Faculty of Engineering and Design
Summer Research Scholarships

2026/2027 Projects (Engineering Science & Biomedical Engineering)

Project code:	ENG054
Project title:	**Advancing Simulation Modelling Tools**
Discipline:	Engineering Science & Biomedical Engineering
Supervisor(s)	Thomas Adams Cameron Walker, Michael O'Sullivan
Contact details	thomas.adams@auckland.ac.nz
Skills Needed	Prior experience with conceptual modelling for DES, and the HCCM standard in particular would be beneficial. DES Conceptual Modelling, Software Development

Project description (Max. 200 words)

In terms of Discrete Event Simulation (DES) a conceptual model is a formal representation of the system being modelled, and acts as an intermediary step between the real world situation and the computer model. Hierarchical Control Conceptual Modelling (HCCM) is a framework that defines a strict standard that conceptual models should adhere to, which improves the ability to communicate conceptual models unambiguously.

Currently both developing a conceptual model that adheres to the HCCM standard, and implementing it in a DES software, are difficult, error-prone, and time-consuming tasks. For the conceptual model, all of the components of the system, and the relationships between them need to be specified precisely. For the simulation model, you must make sure that the conceptual model is represented accurately.

This project would investigate the use of a software tool (or tools) to automate parts of conceptual model development and simulation implementation. The aim is for users to be able to construct the activity diagrams of the entities in the system. Then the tool creates all of the necessary structural and relational information from the activity diagram. Users would then only need to add any additional details or make minor modifications.

The tool should also be able to convert the conceptual model to various formats, for example the basis of a model file for a simulation software, or formats designed for comprehension such as pdf or HTML.

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2026/2027 Projects (Engineering Science & Biomedical Engineering)

Project code:	ENG055
Project title:	**Visual Audio Reconstruction from Vintage Wax Cylinders**
Discipline:	Engineering Science & Biomedical Engineering
Supervisor(s)	Cameron Walker Poul Nielsen
Contact details	cameron.walker@auckland.ac.nz
Skills Needed	Proficiency in Python (specifically OpenCV, NumPy, and SciPy) or MATLAB. Core understanding of basic image processing concepts (edge detection, thresholding, pixel coordinate tracking). Familiarity with foundational digital signal processing (sampling rates, filtering, Fourier transforms). Strong problem-solving skills and a hands-on approach to setting up camera equipment.

Project description (Max. 200 words)

Wax cylinders were the earliest commercial medium for recording and reproducing sound, dominating the late 19th and early 20th centuries. Unfortunately, many surviving cylinders are too fragile, degraded, or physically deformed to be played on mechanical phonographs without risking permanent damage. This project aims to develop a non-invasive, optical method for audio recovery. The student will design and execute a system that captures high-resolution video of a rotating wax cylinder and uses digital image processing techniques to extract the audio signal from the visual tracking of the grooves.

Key Objectives Optical Capture System: Set up a stable macro-photography/video capture rig to record a wax cylinder rotating at a controlled speed, ensuring optimal lighting to emphasize groove depth and modulation. Image Processing Pipeline: Develop algorithms (using Python/OpenCV or MATLAB) to trace the physical path of the groove over time from successive video frames. Audio Extraction: Translate the physical deviations of the groove path into a continuous time-series signal, filtering out tracking artifacts, and exporting the result into a standard audio format (e.g., WAV). Performance Benchmarking: Compare the optically reconstructed audio against a known baseline digital recording to evaluate fidelity, signal-to-noise ratio, and the model's overall effective resolution.

Project Outcomes By the end of the summer, the student will have delivered a working prototype software pipeline capable of turning a video file of a rotating cylinder into a playable audio track. The student will gain highly valuable, transferable skills in computer vision, mathematical modeling of physical systems, and experimental design, culminating in a short technical report or presentation.

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2026/2027 Projects (Engineering Science & Biomedical Engineering)

Project code:	ENG056
Project title	**Equitable Multi-objective Shortest Path Routing**
Discipline	Engineering Science & Biomedical Engineering
Supervisor(s)	Andrea Raith
Contact details	a.raith@auckland.ac.nz
Skills Needed	Operations Research / Optimisation / Mathematical Modelling / Programming

Project description (Max. 200 words)

Many optimisation problems have multiple conflicting objectives making them multi-objective optimisation problems. This means that, instead of a single optimal solution, we aim to identify (Pareto) efficient solutions, which are those solutions that do not allow further improvement of all objectives simultaneously. Once this set of solutions is obtained a decision maker can analyse and compare the different efficient alternatives and identify their preferred choice. There are many examples of shortest path problems with two or more objectives. A car driver might want to travel on a path that is short but also consumes as little fuel as possible, or a cyclist might want to find a path that is as short as possible while at the same time choosing a safe, or one with minimal elevation gain. In the first case both the shortest path and the most fuel-efficient path exist, but also other paths that present different Pareto-efficient trade-offs between the two criteria.

In this project we will develop algorithms for multiobjective shortest path problems that target to find solutions that are also Lorenz optimal, i.e. that are equitable in their use of resource along the path. We will also explore robust multiobjective shortest path problems in the context of internet routing.