: *Synthesis and characterisation of poly glycerol sebacate bioelastomer*

Jessica Macfarquhar: *Design and development of Antarctic Ice coring equipment*

Junkeng (Oscar) Su: *Development and Implementation of a Gaze-Directed Flight Control System for Fixed-Wing UAVs*

Liam Holliday: *Quantifying potential benefits surrounding the use of Distributed power in New Zealand's Rail Network*

Morgan Stuthridge: *Benchmarks for Aerodynamic Modelling of Hypersonic Vehicles*

Oliver Marchl: *Using Granular Materials in Wall Cavities to Reduce Low-frequency Impact Noise*

Sebastian Yeoman: *Propagation of Sound Through Gaps*

Master's students enrolled in 2024

Andrew Garner: *Manager worker relationship in industrial operation. Personal productivity and its contributions to national productivity: A New Zealand – Denmark contrast*

Caleb Ibbotson: *Investigating the Viability of Using Machine Learning as a Method of Optimizing the Gait of An Existing Planar Snake Robot Characterization Post Hot-Fire and Material Properties*

Dylan Cameron: *Development of a system for feature cost estimation system for informing early design decisions*

Finn Peterson: *Investigation into the Efficacy of an Adaptive Aerofoil System on Multirotor Drones*

Jordan Smith: *Deep Learning Approach for Improving Emotional Recognition Skills for Individuals with Autism Spectrum Disorder: Development of Foundational Technology*

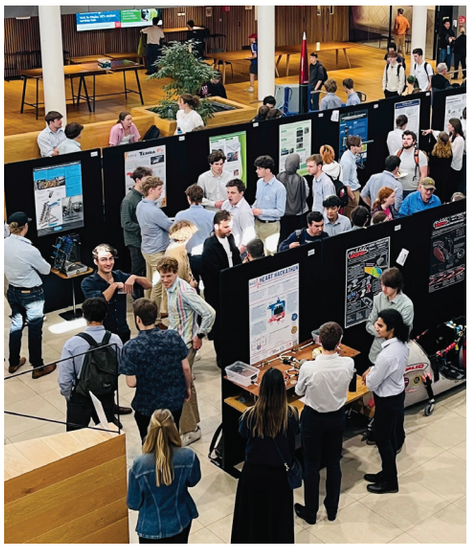
Kailin Paul: *Mobile robotics – snake robot*

Zane Goggin: *Computational fluid dynamics of upper airway during optiflow+ duet asymmetric interface nasal high flow therapy*

Undergraduate students

The Mechanical Engineering Department has continued to attract interest from first-year undergraduate students, as reflected in the enrolment numbers for both Mechanical (Mech) and Mechatronics (Tron) Engineering, which together exceeded 300 new students in 2024.

The department experienced an overall 15% growth in second-year enrolments compared to 2023. Specifically, 179 students enrolled in Mechanical Engineering, while 135 students enrolled Mechatronics Engineering. The average GPA of incoming students over the past few years has been steady at about 6 (B+) for Mechanical Engineering.

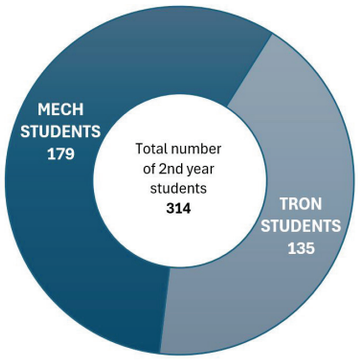


Final Year Project Presentation Day 2024.

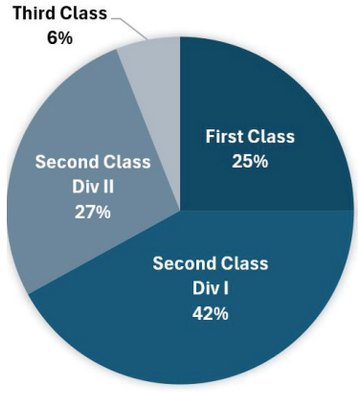
Student Demographics, Distribution of Major and Performance Overview

The number of Māori/Pasifika students has had a moderate growth over the recent years but UC's strategy aims for strong growth & retention going forward.

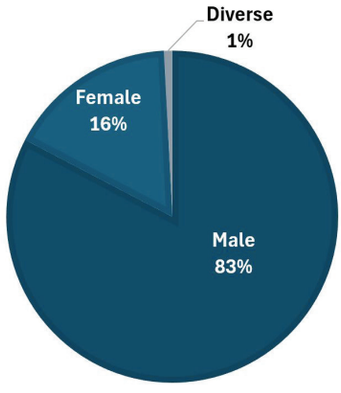
The Mechanical Engineering incoming cohort has a steady number of female students which has grown since our lowest in 2013. Female students in 2024 represent ~16% of the cohort, a number which we would like to increase going forward. The department continues to strive to implement and invest in innovative outreach activities to further increase the diversity of our incoming students and boost the number of female graduates in our disciplines.

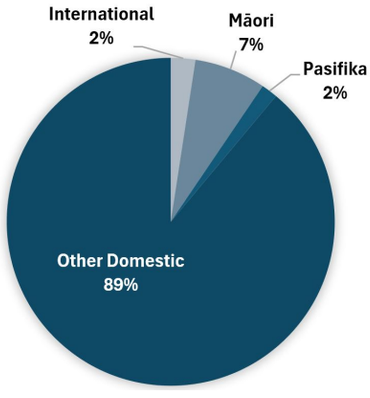


57% and 43% students enrolled in Mechanical Engineering and Mechatronics Engineering respectively.



Honour Split in Graduate Students 2024.



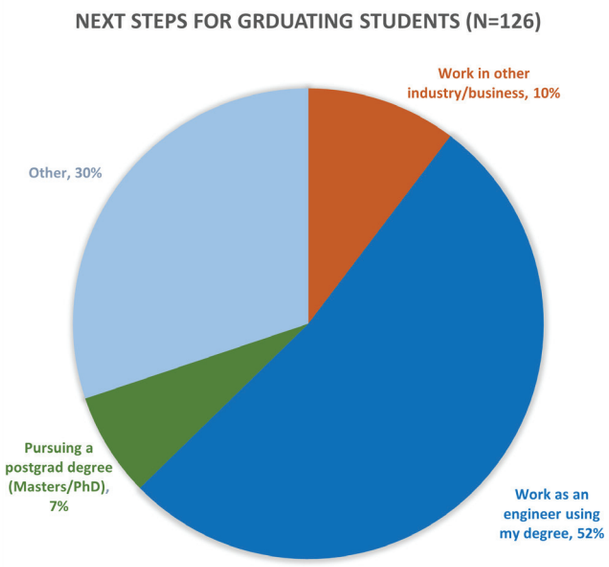


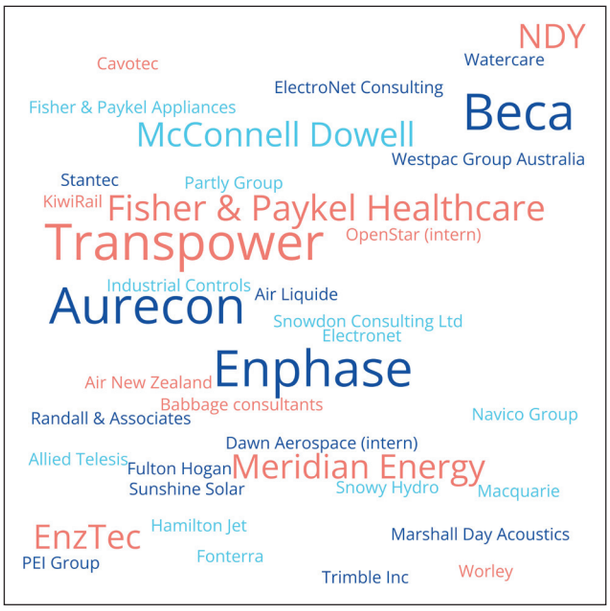
Gender & Ethnicity Diversity in Mechanical Engineering (2nd–4th Year, 2024).

Graduate Employability

A survey was conducted from October to November 2024 to gather insights into the future employability of the department's final-year students, prior to their graduation. All 400-level students were invited to participate, with responses providing information on their post-graduation plans, employment destinations, expected salaries, and job locations.

Of the 126 respondents, 52% indicated they would enter the workforce using their degree, while 30% selected 'Other,' which included taking a gap year for leisure. Another 10% reported transitioning to different sectors, and 7% planned to pursue postgraduate study. Among the 53 respondents who provided employer details, notable companies hiring graduates included Fisher & Paykel Healthcare, Aurecon, Beca, Enphase, and Transpower.

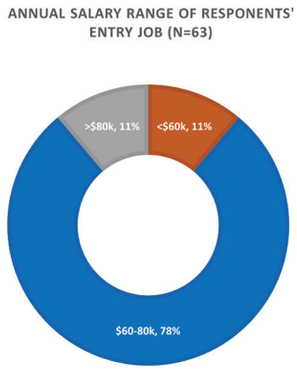


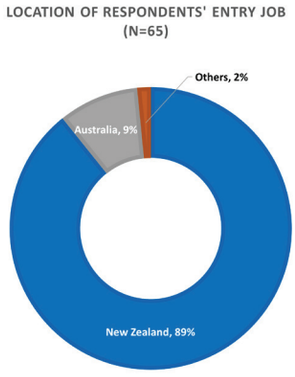


Companies employing our students.

