**ACADEMIC PROJECT SUBMISSION DETAILS:**

<table>
<thead>
<tr>
<th>Supervisors:</th>
<th>Amir Hossein Tarighaleslami and Martin Atkins</th>
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</thead>
<tbody>
<tr>
<td>Project Title:</td>
<td>A Study on the New On-line Heat Exchanger Fouling Mitigation for New Zealand Process Industries</td>
</tr>
<tr>
<td>Field:</td>
<td>Chemical/Mechanical Engineering</td>
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<tr>
<td>Division/School:</td>
<td>HECS - Division of Health, Science, Computing &amp; Engineering</td>
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**EXPECTED OUTCOMES:**

1. Creating a model for a selected type of heat exchanger using one of the new on-line fouling mitigation techniques
2. Assessing the energy and economy benefits of using the selected fouling mitigation technique for the studied New Zealand process industry
3. Final report and poster for student competition

**STUDENT TASKS:**

1. Literature review
2. Identifying new heat exchanger fouling mitigation technique
3. Studying a New Zealand process industry, e.g. pulp and paper plant or oil refinery
4. Modelling and analysing the results
5. Writing the report

**REQUIRED SKILLS:**

1. Understanding of energy and mass balance
2. Good knowledge of thermodynamics
3. Good knowledge of heat transfer mechanisms
4. Programming knowledge is an advantage

**PROJECT ABSTRACT:**

Heat exchangers are the workhorse of most chemical, petrochemical, pulp and paper, food processing, and power-generating processes. The global heat exchanger market is estimated to top a total of $18.9 billion by 2020, with an increase of 3-5% per annum. Despite this very positive market outlook, manufacturers are under increasing pressure to produce heat exchangers that are more efficient in terms of heat recovery and use of material, while at the same time being faced with fluids that are increasingly difficult to process.
PROJECT ABSTRACT:

One major problem directly related to these requirements is the deposition of unwanted materials on the heat transfer surfaces, which occurs in the majority of heat exchangers. Conservative studies estimate that heat exchanger fouling leads to additional costs in the order of 0.25% of the gross domestic product (GDP) of industrialized countries, and that it is responsible for 2.5% of the total equivalent anthropogenic emissions of carbon dioxide. Therefore, efficient mitigation and cleaning methods must be available to safeguard the operation of heat exchangers.

Two basic approaches are possible to combat heat exchanger fouling, namely, mitigation (including on-line cleaning) and off-line cleaning techniques. The general criteria for the selection of any of these strategies are dominant fouling mechanism; severity of fouling; and type of heat exchanger. In this project, the new technologies related to on-line cleaning such as ultrasonic and thermal socking will be studied to determine the benefits of such techniques on energy efficiency, pollution reduction and the economy of New Zealand industries.
### ACADEMIC PROJECT SUBMISSION DETAILS:

<table>
<thead>
<tr>
<th>Supervisor/s:</th>
<th>Mostafa Seifan</th>
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<tbody>
<tr>
<td>Project Title:</td>
<td>3D printing of concrete</td>
</tr>
<tr>
<td>Field:</td>
<td>Civil Engineering</td>
</tr>
<tr>
<td>Division/School:</td>
<td>HECS - Division of Health, Science, Computing &amp; Engineering</td>
</tr>
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### PROJECT #: 32

### EXPECTED OUTCOMES:

1. Determining the effects of premix components of printability and mechanical property of concrete
2. Developing a printable premix cement-based mixture
3. Proposing a viable approach for accelerating the setting out

### STUDENT TASKS:

1. Critical literature review
2. Screening different design mix
3. Extrudability of premix matrix
4. Optimisation study on premix design
5. Mechanical properties of the optimum design
6. Testing different approaches to accelerate the setting out

### REQUIRED SKILLS:

1. Concrete design - concrete preparation
2. Familiar with 3D printing process
3. Concrete testing process (fresh and hardened concrete testing)
4. Familiar with material/chemistry science
5. Writing skills
6. Creativity and critical thinking

