UQ Summer Research Project Description

Project Title:	**CFD simulations of high-speed Earth re-entry experiments**
Project Duration:	10 weeks at 36 hours a week. The project could be completed remotely if necessary but it would be better to have the work done on-site so the student can interact with members of our laboratory
Positions Available:	1
Description:	UQ's Centre for Hypersonics are currently experimentally investigating the flow environment experienced by vehicles which re-enter Earth from Mars or other parts of the solar system at speeds from 12 to 15 km/s. As these conditions are difficult to simulate experimentally, a lack of experimental data exists for validating models of these entry environments and this is what the experiments aim to address. At these high-speed conditions, the flow radiates very strongly, which has a large effect on the features in the post-shock flow, and makes these entries physically different to re-entry from Low Earth Orbit or the moon. The goal of this project is to take the current simulation models used in our laboratory for the simulation of our experiments using the in-house Eilmer4 CFD code and apply them to the simulation of these current high-speed Earth re-entry experiments. While it is not expected that the student would be able to perform final simulations in the duration of the project, due to the complexity of it, it is hoped that they could do the legwork to build an appropriate simulation model, perform some preliminary simulations, and document their decisions to allow the work to be further built upon by other students and staff working on the larger high-speed Earth re-entry project.
Expected Outcomes and Deliverables:	Final CFD model of the experiment, preliminary results, documentation of everything so that the work can be further built upon by other students and staff working on the larger high-speed Earth re-entry project.
Suitable for:	4th or 5th year Mechanical or Mech/Aero Engineering students. Experience with heat transfer, fluid mechanics, and hypersonics (MECH3400, MECH3410, AERO4470, potentially AERO4800) essential. Some CFD knowledge is essential, preferably will have done MECH6480 and/or have practical CFD experience from using CFD in courses, or in other projects.
Supervisor:	Chris James c.james4@uq.edu.au

UQ Summer Research Project Description

Project Title:	**Thermography on sharp hypersonic cones**
Project Duration:	10 weeks
Positions Available:	1
Description:	Heat transfer to hypervelocity vehicles is complicated by chemical interactions between the high temperature shock layers and the aerodynamically heated heat shield surfaces. The chemical processes include catalytical recombination of dissociated species, and ablation of the surface. Surface mounted instrumentation is problematical for measuring these effects, as they have to be mounted in an extremely ablative surface, and having different properties to the heat shield, can adversely effect the measured quantity itself. Remote sensing can offer a way around these issues, it is difficult to use in such situations because of the high level of radiation from the shock layer itself. Surface pre-heating increases the level of the surface radiation flux, and the use of sharp bodies reduces the level of shock layer radiation to manageable levels, so that thermography becomes viable. The purpose of this project is to design an electrically heated forebody to a conical model to reproduce a wide range of surface temperatures to study the surface interaction phenomena, for use in the UQ X2 and X3 expansion tubes.
Expected Outcomes and Deliverables:	A final design of the test model which we can manufacture and hopefully test in our X2 expansion tube facility.
Suitable for:	3rd, 4th or 5th year Mechanical or Mech/Aero Engineering students. Some engineering design knowledge (such as how to perform analytical stress analysis, and use CAD and ANSYS) and an interest in hypersonics, heat transfer, and fluid mechanics would be useful, but not essential.
Supervisor:	Richard Morgan r.morgan@uq.edu.au

UQ Summer Research Project Description

Project Title:	**A New Fracture Test for Ceramics**
Project Duration:	10 weeks COVID-19 considerations: The project is intended to be entirely experimental laboratory research, hence is expected to require 10 weeks of on-site work (full-time or nearly so). As a contingency, conduct finite element stress analysis to determine the stress distribution in specimens subjected to the ball mill edge chipping test.
Positions Available:	1
Description:	Trelleborg Engineered Systems Australia manufactures wear-resistant liner systems for ore handling equipment for high-volume mining operations such as iron ore. To remain internationally competitive, they need to develop superior products using a new generation of technical ceramics. As well as abrasive wear resistance, these very hard ceramic materials need resistance to brittle fracture. UQ Materials Performance has developed a novel, high-productivity testing device to quantify the fracture resistance of abrasion-resistant materials including ceramics, denoted BMECT (ball mill edge chipping test). For acceptance in the market, it is necessary to correlate the data from the BMECT with results from standard fracture tests such as ASTM C1421 or ASTM C1161.
Expected Outcomes and Deliverables:	*What applicants can expect to gain/learn:* Students will gain exposure to technical staff in a global manufacturer of mining products. They will experience hands-on laboratory research in a professional engineering setting. They will produce experimental findings of direct value to the industry partner. *Expected outcomes and deliverables:* Prepare specimens to tight dimensional tolerances; Perform laboratory tests and analyse the experimental data; Formal report(s) giving full details of methodology, QA and results; (Possibly) FEA showing stress distributions in specimens subjected to the BMECT.
Suitable for:	3rd and 4th year students in Mechanical & Materials Engineering. Require the following demonstrable attributes: (1) Hands-on mechanical aptitude, including familiarity with the principles of safe operation of rotating equipment and prior training in machine workshop practice; (2) Demonstrable work-ethic, attention to detail and accuracy; (3) Good marks in MECH3300 Finite Element Method.
Supervisor:	Dr Jeff Gates & Dr Yahia Ali J.Gates@uq.edu.au

