UQ Summer Research Project Description

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Project title:	**UQMP Mechanical and Materials Failure Investigations (trainee consultant)**
Project duration:	10 weeks
Description:	Work with UQ Materials Performance consultants on industry-funded investigation projects, focused on mechanical & materials failure investigations and/or condition assessment. Projects involve evidence gathering by a combination of visual observations, physical testing and engineering analysis, leading to provision of solutions to industry problems. Activities include: Macro-photography, stereomicroscopy; Specimen preparation; Hardness testing; Microscopic examination and interpretation of material microstructures, interpretation of fracture surface morphologies.
Expected outcomes and deliverables:	Specimens prepared to comply with specifications; Photographs with fields of view & image clarity to reveal diagnostic information; Measurement data with demonstrable accuracy & precision; Interpretation using sound engineering principles & logic, to contribute to professional consultancy reports.
Suitable for:	Students with both mechanical and materials engineering knowledge; Passionate about engineering and problem solving; Adept at listening and following instructions; Evidence of mechanical aptitude, geometric perception and observation skills; Attention to detail, accuracy; Experience with hand tools and machine tools.
Primary Supervisor:	Dr Jeff Gates, projects@uqmp.uq.edu.au
Further info:	

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Project title:	**UQMP Contract Research in Performance Assessment of Wear-resistant Materials (trainee research engineer)**
Project duration:	10 weeks
Description:	Be trained in and conduct professional-level performance assessment of abrasion resistant materials, using UQMP's unique suite of industrially-focussed abrasive wear assessment devices (ICAT and BMAT). Work on a variety of medium-term contract-research projects. Activities include: Specimen preparation using machine tools; Set up and conduct of wear tests; Measurement of mass loss; Data collation; Measurement of hardness and examination of microstructures for correlation with wear performance data.
Expected outcomes and deliverables:	Specimens prepared to comply with dimensional tolerances & surface-finish requirements; Accurate setup & documentation of test conditions; Measurement data with demonstrable accuracy & precision; Interpretation using sound engineering principles & logic, to contribute to professional research reports.
Suitable for:	Students with both mechanical and materials engineering knowledge; Passionate about engineering and meeting client needs; Adept at listening and following instructions; Evidence of mechanical aptitude; Attention to detail, accuracy; Experience with hand tools and machine tools.
Primary Supervisor:	Dr Jeff Gates, projects@uqmp.uq.edu.au
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Project title:	**Simualtion and Control of a Drone**
Project duration:	10 weeks
Description:	The research project involves the simulation and testing of a drone performing manoeuvres. The gathered data will be used to enhance how the control is operated and how to perform optimum high speed manoeuvres.
Expected outcomes and deliverables:	The candidate will work as part of a research team investigating counter-drone drones. You will learn about how to conduct accurate simulations of the drone flying in a dynamic environment and how this can be integrated with optimal control approaches.
Suitable for:	3rd or 4th year student in Mech or Mech and Aero stream. A strong basis in coding (using python, C++, matlab) is desirable and the candidate should have a good grasp of fluid dynamics and dynamics.
Primary Supervisor:	Dr Ingo Jahn, i.jahn@uq.edu.au
Further info:	

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Project title:	**Hypersonics Fluid Structure Interactions**
Project duration:	10 weeks
Description:	The research project involves conducting simulations and developing control strategies for a model of a hypersonic wing and actuator. This will result in an improved understanding on (a) how to conduct sub-scale experiments in hypersonic facilities to explore vehicle control, and (b) how to simulate and develop control approaches for flight prototypes.
Expected outcomes and deliverables:	The candidate will learn how to conduct Hardware in the Loop Simulations as part of a greater team to develop control surfaces and control strategies for hypersonics vehicles.
Suitable for:	3rd or 4th year student in Mech or Mech and Aero stream. A strong basis in coding (using python, C++, matlab) is desirable and the candidate should have a good grasp of fluid dynamics and dynamics. Familiarity with UQ's simulation code Eilmer is essential.
Primary Supervisor:	Dr Ingo Jahn, i.jahn@uq.edu.au
Further info:	

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Project Title:	**UQ Racing – An Aerodynamic Investigation into Motorsports Components in Pitch and Yaw**
Project Duration:	10 weeks
Description:	This project involves investigating the flow fields around aerodynamic components operating in ground effect and the effects that realistic yaw and pitch scenarios would have upon its aerodynamics. Projects involve physical testing, data acquisition and engineering analysis through virtual validation, which will allow for the visualisation and identification of the types of flows generated by altering the yaw angles of various motorsports components. Activities Include: Construction of test geometry; Wind tunnel experimentation; Geometry preparation for CFD, CFD setup and analysis; Geometry optimisation, validation and documentation
Expected outcomes and deliverables:	Geometry prepared which will allow for the analysis of a wide array of aerodynamic components in accordance with modern motorsports regulations. Geometry prepared which will also accurately approximate the physical state of these components in pitch and yaw scenarios. CFD simulations, post-processed images and animations to accurately illustrate the flow fields around any relevant geometry in extreme pitch and yaw cases, examination and interpretation of these flow structures through first-principles analysis, generalised design recommendations and considerations for aerodynamicists within the industry.
Suitable for:	Mechanical and Aerodynamics students with previous CFD and CAD knowledge; Evidence of aptitude within the fields of fluids and vehicle dynamics; Students who are seeking to broaden their knowledge of ground-effect aerodynamics. Students with sharp observational skills, attention to detail and a willingness to learn;
Primary Supervisor:	Dr. Stephen Hall, s.hall@uq.edu.au
Further Info:	