Regarding salary expectations (N=63), the majority (78%) anticipated earning between $60,000 and $80,000 per year, while 11% expected salaries either below or above this range. In terms of job location (N=65), 89% planned to work in New Zealand, 9% in Australia, and 2% elsewhere.

While this is the first time the department has conducted such a survey, it provided valuable insights into the employability of final-year students. However, there are opportunities to improve the process. For instance, conducting the survey at different times of the academic year could help gather more representative and accurate responses, potentially increasing response rates. The department plans to refine this approach in future surveys to better support students' career development and track post-graduation outcomes more effectively.





Second-year Mechanical Engineering student working on the internal Warman Competition as part of the course requirements.

Teaching and Learning

Teaching and Learning Developments

In 2024, 179 students entered the BE(Hons) degree in Mechanical Engineering in their second year, based on their first-year academic performance. This highest-ever number of students entering the programme required adjustments to several processes and methods. The Department also welcomed five international students and had one student undertaken a semester abroad at an exchange university.

The Department offered 19 elective courses for final-year students, including the new Flight and Spaceflight Mechanics (ENME488), which is the fifth elective in the Aerospace Minor. Over the past few years, there has been an increase in aerospace-related electives (ENME404 and ENME460), while the number of students enrolling in thermo-related courses (ENM405, ENME465, and ENGR401) has decreased slightly. There has also been a small decline in students choosing materials-related electives.

A conjoint degree structure was developed for implementation in 2024. The conjoint degree is offered with several other qualifications, including Bachelor of Commerce, Bachelor of Health Science, Bachelor of Data Science, and Bachelor of Product Design. The uptake has been moderate so far but it is expected to grow in coming years for Mechanical, with significant interest in Mechatronic conjoint degrees.

A major milestone in 2024 was the accreditation process by Engineering New Zealand. This involved extensive documentation preparation that began in 2022, followed by a review panel assessing our facilities and gathering feedback from students, staff, and alumni. By the end of the year, we were thrilled to receive confirmation of the re-accreditation of all our engineering programmes, with commendation for our forward-thinking, practical approach and highly motivated staff.

Minor in Aerospace Engineering

The Aerospace Engineering Minor within the BE(Hons) Mechanical Engineering degree provides students with an enhanced pathway into the industry. UC is the only university in Aotearoa offering an undergraduate aerospace programme, involving the design, development, testing, and production of aircraft, spacecraft, and related systems and equipment.

The Minor covers key areas such as design, development, and maintenance of flight vehicles, which involves knowledge and skills in Aerodynamics, Material Science, Computational Simulation, Aerostructure Design, Propulsion, and Flight Control. Students gain expertise in both established and emerging aerospace technologies and processes in the fields of aerospace design, vehicle structural integrity analysis, subsonic and hypersonic flight dynamics, vehicle guidance and stability techniques, aerospace airframes, and propulsion systems, while exploring the industry's impact in New Zealand and globally.

Students in ENME362 Aerospace Design visited Pratt & Whitney/Air New Zealand Engine Centre at Christchurch Airport.

In 2024, the Minor remained highly popular, reaching its enrolment cap of 40 students for the third consecutive year. Highlights included guest lectures from test pilot Prospero 'Paco' Uybarreta (principal experimental test pilot) and Pratt & Whitney propulsion engineer Dr. Jonas Aust. Students also visited the Pratt & Whitney/Air New Zealand Engine Centre at Christchurch Airport, and the top five students from ENME362 Aerospace Design course participated in a hands-on flight experience at the Canterbury Recreational Aircraft Club.

The aerospace electives now on offer are Computational Fluid Dynamics (ENGR 401), Aerodynamics (ENME404), Aerospace Propulsion (ENME460), Aerospace Structures (ENME486), and Mechanics of Flight and Spaceflight (ENME488). This year, UC MechEng welcomed Prof. Raj Das from RMIT University as an Erskine visitor, contributing to Aerospace Structures lecturing and research supervision.

Students in ENME351 Biomedical Design learning to troubleshoot medical devices.

Minor in Biomedical Engineering

The Biomedical Engineering Minor, offered as part of the BE(Hons) Mechanical Engineering degree, provides students with a comprehensive education in designing medical devices such as prosthetics, implants, and assistive technologies. Launched in 2019, the Minor combines practical learning in areas such as biomechanics, ergonomics, and concept design, with essential knowledge in bioethics and medical regulatory compliance. Students benefit from hands-on experience in advanced biomedical labs, with access to cutting-edge equipment like motion capture cameras, force plates, and instrumented sports equipment. Through summer work placements in hospitals, clinics, and industry, students gain real-world experience in the design, maintenance, and implementation of medical technologies, both locally and internationally.

The Minor promotes diversity in the field of Mechanical Engineering, particularly among female, Māori, and Pasifika students. Its curriculum emphasises responsible biomedical design, sustainability, and ethical considerations, preparing students for the global challenges in healthcare. Student projects, such as those in Tonga (see page 26), highlight the Minor's focus on practical impact. Previous initiatives included developing an Assets Register for the Tongan Ministry of Health to track medical equipment and supplies.

With an enrolment of around 30 students annually, the Minor maintains a strong pipeline to postgraduate study, with many graduates advancing to further research. The program's success in fostering diversity is reflected in the growing participation of female students, with 40% of female Mechanical Engineering students choosing to pursue the Biomedical Engineering Minor.

Mentorship & Student Support

The Department continued to prioritise student support in 2024, fostering a strong sense of community among undergraduates through various initiatives. The Mech Mentors programme, which provides structured peer support, expanded in response to student needs. It introduced weekly study sessions led by senior students and mentors, and the addition of a Mech Tech challenge mid-semester. These efforts helped encourage cross-cohort collaboration, with Mechatronics students also participating, strengthening ties between the two cohorts.

Second-year students shared their positive experiences with the mentorship initiatives:

- "(Mentors were) really supportive and kind to all the students – they put in a lot of effort to help out."
- "I got some excellent advice about work and work experience."
- "I loved being around my group and the social aspect of it. I found it was a great way to be introduced to mechanical engineering, and I think it should be standard for all engineering disciplines."

Notably, over half of the third-year students who applied to be mentors for 2025 shared that their experience with Mech Mentors the previous year had such a positive impact on them that they were eager to 'give back' and offer the same support to incoming second-year students. This feedback underscores the success of the programme.

Additionally, the Study Management programme, led by postgraduate students, continued to provide mentoring and peer support to academically at-risk undergraduates, helping them navigate academic challenges and find their way to success. To further encourage community, morning teas for women and diverse students were introduced, providing informal opportunities for connection, collaboration, and tuakana-teina (older-younger) mentoring.

Inspired by the success of these initiatives, a new scheme was introduced for Master of Engineering Studies students, pairing incoming students with those who had started the programme earlier for informal "coffee and chat" meetups, extending manaakitanga through these welcoming, one-on-one connections.

These mentorship programmes have been integral to fostering student success, helping them navigate challenges, and building a strong sense of belonging within the Department.

Internal Competitions for Hands-On Learning

Beyond the classroom, students gained valuable hands-on experience by participating in internal competitions as part of their courses. In the annual *Beam Testing* challenge, third-year Mechanical and Mechatronics students in ENME/ENMT301 designed, built, and tested pin-jointed aluminium structures,

Beam Testing Challenge 2024.

Warman Competition 2024 Internal Heat.

aiming to break at a stress concentration while holding between 20kg and 39kg. Most structures successfully broke at the intended load, demonstrating students' ability to apply theoretical concepts to real-world engineering challenges.

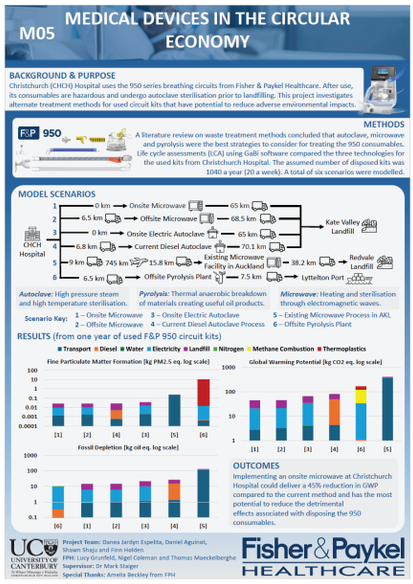
Mechanical and Mechatronics students also participated in the annual *Warman Competition*, where teams designed and built a device to complete a specific engineering task. Meanwhile, Mechatronics students took on *RoboCup and Wacky Racers*, tackling robotics and remotely controlled vehicles challenges in a creative and competitive setting. These competitions provided an opportunity for students to apply theoretical knowledge in a practical environment, enhancing both their technical and problem-solving skills.