### PROJECT ABSTRACT:

Additive manufacturing (3D printing) of cement-based materials is a great revolution in the construction industry. This technology enables the construction of complex geometry without the use of formwork by reducing the construction cost, labour interventions, and time-consuming processes without the use of temporary support. However, the success of such a layer by layer construction technique relies on the properties of extruded premix concrete and the additive used to accelerate the setting of mechanical properties just after extrusion.
**PROJECT ABSTRACT:**

This research study will be performed to design an optimum premix cement-based matrix and investigate the potential approaches to address the current issues associated with the setting out the concrete layer.
## ACADEMIC PROJECT SUBMISSION DETAILS:

<table>
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<tr>
<th>Supervisor/s:</th>
<th>Alessandro Fascetti</th>
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<tbody>
<tr>
<td>Project Title:</td>
<td>Development of Virtual Reality Interfaces for Disaster Response and Mitigation Analyses</td>
</tr>
<tr>
<td>Field:</td>
<td>Civil Engineering, Computer Science, Computer Graphics Design</td>
</tr>
<tr>
<td>Division/School:</td>
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</table>

### EXPECTED OUTCOMES:

1. Virtual Reality environment
2. Definition of critical scenarios
3. Analysis of the disaster response for the selected building and scenarios

### STUDENT TASKS:

1. Analysis of the BIM model of a civil engineering structure
2. Creation of a 3D model of the structure in the VR environment
3. Definition of the analysis scenarios
4. Simulation of the natural hazard and subsequent progressive collapse of the structure

### REQUIRED SKILLS:

1. General Programming
2. Virtual Reality Applications (Unreal Engine)
3. Broad knowledge of structural systems and components
4. Computer graphics design

### PROJECT ABSTRACT:

This project will revolve around the creation of Virtual Reality tools for the analysis of multi-hazard scenarios, in the context of structural assessment and resilience.

The scope of the project will be the creation of a high-fidelity VR environment of a large structure, to analyse disaster response and mitigation strategies. We will use the Unreal engine to create a digital twin of a building, by interfacing the Building Information Model of the structure. We will then analyse possible scenarios in which a natural hazard can trigger the progressive collapse of the building. The VR simulations will then be used to quantify the resilience of the system in terms of disaster mitigation.
ACADEMIC PROJECT SUBMISSION DETAILS:  

<table>
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<tr>
<th>Supervisor/s:</th>
<th>Aydin Berenjian, Dr. Mostafa Seifan and Dr Rajab Abousnina</th>
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<tbody>
<tr>
<td>Project Title:</td>
<td>The Effect of slag ratio on the strength of rock dust alkali-activated pastes</td>
</tr>
<tr>
<td>Field:</td>
<td>Civil/Material/Process engineering</td>
</tr>
<tr>
<td>Division/School:</td>
<td>HECS - Division of Health, Science, Computing &amp; Engineering</td>
</tr>
</tbody>
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EXPECTED OUTCOMES:

1. Novel waste Treatment protocols
2. Sustainable concrete

STUDENT TASKS:

1. To investigate the effect of slag on the physical and mechanical properties of rock dust alkali-activated pastes compared to fly ash alkali-activated pastes
2. To investigate the effect of different percentages (5, 10, 15 and 20%) of slag on the fly ash and rock dust alkali-activated pastes.
3. Investigate the effect of different % of slag on the microstructural properties on rock dust alkali and fly ash activated pastes
4. Investigate the effect of molarity (8, 10, 12 and 14), on the physical and mechanical properties of dust alkali-activated pastes.

REQUIRED SKILLS:

1. Interest in materials design and structured research
2. Able to design experiments
3. Excellent written and verbal communication skills

PROJECT ABSTRACT:

Concrete is one of the most widely used building materials; however, it is not sustainable. The cement and concrete industry contributes about 7% of worldwide yearly CO2 emission. A promising solution is to replace cement with basalt rock dust, a by-product of mechanical rock crushing, to produce a sustainable concrete herein called rock dust-based geopolymer concrete. On the other hand, the main by-product of steel making is slag (known as steel aggregate). Slag is non-metallic residue from the iron and steel making processes. It contains minerals such as silica, alumina and titanium from the iron sand and other combinations of calcium and magnesium oxides, derived from other raw materials.
PROJECT ABSTRACT:

In the case of slag-fly ash blended systems the reaction rate generally increases with higher amounts of slag and at higher activator amounts, but this can come at the cost of more challenging workability including relatively rapid slump loss. An increased amount of fly ash delayed the setting, reduced the compressive strength, modulus of elasticity and Poisson's ratio and resulted in high ductility and toughness but enhanced the homogeneity of the hardened matrix and limited the micro cracking. The effects of fly ash and alkali activator on fresh and hardened concrete properties was widely investigated. Furthermore, the relationship between phase composition (fly ash and slag) has been investigated. Furthermore, using rock dust alkali-activated has been initially investigated here at University of Waikato. The initial elucidates that geopolymerisation can be a feasible technological solution for the rock dust waste for the production of cementitious matrices. However, in order to provide a better understanding of this new reactive material (rock dust), further investigation of the effect of slag on the physical and mechanical properties of rock dust-based geopolymer and the effect of molarity are needed in order to determine their end-use application. Once achieved, this will potentially solve the issues of this waste material.
ACADEMIC PROJECT SUBMISSION DETAILS:

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<tr>
<th>Supervisor/s:</th>
<th>Chanelle Gavin and Dr. Mark Lay</th>
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<tr>
<td>Project Title:</td>
<td>Protein foams for packaging applications</td>
</tr>
<tr>
<td>Field:</td>
<td>Materials Engineering/Materials Science</td>
</tr>
<tr>
<td>Division/School:</td>
<td>HECS - Division of Health, Science, Computing &amp; Engineering</td>
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EXPECTED OUTCOMES:

1. A literature review of existing research and food grade additives
2. A foamed protein product
3. Testing, data collection and analysis of the resulting foam/s
4. A journal article draft

STUDENT TASKS:

1. A literature review of protein plastic foams produced via this method and appropriate additives for packaging.
2. Foam a range of proteins using these methods
3. Use mechanical analysis techniques including compression testing to assess foam behaviour
4. Examine the thermal behaviour of the protein foams
5. Investigate protein secondary structure
6. Draft a journal article

REQUIRED SKILLS:

1. Ability to collate and analyse existing research
2. Willingness to try multiple different formulations
3. A good understanding of materials and/or proteins
4. Able to follow procedures for testing
5. Independence and adaptability

PROJECT ABSTRACT:

Protein plastic foams are a renewable, and in most cases biodegradable, alternative to traditional plastic foams. Foaming of these materials is an emerging field with common manufacturing method including costly batch foaming, foam extrusion and foam injection moulding equipment. An alternative method to produce thermoplastic protein foams is by incorporating the blowing agent, chilling the resulting foam and solidifying the structure by freeze-drying.
PROJECT ABSTRACT:

Alternatively foaming may be possible by placing a gelled material under vacuum in a freeze-drier also. The advantage of these methods is a product close to the required shape for a packaging material. This project will examine if foaming via these methods is suitable for foaming a range of proteins. This work will investigate the use of processing additives so that the material can be considered thermoplastic after foaming or at least retain some elasticity. This may including adding chemical denaturants, plasticisers, lower molecular weight proteins or calcium and sodium bentonite. Where possible food grade additives would be desirable. Successful foams will be analysed for expansion ratio, compressive strength, elasticity and foam structure. The material properties of these foams will also be examined using FT-IR/Raman for protein structure, thermogravimetric analysis and dynamical mechanical analysis will be used to examine how the materials behave thermally and SEM can be used to examine protein morphology.
**ACADEMIC PROJECT SUBMISSION DETAILS:**

<table>
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<tr>
<th>Supervisor/s:</th>
<th>Leandro Bolzoni</th>
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<tbody>
<tr>
<td>Project Title:</td>
<td>Processing and characterisation of powder metallurgy Ti-based alloys</td>
</tr>
<tr>
<td>Field:</td>
<td>Materials Science and Engineering</td>
</tr>
<tr>
<td>Division/School:</td>
<td>HECS - Division of Health, Science, Computing &amp; Engineering</td>
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**EXPECTED OUTCOMES:**

1. This research project aims to develop the basis for the creation of new alloys comprising recycled materials for their formulation.
2. The data about their manufacturing behaviours and final properties are expected to be of scientific interest and can constitute the preliminary information for a more extensive research work funded by external agencies.
3. Proper analysis of the results obtained via the work performed through this Summer Research Scholarship could potentially be presented at international conferences or published in a peer-reviewed article.
4. The project will expand the research portfolio of the Titanium Research Group and provide scientific understanding for future bidding of external funding.