UQ Summer Research Project Description

Project Title:	**Understanding Performance Differences between Laboratory and Industrially Heat-Treated Castings**
Project Duration:	10 weeks COVID-19 considerations: The project is intended to be entirely experimental laboratory research, hence is expected to require 10 weeks of on-site work (full-time or nearly so). Contingency plans centre on reduced period (to 6 weeks), and/or shift to literature review.
Positions Available:	2
Description:	Bradken is an Australian-based global manufacturer of equipment and consumbles for mining and mineral processing. In the last 4 years Bradken has expanded its R&D activities, in order to remain at the forefront of technologies and consolidate its position as a premium producer. In 2020-2021, UQ Materials Performance conducted a contract R&D project which revealed that there is a significant difference in abrasive wear resistance between castings heat treated in the laboratory and those heat treated industrially. This phenomenon has not previously been reported. The summer research project will conduct systematic experiments designed to reveal the mechanisms underlying the differences in microstructure and abrasion resistance as a function of heat treatment parameters.
Expected Outcomes and Deliverables:	*What applicants can expect to gain/learn:* Students will gain exposure to technical staff in a global manufacturer of mining products. They will experience hands-on laboratory research in a professional engineering setting. They will produce experimental findings of direct value to the industry partner. *Expected outcomes and deliverables:* Prepare specimens to required dimensional tolerances; Perform laboratory tests and analyse the experimental data; Formal report(s) giving full details of methodology, QA and results; (Possibly) Literature review to find available information on effects of heating and cooling rates on microstructure and properties of white cast irons.
Suitable for:	3rd and 4th year students in Mechanical & Materials Engineering. Up to 2 positions available. Require the following demonstrable attributes: (1) Hands-on mechanical aptitude, including familiarity with the principles of safe operation of rotating equipment and prior training in machine workshop practice; (2) Demonstrable work-ethic, attention to detail and accuracy.
Supervisor:	Dr Jeff Gates & Dr Yahia Ali J.Gates@uq.edu.au

UQ Summer Research Project Description

Project Title:	**Molycop Grinding Media Performance Quantification**
Project Duration:	10 weeks COVID-19 considerations: The project is intended to be entirely experimental laboratory research, hence is expected to require 10 weeks of on-site work (full-time or nearly so). As a contingency, it can be converted to a mechanical design exercise.
Positions Available:	2
Description:	Molycop is the world's largest manufacturer of grinding media for ball mills and SAG mills used in mineral processing. Molycop have recognised that they do not have a reliable method for predicting the service performance of candidate grades of grinding balls for a given customer, since standard laboratory abrasion tests have been shown to lack quantitative predictive ability. The ball mill abrasion test (BMAT) developed by UQ Materials Performance does have such predictive ability, but requires further validation by correlation with in-plant marked ball wear trials (MBWT). The Summer Research Project will perform a series of laboratory experiments to refine the BMAT test methodology in order to maximise reliability and efficiency. It may also involve the design of an enhanced test device (hybrid BMAT/HERIT, high energy repeated impact test) to be constructed and commissioned in 2022.
Expected Outcomes and Deliverables:	*What applicants can expect to gain/learn:* Students will gain exposure to technical staff at the world's largest manufacturer of grinding media. They will experience hands-on laboratory research in a professional engineering setting. They will directly see the correlation between laboratory test predictions and industrially measured performance data. *Expected outcomes and deliverables:* Several sets of alloy performance data, for inclusion in a contract-research report; Results of controlled experiments showing the influence of test parameters on quantitative predictions; Formal report(s) giving full details of methodology, QA and results; (Possibly) a full set of design drawings of a new test machine, ready for manufacture.
Suitable for:	3rd and 4th year students in Mechanical & Materials Engineering. Up to 2 positions available. Require the following demonstrable attributes: (1) Hands-on mechanical aptitude, including familiarity with the principles of safe operation of rotating equipment and prior training in machine workshop practice; (2) Demonstrable work-ethic, attention to detail and accuracy.
Supervisor:	Dr Jeff Gates & Dr Yahia Ali J.Gates@uq.edu.au

UQ Summer Research Project Description

Project Title:	**Investigation of Squeal Phenomena**
Project Duration:	8 weeks
Positions Available:	1
Description:	Squeal is a tonal noise (in the hearing range of 1-10kHz) from a frictionally excited unstable mode of vibration that results from the slowing of a vehicle with disk brakes (brake squeal) or cornering of a train (wheel squeal). Its occurrence is often identified as 'fugitive', and unpredictable, ie a 'squealing' brake does not squeal during all braking events. There have been many theories formulated to understand the phenomenon of squeal including the main mechanisms of; falling friction, sprag-slip and modal coupling (or 'Binary flutter') but the merits and applicability are keenly debated. To address this, the UQ nonlinear mechanics team recently published the closed form identification, quantification and mitigation of squeal occurrence and noise amplitude under all mechanisms, for the first time. This unique insight has inspired the development of two unique experimental testrigs to validate the modelling predictions. This project aims to obtain and analyse the testrig experiment data to achieve this.
Expected Outcomes and Deliverables:	A validation between mathematical predictions and experimental measurements of squeal.
Suitable for:	4th or 5th year Mechanical or Mech/Aero/Mechatronics Engineering student. Strong ability and interest in dynamics.
Supervisor:	Prof Paul Meehan meehan@uq.edu.au