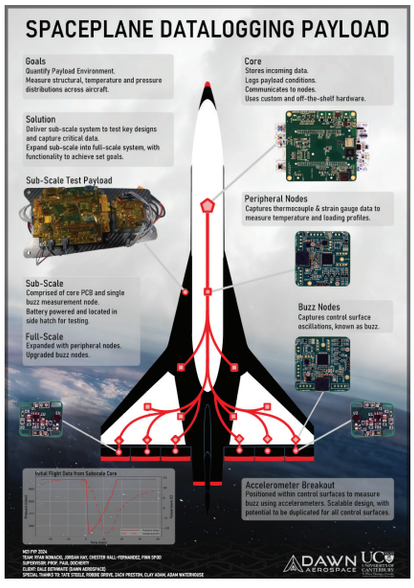
Final-Year Industry & Research Projects

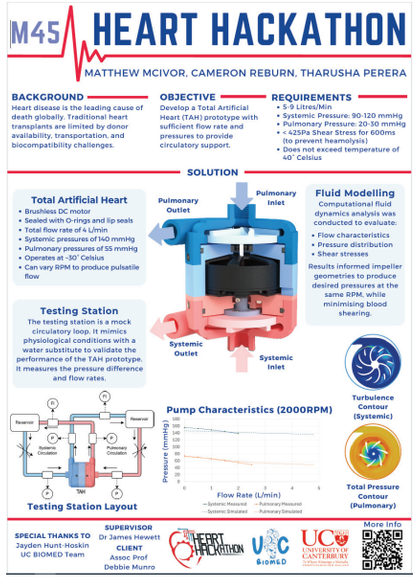
In 2024, students in the Department of Mechanical Engineering completed a total of 50 final year projects (FYPs). This continues a steady rise over recent years: for comparison, there were 46 projects in 2023, 43 in 2022, 42 in 2021 and 34 in 2020.

Out of these, 31 projects were sponsored by 25 external organizations, 8 were sponsored by research grants whilst 10 were internal Mech Eng projects (UC Motorsport, UC Aerospace, UC Human Power and department marketing). The focus areas of these projects include the design and development of equipment for the agricultural and food industry, advancements in automotive technology, aerospace, and healthcare engineering. One remarkable highlight was a non-profit project to develop a highly realistic animatronic model kōkako bird for the South Island Kōkako Trust.

Scan the QR code for more details about the final year projects.







Final Year Projects posters

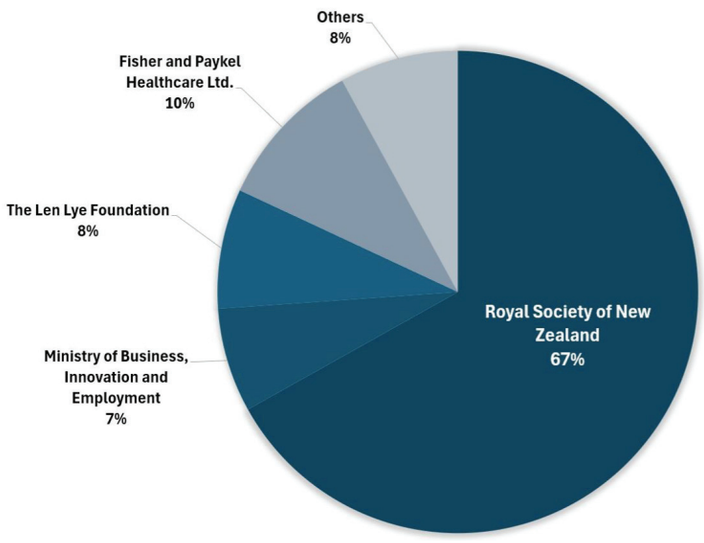
Research

Research Fundings and Publications

UC's Department of Mechanical Engineering hosts approximately 100 postgraduate students, with significant research groups in areas such as biomedical engineering, robotics, renewable energy, materials science, design, and both solid and fluid dynamics engineering. In 2024, the Department was successful in 14 grant applications that represented $1,754,771 in new research funding. The Department also demonstrated its dedication to scholarly excellence by publishing a total of 136 journal articles and 63 conference papers. The department's strong performance in publication of its research findings is a testament to its commitment to advancing various fields through cutting-edge research, making us a research leader within the Faculty of Engineering at UC. In the 2024 QS World University Rankings by Subject, the University of Canterbury's Mechanical Engineering program is ranked among the top 300 globally. Within New Zealand, UC's Mechanical Engineering program is ranked second nationally. These rankings reflect the department's strong emphasis on research and its commitment to excellence in the field of Mechanical Engineering.

Successful Research Grant Applications

The department secured approximately $1,754,700 of external research income in 2024. The biggest contributor by far was the Royal Society of New Zealand - the total amount has increased from 5% of all successful grants in 2022 to 63% in 2024. Others, including Health Research Council of New Zealand, Canterbury Medical Research Foundation, Transtech Dynamics Limited and Tertiary Education Commission, contributed 8% of all the external income. We are committed to continue delivering high standards in various research areas and securing external research funding for future projects.



Value distribution of earned external research contracts

Selected Research Projects 2024

Advancing Flow Visualization and Fluid Mechanics Research

(27-28 November | 14th Pacific Symposium on Flow Visualization and Image Processing)

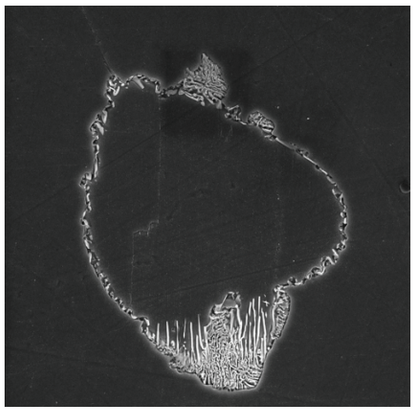
The UC Mechanical Engineering Department hosted the 14th Pacific Symposium on Flow Visualization and Image Processing (PSFVIP), chaired by Prof. John Cater. Gathering 36 researchers from Japan, the Netherlands, the USA, Australia, and New Zealand, the event highlighted recent advances in the field.

Presentations covered a diverse range of topics, from visualizing oil films in combustion chambers to designing fish-friendly pumps that allow eels to pass through safely. Notable talks included a NASA-led exploration of air taxi flow dynamics and a novel laser-based method for detecting ultrasound signals. The symposium fostered valuable knowledge exchange and discussion on emerging techniques in flow visualization and image processing.

Advanced Metal Alloy Research in the 03

(Master Student Ben Wilson and Professor Catherine Bishop)

Cu-Ni-Sn alloys are known for their high-strength and wear-resistance properties and have applications in aerospace, mining, and heavy machinery. Under the supervision of Prof. Catherine Bishop and Christchurch-based AW Fraser (Sam Plummer), Ben Wilson is carrying out his master's degree on research that is aimed at optimising the heat treatment of cast Cu-Ni-Sn bronzes. The overall aim of the project is to develop an industrial process



A backscattered electron image taken using the departments new SEM. Image is of discontinuous precipitation, an important reaction in the Cu-Ni-Sn ternary system.

for the manufacture of Cu-Ni-Sn alloys that targets export markets. AW Fraser is the sole manufacturer of bronze alloys in NZ, with a desire to produce highly specialized materials that place NZ on the world-stage for manufacturing of state-of-the-art products. The research is made possible using the combined resources and expertise of AW Fraser and the Department, requiring that Ben also work onsite at the AW Fraser. The research is utilising the Department's new scanning electron microscope (Tescan Clara) that is capable of high-resolution imaging and advanced chemical analysis, and extensive mechanical testing facilities. In the past, AW Fraser has collaborated extensively with the Department through the sponsorship of various undergraduate and postgraduate research projects, including design of water-cooled dies for continuous casting, residual stress measurement and stress corrosion cracking, designing inoculants for optimized cast microstructures and fundamental studies of stress corrosion cracking in bronze alloys.

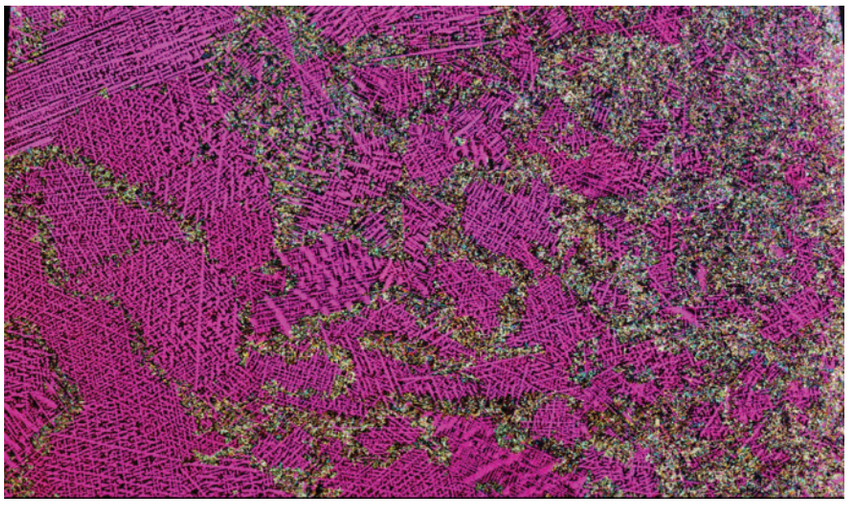
Design and Development of Rapid Ice Sampling Devices

(Master's student Jessica MacFarquhar, Professor Geoff Rodgers)

Currently, ice sheet models do not have an accurate representation of the physical properties of glacial ice, such as the anisotropy, elastic, and viscous properties that influence ice flow. These models are critical to predictions of the rate of sea-level rise that will result from the increased flux of ice from the land into the sea. To improve this, a representative suite of ice samples from numerous locations and depths is needed. This extensive ice sampling has never been attempted as it not feasible using conventional drilling practices. A method has been developed to rapidly drill and bail hot water boreholes so that specialist ice sampling equipment can be deployed.