UQ Summer Research Project Description

Please use this template to create a description of each research project, eligibility requirements and expected deliverables. Project details can then be uploaded to each faculty, school, institute, and centre webpage prior to the launch of the program.

Project Title:	**UQ Racing – An Aerodynamics Investigation into Tyre Wake Mitigation Techniques**
Project Duration:	10 weeks
Description:	This project involves investigating the flow fields around a rotating tyre and creating a set of general design guidelines in order to mitigate any adverse effects that the generated tyre wake would cause on nearby aerodynamic components. Projects involve physical testing, data acquisition and engineering analysis through virtual validation, which will allow for the visualisation and identification of the types of flows and vortices around the tyre and any designed aerodynamic components. Activities Include: Utilisation of a CMM to generate tyre geometry; geometry preparation for CFD, CFD and FEA setup and analysis; Aerodynamic component design and virtual validation; Component optimisation which adheres to the restrictions placed by modern motorsports open-wheeled rulesets.
Expected outcomes and deliverables:	Geometry prepared which will accurately approximate the physical state of a tyre. Optimised aerodynamics components which meet the regulations set by modern open-wheel formulas, CFD simulations and post-processed images and animations which accurately illustrate the flow fields around the tyre and any aerodynamic components, examination and interpretation of these flow structures through first-principles analysis, recommendations based on sound engineering principles which will aid aerodynamicists in designing highly efficient aerodynamics components.
Suitable for:	Mechanical and Aerodynamics students with previous CFD and CAD knowledge; Evidence of aptitude within the field of fluid dynamics; Students who are seeking to broaden their knowledge of ground-effect aerodynamics. Students with sharp observational skills, attention to detail and a willingness to learn; Students with previous aerodynamics design experience;
Primary Supervisor:	Dr. Stephen Hall, s.hall@uq.edu.au
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Project Title:	**UQ Racing – An Investigation into Tyre Deformation Aerodynamics**
Project Duration:	10 weeks
Description:	This project involves investigating the flow fields around a tyre and the effects that generic tyre loading scenarios would have upon its aerodynamics. Projects involve physical testing, data acquisition and engineering analysis through virtual validation, which will allow for the visualisation and identification of the types of flows and vortices around the tyre. Activities Include: Utilisation of a CMM to generate tyre geometry; geometry preparation for CFD, CFD and FEA setup and analysis;
Expected outcomes and deliverables:	Geometry prepared which will accurately approximate the physical state of a tyre with and without cornering loads applied onto it. CFD simulations and post-processed images and animations to accurately illustrate the flow fields around the tyre, examination and interpretation of these flow structures through first-principles analysis
Suitable for:	Mechanical and Aerodynamics students with previous CFD and CAD knowledge; Evidence of aptitude within the field of fluid dynamics; Students who are seeking to broaden their knowledge of ground-effect aerodynamics. Students with sharp observational skills, attention to detail and a willingness to learn;
Primary Supervisor:	Dr. Stephen Hall, s.hall@uq.edu.au
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Project Title:	**Investigation of rocket launched hypersonic re-entry flight experiment**
Project Duration:	10 weeks
Description:	Since planetary entry was first considered, due to the extreme costs of flight testing, ground testing has been an important way to understand the phenomena which is encountered by craft returning from space. Instrumented flight tests such as Fire II and Apollo, both performed in the 1960s during the Apollo program, are still considered to be benchmark flight testing data for Earth re-entry. While a lot can be learned from ground testing, not everything in a full system can be simulated together in ground tests, and experiments are often performed at smaller than flight scale. This can make it difficult to study some phenomena or the way in which different phenomena interacts together. While flight testing is very expensive, some hypersonic flight tests are still performed, generally using rocket launched projectiles which are launched out of the atmosphere, with an experiment performed as they return back to Earth. These include the successful HYSHOT and HiFire experiments designed in Australia, mainly for testing scramjet engines, and the Bow Shock UltraViolet (BSUV) flights which examined ultraviolet radiation seen during hypersonic flight at 3 to 5 km/s. More recently, it has been proposed that Cubesats could be used for re-entry testing, with the QARMAN cubesat designed by the Von Karaman Institute in Belgium and Centrale-Supélec in France, which will examine the radiation seen during a cubesat's re-entry. There is still much about hypersonic phenomena which could benefit from further flight testing. This project aims to consider which types of hypersonic planetary entry phenomena could be studied in the return phase of a rocket launched payload, in the hope that this could be tested in a UQ designed mission in future years.
Expected outcomes and deliverables:	A mature report detailing the re-entry testing profiles which would be possible using a small rocket launched flight testing vehicle as well as the phenomena which this would allow to be studied, as well as the instrumentation which could be used to take and record data during the experiment.
Suitable for:	3rd or 4th year UQ Mechanical and Aerospace Engineering Student. Knowledge and interest in hypersonic, rockets, and space engineering would be very useful for the project, but not essential.
Primary Supervisor:	Prof Richard Morgan, r.morgan@uq.eu.au
Further Info:	Feel free to contact Professor Richard Morgan (r.morgan@uq.edu.au) or Dr Chris James (c.james4@uq.edu.au) if you want more information about the project.