UQ Summer Research Project Description

Project Title:	**Investigation of Decarbonisation of Railway Vehicles**
Project Duration:	8 weeks
Positions Available:	1
Description:	A rapidly growing list of over 25 countries are implementing full phase-out of fossil fuel vehicles by 2025-40 including the US and China. Electric vehicles (EVs) are the most promising transportation solution to reduce greenhouse gas emissions and reduce fossil fuel dependency. At present, more than 90 per cent of railway freight emissions are due to consumption of energy (mostly diesel) in the operation of locomotive fleets. Therefore, it is planned to decarbonise the railway fleet by 2050 by means of hybridisation steps using battery and hydrogen fuel cell technology. To address this, the main objective of this project is to provide assistance with the overall aims to develop, test and utilise an optimised energy management algorithm to analyse and implement new battery and fuel cell technology in trains to achieve decarbonisation based on efficient models of the underlying physics.
Expected Outcomes and Deliverables:	Mathematical predictions of the power and energy requirements of typical locomotive runs and preliminary modelling of the hybrid and fully electric prototypes.
Suitable for:	4th or 5th year Mechanical or Mech/Aero/Mechatronics Engineering student. Strong ability and interest in dynamics.
Supervisor:	Prof Paul Meehan meehan@uq.edu.au

UQ Summer Research Project Description

Project Title:	**Graphic User Interface (GUI) design for the machine learning application**
Project Duration:	10 weeks (36 hrs per week) and applicant can work remotely for the software development.
Positions Available:	1
Description:	The project aims to design python GUI for windows and dialogs in PyQt framework. The GUI design is part of geoscience software development project to perform geological/geophysical data computation and visualization based on the established machine learning and computer vision algorithms.
Expected Outcomes and Deliverables:	The GUI applications often consist of a main window and several dialogs which can be developed by Qt Designer or plain Python code. The expected outcomes may include: ✓ building a GUI desktop calculator ✓ creating menus, toolbars and status bar ✓ creating professional-looking GUI applications ✓ fit-to-purpose modifying the open-source codes In this project, the student would gain skills in python programming and knowledge of software development. The student may have an opportunity to generate publications from the research and may also be asked to produce a report or oral presentation at the end of the project.
Suitable for:	This project is open to applications from 3rd or 4th year students who have a passion in python programming with a background in information technology (e.g., computer science, software engineering, data science and etc), earth science or engineering. Preferably with a GPA>5.5.
Supervisor:	Zhongwei Chen Zhongwei.chen@uq.edu.au

UQ Summer Research Project Description

Project Title:	**Effect of cross-section shape on rock strength**
Project Duration:	10 weeks (36 hrs per week The project requires on-site attendance and working in the lab.
Positions Available:	1
Description:	This project is to experimentally study the effect of cross-section shape on uniaxial compression strength in soft rock (e.g., coals). Various shapes of rock and coal samples will be prepared and tested to identify the correlation between a shape factor and the compressive strength. The student will also be provided the opportunity in conducting other relevant lab testing.
Expected Outcomes and Deliverables:	The applicant will be provided the opportunity to learn various laboratory experiment skills and data analysis techniques. The deliverables would include a set of experimental data and a detailed report of the findings.
Suitable for:	The project is open to applicants in the third or fourth year who are interested in conducting a research project in minerals and resources sector. Preferably with a GPA>5.5.
Supervisor:	Zhongwei Chen Zhongwei.chen@uq.edu.au

UQ Summer Research Project Description

Project Title:	**Autonomous Driving**
Project Duration:	10 weeks, 36 hours per week. The project requires on-site attendance and working in the lab.
Positions Available:	1
Description:	The School of Mechanical and Mining Engineering intends to introduce an course on Autonomous driving in 2022. The course will use a Lexus 450H as the platform and the Autoware-Auto open source stack. In the lead up to the introduction of this new course there is a body of research and implementation that needs to be undertaken. A student is sought to support this work.
Expected Outcomes and Deliverables:	The applicant will be provided the opportunity to learn the foundations of autonomous driving systems including sensors, actuation, safety systems, algorithm design, software, and control. The deliverables will include components (hardware or software) that will contribute towards bringing the vehicle to a state where it can be used in for the course.
Suitable for:	The project is open to applicants in the third or fourth year who are interested robotics and automation or who like the idea of cars. This is a development opportunity and a great chance to learn.
Supervisor:	Prof Ross McAree p.mcaree@uq.edu.au