Master of Mechanical Engineering student Jessica MacFarquhar has designed and developed two rapid ice sampling systems, expanding on work from two final year student teams in 2023, as a part of the Tere Tīpako Tio: Rapid Extensive Antarctic Ice Sampling Aotearoa Project. These systems were designed to operate in dry 125mm boreholes created

Close up of Sidewall Ice Sampler.



Polarized light image showing the dendritic structure of as-cast Cu-Ni-Sn produced by AW Fraser.

Expansion of sidewall Ice Sample.

rapidly with high pressure hot water. One system was designed to collect a 70mm diameter ice sample up to 1m long from the bottom of the hot water drilled boreholes, and the other system was designed to collect a 50mm ice sample up to 100mm long from the side wall of the hot water drilled boreholes. From mid-November to mid-February Jessica was in Antarctica and tested these systems on the McMurdo Ice Shelf, alongside collaborating on other research with colleagues from University of Otago, Swansea University, and Lancaster University. The testing was successful and resulted in ice samples being collected from 3 boreholes at depths of 8m, 18m, 25m, and 40m. The physical properties of these ice samples will be analysed to improve the representation of ice in ice sheet models.

New Research on Coaxial Rotor Aerodynamics for UAVs

(PhD Student Dale Dai and Associate Professor Digby Symons)

PhD student Dale Dai and his supervisor, Assoc. Prof. Digby Symons, have had their novel theoretical work on coaxial rotors accepted for publication in Aerospace Science and Technology.

Their paper, Iterative BEMT Analysis Extended to Model Coaxial Rotor Aerodynamic Performance in Hover, introduces a new method for accurately predicting the thrust and power consumption of coaxial rotor pairs. This approach significantly reduces the setup and computational cost compared to high-fidelity computational fluid dynamics analysis.

The research extends classical blade element momentum theory (BEMT)—traditionally used for analyzing single rotors—to coaxial contra-rotating rotor pairs while minimizing the approximations and empirical factors seen in previous studies. Co-authored with UC alumnus Assoc. Prof. Michael Kingan from the University of Auckland, this work is part of an ongoing collaboration focused on developing low-noise rotor systems for unmanned aerial vehicles.

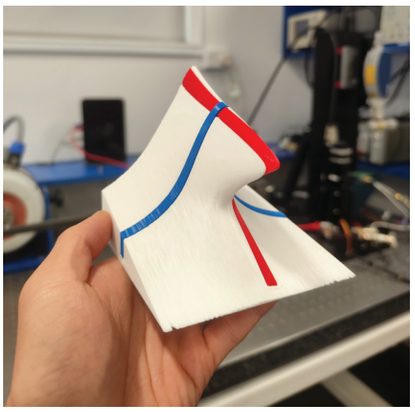
Good vibrations of the Non-linear Type

(PhD student Seigan Hayashi and Professor Stefanie Gutschmidt)

In most engineering applications, a linear analysis is sufficient for their design and operating ranges. However, many structures exhibit nonlinear behaviours, making linear models unrepresentative. Thus, there is demand for a standardised methodology which can be applied to determine the dynamic response in a world of increasing complexity via nonlinearities. Ph.D. candidate Seigan Hayashi, under the supervision of Professor Stefanie Gutschmidt, aims to change the paradigm by embracing these nonlinear concepts, rather than avoid them.

Owing to their technological importance, micro- and nano-electromechanical systems (M/NEMS) are the subject of a rapidly growing body of nonlinear dynamics research. Their dynamics sit firmly in the nonlinear regime, as they operate at large amplitudes and feature strong nonlinear coupling.

Seigan's research explores 'experimental continuation', a technique for tracing out a nonlinear response by directly investigating a physical experiment subject to changes in a system parameter, including those with multi-valued responses and changes in stability. Prior to Seigan's thesis, experimental continuation had not been applied to fast-timescale systems due to the need for minimal delays in real-time feedback control. Overcoming these challenges, Seigan demonstrated its feasibility by investigating a MEMS cantilever, revealing its complex dynamical landscape. He further visualised its unique bifurcation structure using 3D printing technology.



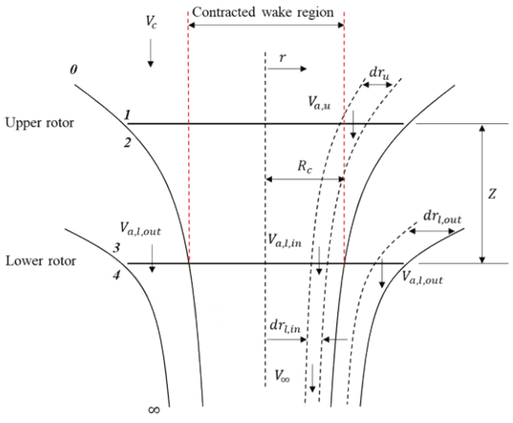
A graph you can hold: MEMS Dynamics.

Seigan has presented his findings at the 11th European Nonlinear Oscillations Conference (ENOC) in Delft, Netherlands. The stated goal of ENOC is to promote the cross-fertilization of ideas and stimulate international interactions in various areas of nonlinear dynamics. Seigan's talk, titled "Control-based continuation of an externally excited MEMS self-oscillator," won the "Young Investigator Award – 1st Place", solidifying his presence within the international nonlinear dynamics' community.

Strain as an Indicator for Stress Fractures in Racehorses

(PhD Student Ramesha Soysa and Associate Professor Deborah Munro)

The horse racing industry, while financially significant, faces ongoing challenges related to the welfare of racehorses, particularly stress fractures resulting from intense training and competition. One of the most prevalent and concerning injuries is the third metacarpal (MC3) bone fracture, which accounts for approximately one-third of all limb fractures. These fractures, especially condylar fractures in the MC3, can severely affect the health,



performance, and welfare of the horse. They are often complicated by bone comminution, which may require euthanasia in severe cases and poses significant difficulties in treatment and recovery for others.

Despite the high incidence of these fractures, there is currently no comprehensive method for accurately assessing fracture risks in racehorses. Recent studies suggest that strain measurements on the MC3 bone during racing conditions may serve as a promising indicator of high loads and fracture risk. The goal of this research is to develop implantable sensing technologies capable of detecting early signs of potential fractures, enabling proactive management and minimising the risk of injury to racehorses.

This study examined the mechanical properties of the MC3 bone under high compressive loads, simulating the stresses experienced during galloping. Using a fixture that secured the bone in a manner mimicking natural conditions, six MC3 bones from euthanised horses were instrumented with strain gauge rosettes at four key locations: Lateral Condyle (CondL), Medial Condyle (CondM), Dorsal DistoLateral (DisL), and Dorsal DistoMedial (DisM). Each bone underwent a preloading phase followed by five cycles of 12 kN sinusoidal loading to replicate galloping forces.

Strain patterns were observed both before and after introducing an artificial slot into the lateral condylar groove to simulate a fatigue crack. Results showed a strong correlation between load and minimum principal strain in both intact and fatigue crack-induced (FCI) bones, with R-squared values exceeding 0.99. Post-FCI analysis revealed that 83% of bones exhibited an increase in the minimum principal strain-load response slope, indicating uniform changes in material behaviour. Additionally, the post-FCI y-intercept values across the MC3 locations showed higher initial strain, suggesting potential changes in bone properties.

This study highlights the importance of strain as an indicator for early detection of stress fractures, and it supports the long-term goal of developing sensing technologies that can improve the management and welfare of racehorses. Access the full article on [DOI: 10.1115/1.4067139] or via the QR code.

Advancing Composite Repairs: Predicting Strength for Aerospace Applications

(Dr Stephen Daynes)

Composite materials are the backbone of modern aerospace structures, offering exceptional strength, stiffness, and fatigue resistance. However, these high-performance materials remain vulnerable to in-service damage from bird strikes, tool drops, and lightning strikes. Addressing such damage effectively is critical to ensuring the safety and longevity of aircraft structures.

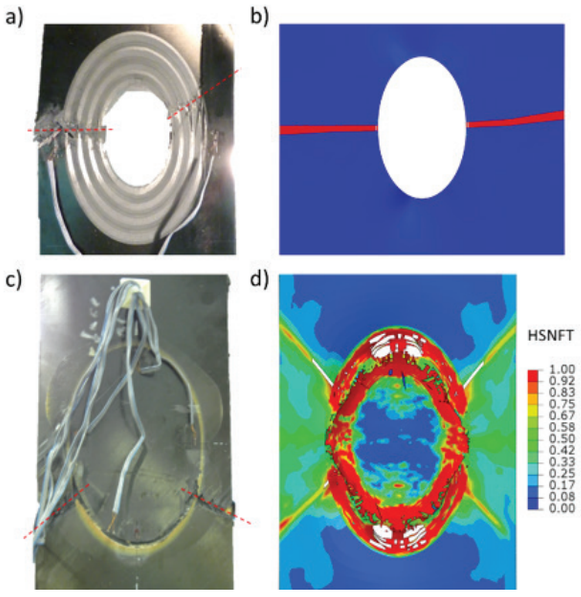
One of the most efficient repair methods involves machining away the damaged region and applying an adhesively bonded scarf repair. Unlike traditional bolted repairs, which introduce stress concentrations and additional weight, scarfed repairs provide a smooth, aerodynamic profile and maintain structural integrity. However, accurately predicting the strength of these repairs has long been a challenge due to the complex stress distributions and varying material properties within composite laminates.