UQ Summer Research Project Description

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Project Title:	**Investigation of MEMS pressure sensor arrays for shock tunnel use**
Project Duration:	10 weeks
Description:	Some aerodynamic phenomena involve large pressure gradients, and close spaced sensors are required to get sufficient spatial resolution to adaquatly resolve them. The problem is exasperated when small scale models are tested in wind tunnels, and most commercial pressure gauges cannot be packed together tightly enough to quantify the extent and magnitude of the pressure gradients. COTS sensors in the form of minaturised MEMS sensor elements, known as 'dies' are now available at reasonable prices and offer the possibility of forming close clustered sensor arrays with sensor spacings ~ 1mm or less. This project involves the design of a MEMS sensor pressure transducer array, and thge construction and testing of a prototype.
Expected outcomes and deliverables:	Development and testing of Proof of concept of MEMS based pressure sensor array.
Suitable for:	3rd or 4th year UQ Mech, Mechanical and Aerospace or Mechatronics Engineering Student. Knowledge and interest in instrumentation would be very useful for the project, but not essential.
Primary Supervisor:	Prof Richard Morgan, r.morgan@uq.eu.au
Further Info:	Feel free to contact Professor Richard Morgan (r.morgan@uq.edu.au) or Dr Chris James (c.james4@uq.edu.au) if you want more information about the project.

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Project Title:	**Experimental testing of a Scramjet for Space Access**
Project Duration:	10 weeks
Description:	The research project involves being a member of a small team that will conduct a hypersonic test of a scramjet engine in UQ's T4 shock tunnel
Expected outcomes and deliverables:	Experience of how hypersonic experiments are conducted at UQ
Suitable for:	Good mathematical and coding skills; as well as problem solving
Primary Supervisor:	Prof. Michael Smart, m.smart@uq.edu.au
Further Info:	

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Project Title:	**A/Prof. Vincent Wheatley: Design of Experiments to Investigate the Richtmyer-Meshkov Instability in Plasmas**
Project Duration:	6 weeks
Description:	In inertial confinement fusion (ICF), hundreds of terawatts of laser power is used to drive a converging shock wave into a small spherical capsule containing a fuel mixture of heavy hydrogen isotopes. When the shock wave converges at the centre of the capsule, the temperature should exceed 100 million Kelvin and a fusion reaction between the hydrogen nuclei should be ignite. The fusion burn should then propagate outward through the fuel more rapidly than it can expand. However, when the shock impacts on the interfaces between the capsule and the fuel layers, hydrodynamic instabilities are triggered. The first of these is the Richtmyer-Meshkov instability (RMI), which occurs when a shock interacts with a density interface. The hydrodynamic instabilities limit the chance of energy break-even or production. Our latest computational research on the RMI uses continuum two-fluid plasma (ions and electrons) equations coupled to the full Maxwell's equations. Using the approach has revealed a great deal of new physics, and that the instability in plasmas may be even worse than predicted by neutral fluid simulations and experiments. To validate this computational discovery, an experiment in which the Richtmyer-Meshkov instability can be observed in a plasma must be designed, which is the goal of this summer research project.
Expected outcomes and deliverables:	In the Centre for Hypersonics expansion tubes, it is possible to generate a hypersonic, ionized (plasma) test flow. There are a variety of techniques that could be used to generate a density interface in this flow and subsequently impact it with a shock wave. Simulating the resulting instability to determine how accurately it can be measured will form the core of this project. Successfully designing a plasma RMI experiment will also pave the way to validate the discovery that the instability can be mitigated by the application of a magnetic field. Through this project, you can expect to gain valuable knowledge in computational physics that is transferable to many different problems.
Suitable for:	This is a challenging project that combines knowledge from fluid dynamics, numerical methods, physics and hypersonics. It is essential that the candidate be willing to learn a lot from outside of their field of expertise to successfully complete the project.
Primary Supervisor:	A/Prof. Vincent Wheatley, v.wheatley@uq.edu.au
Further Info:	