A recent study presents an innovative semi-analytical model capable of predicting the ultimate strength of composite laminates with holes, scarfed repairs, and bonded patches. This model extends the widely used point stress criterion, allowing for precise estimations of strength based on laminate properties, stacking sequence, and notch geometry. The accuracy of the model is validated through experimental testing and computational finite element analysis (FEA), demonstrating strong correlation with real-world data.

By providing a rapid and reliable strength prediction tool, this research marks a significant advancement in composite repair technology. It enables engineers to optimise repair designs with confidence, reducing the need for costly physical testing while improving aircraft safety and performance. As composite materials continue to dominate the aerospace industry, innovations like these will play a crucial role in ensuring their durability and reliability.

Access the full article on https://doi.org/10.1016/j.compstruct.2024.118512 or via the QR code.

PhD Student Ramesha Soysa



Failure modes of high stiffness scarfed elliptical hole panels: (a) SH test, (b) SH FEA prediction, (c) RH test, and (d) RH FEA prediction, showing Hashin fibre failure criterion in the longitudinal 0° ply.

Denkenberger Becomes the Most Published Author in Existential Risk Research

(Associate Professor David Denkenberger)

Associate Professor David Denkenberger has surpassed Seth Baum, founder of the Global Catastrophic Risk Institute, to become the most published author in the global catastrophic and existential risk field. Additionally, ALLFED (Alliance to Feed the Earth in Disasters), where he serves as research director, is now the most published organisation in this field.

At the University of Canterbury, David has supervised a range of innovative projects focused on enhancing disaster resilience. One project involved converting an oven into a wood-burning stove for use during extended electrical outages. Another demonstrated that a car-powered woodchipper could produce four times more energy than required to operate the car when the wood chips were gasified. Although this might sound like a perpetual motion machine, the additional energy comes from the sun, which enable the growth of the wood. In essence, the car is using energy that was originally stored in the biomass. This project also showed that the car could generate 20 kW of electricity—enough to power twenty homes on average. These final-year student projects are set to be published in Energy Engineering.

In addition to his work on disaster resilience, David recently published a comprehensive review article, Food Without Agriculture: Food from CO_2, Biomass, and Hydrocarbons to Secure Humanity's Food Supply Against Global Catastrophe, in Trends in Food Science & Technology. With an impact factor of 15, this journal ranks third in the Food Science category, highlighting the importance of his contributions to securing food sources during global crises.

Marsden Funding Success to Improve the Design of Rotary Atomizers

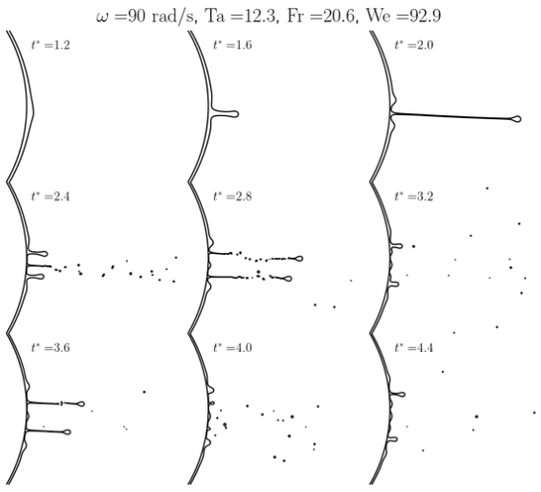
(Professor Mathieu Sellier)

Rotary atomizers are simple devices which allow the break-up of a fluid stream into a myriad of small droplets. They involve a fluid jet impinging vertically at the centre of a rotating surface. Under the effect of the centrifugal force, the fluid spreads outwards and forms a thin liquid film which evolves into ligaments at the rim which ultimately break up into droplets.

Rotary atomizers are routinely used in a range of industrial applications including spray dryers to produce powders in the food industry, painting, microencapsulation, the production of pharmaceuticals, or agricultural sprays for which it is important to maximise the amount of exposed fluid surface area per unit volume.

One of the major drawbacks of traditional designs is the inability to accurately control the droplet size distribution.

Building on earlier numerical modelling work exploring the dynamics of thin liquid films on curved surfaces, see figure below, Professor Mathieu Sellier and collaborators from UC (Dr Natalia Kabaliuk, Dr Selin Duruk, Dr Bradley Boyd) and Ecole Polytechnique Fédérale de Lausanne (Dr Edouard Boujo) have been awarded a $942k Marsden grant from the Royal Society of New Zealand - Te Apārangi to unravel the relationship between the shape and wettability of the rotating surface and the resulting droplet size distribution. This will ultimately improve the design of rotary atomizers and enable the process to be fine-tuned to a desired application, maximizing its efficiency, product quality, and reducing waste.



Simulation of the thin film instability which grows the surface of a rotating sphere and develop into fluid ligaments which eventually break-up into droplet for different flow conditions (simulation by Dr Bradley Boyd).

Community Engagement

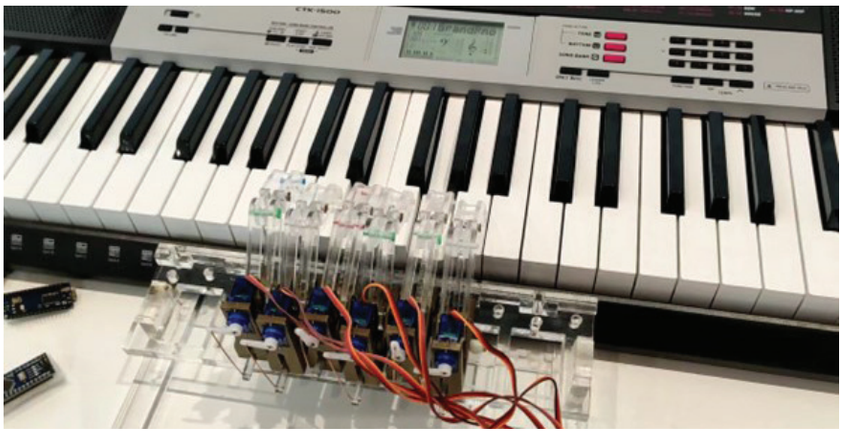
Publicity & Outreach

In 2024 the Publicity & Outreach team was chaired and led by A/Prof Stefanie Gutschmidt, with Owen Kelly leading all technical aspects and Greta Rapalaviciute managing and overseeing all administrative tasks. Furthermore, 2nd year student Vidha Saeed was the key team leader and communicator to form and manage people and teams for our outreach events in 2024 on and off campus. The entire outreach team included a total of 35 members of a broad diversity of skills, programmes, gender and levels of experience. The team helped the department, faculty and university in many regular events as well as new initiatives and one-offs. Throughout the year we received fully booked information and lab tour sessions and attracted large crowds of visitors.

Whether on UC-Central-led events, such as UC Welcome Day, UC Discovery Day, and UC Open Day or the departments' own initiatives such as KidsFest 2024 or hosting Children's Uni and school groups, the expression of interest and number of participants were always more than we could hold sessions for. UC Open day was very special in many ways in 2024. Mech/Tron offered three sessions totalling about 580 prospective students and touring nearly 300 students by 16 tour guides through our labs between 9 and 5 pm. Additionally in 2024, we held two half-an-hour sessions for each of our Minor programmes, Bio-Medical and Aerospace, which attracted another 2x170 students showing interest in studying with us.

On many of these outreach events the department strongly collaborated with the professional clubs (UC TronSoc, UC Motorsport, UC Aerospace, UC Human Powered, UC Bio Medical). Without these, our outreach efforts would not be nearly as effective and successful, and we have enjoyed, valued and keep appreciating this partnership for years to come.

Smaller, but no less successful, events were organized and driven by selected members of the outreach team, as follows:



Math199 Camp

Children's Uni

KidsFest2024

Math199 Camp

(24 May, 1-day, 1.5 h sessions, 51 participants), leaders: Ethan Neal, Ittai Perchig, Vidha Saeed; programming artificial "fingers" to play a song on the keyboard

Children's Uni

(24 & 26 June, 4x56 children, 40 min activities, age 7-12) leaders: Vidha Saeed and George Adams; 4 sessions of earthquake towers, catapults and wind tunnel.

KidsFest2024

(9 & 10 July, 4 sessions, 112 participants) leaders Joshua Peacocke, Vidha Saeed, George Adams sessions of earthquake towers, catapults and wind tunnel

TECHWeek

In May 2024, a team of two staff and six students from the Mechanical Engineering Department headed over to the beautiful West Coast for NZ TECHweek.

On Wednesday night, in collaboration with the Development West Coast Trust (led by Jade Mahuika and Katie Baxter), we hosted an industry networking evening, which has further strengthened our department's relationship with DWC. Conversations and discussions between different parties included inspiring future connections between UC Engineering students and businesses on the West Coast through the likes of Summer Internships and industry projects. We thank DWC for their help with organising this event and we look forward to what the future brings in continuing to work with them to bring opportunities to future and current students as well as the Westcoast region.

TechWeek 2024 exhibition in West Coast.

Experiential Learning – Engineering, Culture, and Community

The Biomedical Engineering Service Trip to Tonga addressed critical challenges in medical equipment access, maintenance, and repair, while providing an invaluable learning experience for eight students—five Mechanical and three Mechatronics. The 11-week programme was structured to balance technical education with real-world application. The first six weeks consisted of intensive technical training, cultural awareness, and Tongan language lectures, along with field trips to the CDHB Bioengineering Labs. During the final five weeks in Tonga, students not only applied their newly acquired knowledge by conducting research projects and repairing medical equipment but also helped provide training to local biomedical technicians, including demonstrating the use of a 3D printer donated by the department. This hands-on experience directly addressed the region's chronic shortage of spare parts and equipment. Key findings from the trip highlighted a backlog of broken equipment, a shortage of supplies, and the urgent need for affordable biomedical technician training. The department plans to continue these trips annually, further developing students' practical skills while supporting sustainable solutions for Tonga's healthcare system.

Nick Dewhurst (left) teaching Tongan technicians at Vaiola Hospital how to use the donated 3D printer.

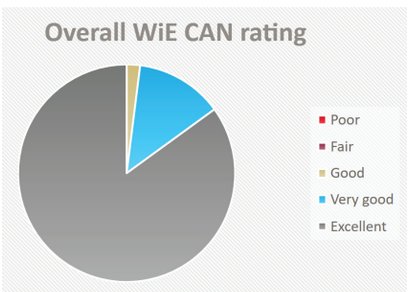
WIE CAN Camp 2024

WIE CAN 2024 saw the Faculty of Engineering hosting 60 high-school students from around NZ to participate in WiE CAN 2024 – the 5th year of UC's five-day residential Woman in Engineering programme, sponsored by the Tait Foundation.

The programme features interactive workshops, inspiring presentations, and fun social activities that aim to introduce girls to the exciting world of engineering.

WiE CAN 2024 had 217 applications from all around New Zealand, with many from the major centres. During the programme the students participated in nine workshops and three challenges from across the faculty's schools and departments, with Electrical and Computer Engineering and Mechatronics Engineering in particular receiving strong praise from the students. The students also demonstrated a strong interest in Mechanical Engineering, with 73% of students indicating that they were most interested in Mechanical Engineering at the end of the programme.

The students all showed great interest in the possibility of a career in engineering, with 85% of students rating the programme as excellent, and over half intending to attend UC in 2025.



***Goal**: 90% attendees rate WiE CAN as very good/ excellent **Result**: 98% attendees rate WiE CAN as very good/excellent; 85% respondents rated WiE CAN as excellent.*

One of the WiE CAN workshops.

Achievements & Awards

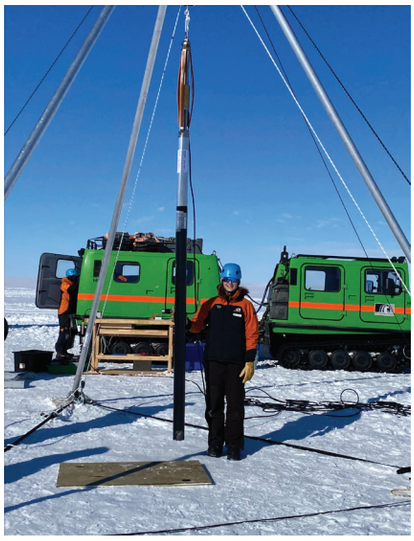
Francis Small Scholarship Recipient for Ice Core Sampling Technology

During February 2024, Master student Jessica MacFarquhar travelled to Antarctica as a part of the Tere Tīpako Tio: Rapid Extensive Antarctic Ice Sampling Project, led by Professor David Prior from the University of Otago. Jessica's involvement in this research was supported by the **Francis Small Scholarship** from the Engineering New Zealand Foundation. The project has an overall aim to provide new tools to advance New Zealand's research contribution to understanding how future changes of the Antarctic Ice Sheet will affect global sea level rise and Southern Ocean dynamics.

Jessica became involved in this project through the Department of Mechanical Engineering's Honors Research and Development course in her final year of Bachelor degree, where she was in a team of three students that were tasked with designing and developing a drill to collect ice core samples from the bottom of an ice borehole that was predrilled with a hot water drill. This drill will assist with the rapid collection of ice cores. Currently using conventional ice core drilling equipment, it can take a week to collect a sample at a depth of 50 metres, whereas using hot water drilling and a separate coring system the goal is to reduce this time to only 2 days.

The solution that students developed was an electromechanical ice coring drill that utilised bespoke design components alongside off-the-shelf augur equipment with key adaptations. This allowed the solution to be significantly cheaper than other ice coring equipment that is currently available. While in Antarctica, Jessica was able to test the performance of the drill prototype, which was successful at collecting ice cores at shallow depths. Jessica now continues building on this design as a part of her Master of Mechanical Engineering Thesis with the scholarship, further developing the drill so it can collect ice core samples at depths greater than 50 metres.

Jessica MacFarquhar



ANZSRS Robert Jensen Respiratory Excellence in Respiratory Science Award

Ella Guy was awarded the prestigious **ANZSRS Robert Jensen Respiratory Excellence in Respiratory Science Award** at the Thoracic Society of Australia and New Zealand 2024 Annual Scientific Meeting in Gold Coast. This award recognizes the presentation that best exemplifies excellence in respiratory measurement across both oral and poster presentations. Ella's presentation, titled *"Model-based Non-invasive Assessment of Respiratory Muscle Strength"*, contributes to ongoing efforts in model-based management of respiratory disease. Her recognition reflects the quality of her work and its relevance to the field of respiratory science, highlighting her contribution to advancing methods in respiratory measurement.

Ella Guy

Internship at NASA with the New Zealand Space Scholarship

PhD student Alexandra McKendry was awarded the **New Zealand Space Scholarship** and completed a 3-month internship at NASA's Ames Research Centre in California's Silicon Valley in June 2024. During the internship, she was mentored by NASA scientists and worked on projects exploring how neuromorphic computing could enhance the autonomous capabilities of small spacecraft. Alexandra gained hands-on experience in the research and observed the real-world implementation on these technologies, further developing her expertise in neuromorphic engineering.

21st International Summer Leadership Academy BIO-X on Data Science in Healthcare, Medicine, and Biology

Four of our PhD candidates—Jaimey Clifton, Josie Dixon, Ella Guy, and Jordan Hill—were selected to participate in the highly competitive **21st International Summer Leadership Academy BIO-X on Data Science in Healthcare, Medicine, and Biology**, held in Chania, Greece, in June 2024. Selection is based on candidates' scientific credentials, and with an acceptance rate of just 3.5%, this prestigious programme fosters leadership through scientific excellence, interdisciplinary collaboration, and cultural awareness.

During the academy, our students attended talks by leading researchers on topics such as AI in healthcare, medical wearables, and biomarkers etc. They presented their work, engaged in discussions with experts and fellow

Alex McKendry (left) and Faun Watson (right, PhD student from Victoria University of Wellington), both of whom interned at Ames Research Centre.

participants, and received valuable feedback. The programme also provided opportunities to build connections with scholars and peers from top institutions worldwide.

Beyond academic activities, participants took part in cultural excursions, including a guided tour of Chania and a formal banquet showcasing traditional Cretan cuisine. We congratulate our students on this achievement and look forward to their continued contributions to biomedical engineering.

Young Investigator Prize at the European Nonlinear Dynamics Conference (ENOC 2024)

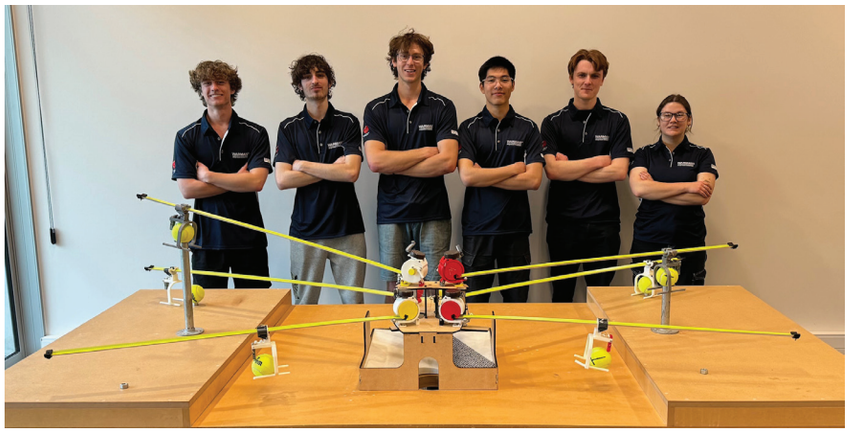
PhD student Seigan Hayashi received the **Young Investigator Prize** at the European Nonlinear Dynamics Conference (ENOC 2024), held in Delft, The Netherlands in July 2024. Seigan's presentation, titled "Control-based continuation of an externally excited MEMS self-oscillator," earned him recognition as one of 15 shortlisted candidates in the young scientist category. His trip to Europe also included academic visits to renowned institutions, including Imperial College London, University of Exeter, University of Bristol, and Leibniz University in Hanover, Germany. Seigan's award highlights the excellence of his research and the impact of his work at an international level.

NCED Best Design Award in 37th International Warman Design and Build Competition

Each year, our second-year students compete for the honour of representing The University of Canterbury at the Warman Design and Build Competition, sponsored by Weir Minerals Australia Ltd (formerly Warman International) and coordinated by the National Committee on Engineering Design (NCED) of Engineers Australia. The design, build, and compete challenge is run as assignments for ENME201 (Design Communication) in Semester One and ENME221 (Design and Manufacture) in Semester Two. Locally, about 180 students from Mechanical Engineering compete in teams of four.

Internationally, about 2000 students from Australasian universities compete, which created 16 campus entries for the 2024 final.

Canterbury regularly brings home a significant prize, and for 2024, our team demonstrated their outstanding ingenuity and produced a convincingly faster machine, winning them the **NCED Best Design Award** at the final. This is a remarkable achievement, and the team deserves our congratulations.



Team UC 2024: Mylo Mcfarlane, Connor Amsterdam, Antony Death, Gene Lee, Max Spence, and Jorja Holden.

Finalist – Momentum Student Entrepreneur Award, 2024 KiwiNet Awards

Jenny Zhu, a recent graduate of our Mechatronics Engineering programme and a New Zealand representative in badminton, was named a finalist for the **Momentum Student Entrepreneur Award** at the 2024 KiwiNet Research Commercialisation Awards for her innovative approach to making umpiring more accessible for recreational players.

Inspired by her own journey—from playing socially as a child to competing internationally—Jenny recognised that while professional athletes benefit from advanced but costly umpiring technology, everyday players often lack reliable officiating. This motivated her to develop a more affordable solution, **LineBuddy**.

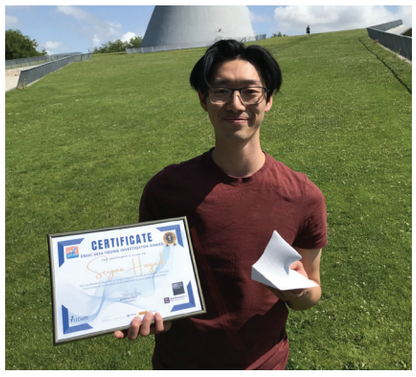
Conceptually, **LineBuddy** applies smartphone technology and object detection to assist with line calls. Players could receive instant in-or-out feedback by setting up a smartphone on a tripod behind the court, presenting a potential low-cost alternative for fair play.

Ngā Ahurei Fellow of the Royal Society Te Apārangi and UC Research Medalist 2024

Professor Dan Zhao was elected as one of 22 new Ngā Ahurei fellows of the **Academy of the Royal Society Te Apārangi** in April 2024, in recognition of his exceptional work in combustion engineering and advancements in low-emission, safe, and efficient engine design. Being named a Fellow acknowledges his international excellence in research and scholarship.

Dan has also received the **UC Research Medal 2024**, the university's highest honour for sustained excellence in research, recognising his outstanding contributions to the field.

Jaimey Clifton, Ella Guy, Josie Dixon, and Jordan Hill on a tour of Chania, Greece, as part of the 21st International Summer Leadership Academy BIO-X programme.



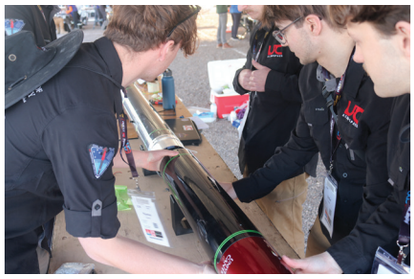
PhD student Seigan Hayashi

Jenny Zhu, the founder of LineBuddy.

Distinguished Professor Geoff Chase (right) with Josh Starkey, Business Development Manager, BNZ (left).

UCM team

Prof Mathieu Sellier and former AFMS president Dr Bianca Capra



UC Aerospace team

Winner – BNZ Researcher Entrepreneur Award, 2024 KiwiNet Awards

Distinguished Professor Geoff Chase has been recognised with the **BNZ Researcher Entrepreneur Award** at the 2024 KiwiNet Research Commercialisation Awards for his exceptional contributions to business innovation in New Zealand. His pioneering research in high-tech automation addresses critical challenges in healthcare and seismic engineering, resulting in tangible, real-world impact.

Geoff's work includes the development of novel blood sugar control protocols, now standard clinical practice in several ICUs and NICUs in New Zealand, Hungary, Belgium, Malaysia, and beyond, improving patient outcomes through advanced automation.

This award acknowledges his dedication to translating research into practical solutions. The judges highlighted his "enthusiasm for commercialisation," which has inspired a new generation of innovators at UC. Geoff has played a key role in the creation of five spinout companies, including Boundary Lifesciences and Intersection Lifesciences (now merged into Tiro Medical), seismic control device company 2.2g-Force, and diabetes care company Tautoko Technology. With two additional spinouts in development, his work continues to drive innovation and address global challenges in healthcare and engineering.

Faculty of Engineering Annual Staff Award 2024

Oscar Torres received the Health, Safety, and Well-being Award at the Faculty Award ceremony.

AFMS Fellowship and Leadership Role in AFMS Council

Professor Mathieu Sellier has achieved several remarkable milestones in fluid mechanics this year. At the 24th Australasian Fluid Mechanics Conference, he was honoured as a **Fellow of the Australasian Fluid Mechanics Society (AFMS),** recognising his profound contributions to the field and the international prestige he brings to Australia and New Zealand. In a historic achievement, he was also elected **president of the AFMS Council**, becoming the first from a New Zealand institution to hold this role. Additionally, James Hewett was elected as a **member of the AFMS Council,** further strengthening the department's connection to the society.

UC Motorsports Achieving 6th Place Overall at Formula SAE-Australasia Competition 2024

Throughout the Formula SAE Australasia 2024 competition, UCM took part in a variety of static and dynamic challenges that tested both the car and the team's capabilities. From design evaluations and business presentations to high-intensity dynamic events like the skid pad and endurance race, the competition provided a platform to demonstrate technical skills, teamwork, and adaptability.

The UCM team achieved remarkable results at the FSAE-A 2024 competition, securing 6th place overall and earning a spot as the 9th-ranked team in the world out of 300+ universities. Their final standings in each event were as follows:

- 5th Business Presentation
- 4th Cost and Manufactuing
- 11th Design
- 8th Acceleration
- 5th Skidpad
- DNF Autocross
- 8th Endurance
- 1st Efficiency
- 6th Overall

Spaceport America Cup 2024

The UC Aerospace team secured first place in the 30K COTS (30,000 ft, Commercial Off-The-Shelf) category at the 2024 Spaceport America Cup in June, successfully defending their title after also winning in 2023. The team was also named Runner-Up for the Team Sportsmanship Award.

Hosted annually by the Experimental Sounding Rocket Association (ESRA), the competition brings together more than 120 university teams and over 1,800 students from around the globe, all competing in distinct categories as well as for the overall championship. Each team is tasked with designing, constructing, testing, and launching a rocket carrying a 2.2-pound payload, with the goal of reaching one of three designated altitudes: 10,000, 30,000, or 45,000 feet, depending on their selected category. Multistage configurations are allowed, along with all major chemical propulsion systems, including solid, liquid, and hybrid fuels.

Professional Clubs & Social Activities

Professional Clubs

Beyond accolades, our students' success is driven by their passion for innovation, teamwork, and leadership, especially within our student-led clubs. These clubs provide hands-on learning opportunities, allowing students to apply engineering principles, tackle challenges, and compete in national and international competitions. They reflect the drive and enthusiasm present within our community.

UC Aerospace

2024 proved to be another very successive year for UC Aerospace, with the club once again showcasing its ability by retaining the 30k COTS title at the Spaceport America's Cup competition in June. With the new and improved Karearea rocket achieving an apogee of 30,491 ft, 491 ft from the target, UC Aerospace once again proves its place in the aerospace sector.

Back in New Zealand, club membership grew by 45%, from 390 members in 2023 to 565 in 2024. With membership increasing, so did our projects. Our level one program saw well over 100 students successfully launching 23 ¼ scale patriots over the launch weekend. Further away from home, returning members ventured up north to Taupiri to represent the club at the National Launch Day hosted by NZRA as well as achieving their level 2 certification.

UC Aerospace — Teams of students were preparing and creating fillets for their rockets in one of UCA's level 1 workshops.

UC Motorsport

Looking away from the rockets, Avionics and Electrical tutorials proved to be very popular with 30 students completing 11 miniature flight computers ready for testing. Throughout the year our club hosted several social events, including a quiz night and a movie night, both of which were jointly run by other UC Engineering clubs. These events were highly enjoyed by our members and allowed them to learn more about some other clubs on campus.

Carrying on from the momentum of previous years, our community reached well over 100 students aged 7 – 17, teaching them how to build and fly their very own park flyer rockets. Students from UCA also volunteered at the NZ Aerospace Summit, assisting with running behind the scenes and allowing us to showcase our projects to industry partners.

Looking forward to 2025, UC Aerospace has decided to refocus our efforts on designing a hybrid rocket engine to power future Spaceport rockets. The club is also aiming to increase inter-club collaboration with both projects and social events as well as our presence within the community at outreach events.

UC Motorsport

The University of Canterbury Motorsport (UCM) team had an outstanding year, highlighted by their impressive performance at the Formula Student FSAE-A 2024 competition in Melbourne, where they secured 6th place overall. Building on the foundations laid in previous years, the team focused on creating a lightweight, simple, and reliable race car that could be fine-tuned for dynamic performance. Their efforts resulted in a 157kg race car that successfully met their design goals and performed exceptionally on the track.

Beyond the FSAE-A competition, UCM saw remarkable growth in student involvement, with increased participation from junior members. The team's outreach efforts included hosting a High School Formula RC competition, which was recognised as a finalist for the Best Community Event award at the UCSA Supreme Club Awards. Additionally, the Alumni Speaker Series event brought together five former UCM members who shared insights from their time with the team and their career journeys, strengthening the connection between past and present members.

UCM's achievements in 2024 reflect the dedication, passion, and collaborative spirit of its members, reinforcing the club's reputation

Let's Talk Cycling Public Seminar.

as a leader in student-led engineering. The team looks forward to building on this success and continuing to push the boundaries of innovation and excellence in the years to come.

UC Human Powered

In 2024, the Human Powered Club grew to 60 members. Throughout the year, we organised termly events, including skill workshops to develop members' abilities (such as Onshape modelling, recumbent bike riding, and bike maintenance training), as well as social rides and movie screenings.

Beyond these activities, we actively engaged with the community. Several members volunteered at the weekly Dr Bike tune-up sessions for staff and students, and we partnered with RAD Bikes to support the wider cycling community. We also hosted a public seminar, Let's Talk Cycling, for anyone interested in cycle commuting and personal bike maintenance. Additionally, we gave a presentation at the South Island Final of the NZ Physics and Mathematics Competition, inspiring secondary school students and their supporters.

Project 100 continued into its second year, with nine new students working on Maroro—our streamlined recumbent bicycle, named after the Māori word for "flying fish." Several road tests were conducted with a new rider pool, including successful fully enclosed runs. While high-speed tests are still pending, the project's top speed goal has been raised to 59 km/h.

We're excited to see more people discovering alternative cycling methods and to witness individuals of all ages inspired by the incredible locomotive potential of human power!

UC Robotics

UC Robotics

In 2024, UC Robotics (UCR) hosted some of its most successful events yet, excelling in VEX robotics, combat robotics, and social activities. At VEX Nationals 2024, our primary team, UCCR1, claimed both the Skills Champion and Competition Winner titles, while UCCR2 delivered a strong performance, bringing more talented students into the VEX scene. Following this success, UCCR1 earned a prestigious qualification for the VEX World Championship, where they will compete on the global stage in early 2025.

The year's standout combat robotics event, Junkyard Joust, saw an incredible turnout, with club members battling it out using creatively improvised bots in a thrilling weekend-long tournament.

Beyond competitions, UCR expanded its focus on social events, giving members the chance to connect over their passion for robotics in both sci-fi and real life. Collaborative events such as Interstellar Movie Night and Quiz Night brought the community together in new and engaging ways.

Looking ahead to 2025, we aim to support UCCR1 at Worlds while continuing to run local VEX competitions. We also plan to launch new robotics projects, developing bots for future events, and to host more accessible, low-commitment social gatherings—ensuring everyone can be part of the exciting future of robotics at UC.

UC BioMed

The UC Biomedical Engineering Club (UC BIOMED) provides Mechanical and Mechatronics Engineering students opportunities to explore and advance human health and wellbeing through technological innovation. The club connects students with the biomedical engineering industry, research initiatives, and hands-on projects, fostering an interdisciplinary approach to engineering in the medical field.

UC BIOMED offers diverse experiences, including attending biomedical engineering conferences in New Zealand and abroad, visiting industry-leading biomedical companies and research groups, and participating in international design

competitions. The club is also actively involved in developing research and summer work opportunities for students, gaining practical experience in medical technology.

Networking & Industry Engagement

By the end of 2023, UC BIOMED had grown to 81 members, participating in UC open days, club days, and major university events such as the UC 150th Anniversary alumni celebration. The club collaborates with industry and academic groups, hosting successful Q&A evenings alongside IEEE and TronSoc. These events featured representatives from leading biomedical companies, including Taska, Enztec, MedSalv, and Fisher & Paykel Healthcare, each drawing around 60 students. Additionally, informal networking events, such as barbecues outside Herea-Roa, provided students valuable opportunities to connect and discuss biomedical engineering pathways. Thanks to these efforts, membership grew to over 110 students in 2024.

Heart Hackathon – UC BIOMED's Flagship Project

Heart Hackathon is an annual international competition where university teams design, prototype, and manufacture a total artificial heart. In 2023, a team of six UC BIOMED members successfully developed a prototype, meeting all competition milestones. In 2024, this initiative expanded into a final-year project, with three fourth-year students leading the effort and an additional 10 members contributing, culminating in participation in the International Society for Mechanical Circulatory Support (ISMCS) competition held in Japan. This year, a team of six FYP students is taking the project further and hopes to compete in Austria.

From hands-on workshops, such as 3D-printing prosthetic arms, to large-scale international projects, UC BIOMED continues to push the boundaries of biomedical engineering innovation at UC.

UC Sustainable Design Society (SUSD)

Founded just two years ago by a group of mechanical engineering students competing in the U.S. Department of Energy Solar Decathlon, our club has rapidly evolved into an interdisciplinary community welcoming students from all fields of engineering and beyond. Our mission is to expand awareness of modern sustainability initiatives and foster innovation. Additionally, we aim to provide our members with opportunities to make a tangible, positive impact on the environment through active participation in ecological projects.

Highlights of 2024

One of the standout moments of the past year was an industry talk delivered by a representative from Zincovery. Members gained valuable insights into the challenges of zinc recycling. While various scientific papers offer solutions to this issue, the real-world implementation of these processes on a larger scale remains complex. The speaker emphasized how chemical engineering expertise plays a critical role in scaling up these processes, making them not only environmentally friendly but also sustainable in ethical, ecological, and social dimensions.

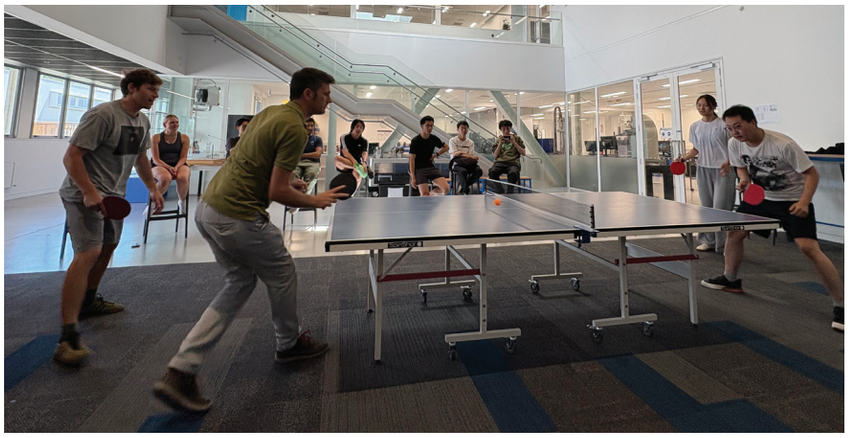
Another remarkable event was the Urban Intelligence Industry Night. An industry professional illuminated the intricacies of traffic management programs during extreme events like floods, offering a glimpse into the importance of adaptable and resilient systems.

This year also featured an enlightening talk on solar energy by the director of Slowjam Energy. Covering topics ranging from the fundamental principles and types of solar batteries to their grid contributions, the discussion highlighted relevant caveats and explored the growing popularity of these technologies due to their remarkable power and cost efficiency.

Active Involvement Opportunities

A particularly exciting project last year was a collaboration with Fulton Hogan on the Takahē Project, an initiative tailored for mechanical and mechatronics engineering students. The aim was to enhance the current Takahē recovery process by designing a safe and stress-free yet effective capturing device for the birds. This effort supports Department of Conservation rangers in monitoring the birds' health, striking a balance between rangers' safety and animal welfare.

Social Activities



A thrilling moment from the intense table tennis tournament final.

The Postgraduates' Mixed Doubles Table Tennis Tournament wrapped up the year in mid-December, after three weeks of exciting round-robin matches. The event brought together mixed-gender teams, pairing students and staff across different skill levels and academic backgrounds. This unique mix fostered teamwork and friendly competition, making for an engaging and inclusive tournament.

Congratulations to the champions, Mathieu Sellier and Finn McIntyre, for their outstanding performance, and to the runners-up, LiXian Guo and CongYu Xu, for their strong effort in the final match. The tournament was a fantastic way to connect, compete, and celebrate the spirit of the game.

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