**STUDENT TASKS:**

1. The student will participate to all the steps needed to create new alloys either leading the task or contributing to its proper achievement as specific training but might be necessary. The student will collaborate on:
2. Production of new powder metallurgy alloys: this involves handling, weighting and mixing of the starting powders;
3. Manufacturing of the billets: the powder mixtures will be compacted via uniaxial pressing at room temperature;
4. Sintering of the material: the transformation of the compacted powder into solid material will be carried out via vacuum or induction sintering;
5. Study the effect of composition and processing parameters on the properties of the alloys: measurements of physical properties, quantification of the tensile behaviour, metallographic preparation and microstructural analysis will be required;
6. Critically analyse the results to explain the behaviour of the alloy using scientific and engineering principles.
REQUIRED SKILLS:

1. Understanding of materials science’s basic concepts such as phase diagrams and how they can be used to develop new alloys.
2. Good practical skill and previous experience on materials’ preparation is a must.
3. Knowledge on manufacturing processes, especially powder metallurgy is desirable.
4. Ability to use fundamental engineering knowledge to solve technical issues related to applied experimental research.
5. Good communication and writing skills combined with a solid materials science background to be able comment, discuss and interpret experimental results on the basis of scientific principles.

PROJECT ABSTRACT:

Titanium and titanium alloy are regarded as very promising materials for a great variety of engineering applications because of their excellent combination of properties such as lightweight, strength and excellent corrosion resistance. The aim of this Summer Research Project is to consider the design, manufacture and characterisation of innovative Ti-based materials in order to assess whether these novel materials with appropriate level of technological and mechanical performances can successfully be attained. The production of the selected compositions will be carry out via the employment of powder metallurgy and thermomechanical processes investigating the effect of different set of processing parameters like temperature and time for manufacturing and/or post-treat the materials to be analysed. In terms of characterisation, the technological characteristics will be determined during the production of the materials whilst for the materials characteristics, physical, mechanical and microstructural properties will be quantified and the results obtained analysed to understand and justify the properties of these materials.
# ACADEMIC PROJECT SUBMISSION DETAILS:

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<tr>
<th>Supervisors</th>
<th>Alessandro Fascetti and Dr. Hin Lim</th>
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<tbody>
<tr>
<td>Project Title</td>
<td>Small-scale automated construction of block-based structures</td>
</tr>
<tr>
<td>Field</td>
<td>Mechanical Engineering, Electronic Engineering</td>
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<tr>
<td>Division/School</td>
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</table>

## EXPECTED OUTCOMES:

1. Attachment for the robotic arm
2. Successful deployment of voxel-based structures
3. 

## STUDENT TASKS:

1. Define the geometry of the voxel-based structure
2. Create an attachment for the ABB arm, specifically designed for the blocks in exam
3. Test the attachment on sample structural topologies

## REQUIRED SKILLS:

1. General Mechanical Engineering skills
2. Knowledge of robotic positioning systems

## PROJECT ABSTRACT:

In this project, advances in research are sought to deploy a small scale (1:10) robotic application to the field of automated construction.

Voxel-based systems composed of 3-d printed basic elements will be used as a validation study for a prospective real-scale application. We will focus on the definition and application of the appropriate tools for the automated construction of such systems, by leveraging the capabilities of the ABB IRB20 robotic arm.
ACADEMIC PROJECT SUBMISSION DETAILS:

<table>
<thead>
<tr>
<th>Supervisor/s:</th>
<th>Phil Ross and Mark Lay</th>
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<tr>
<td>Project Title:</td>
<td>Cars vs. Clams</td>
</tr>
<tr>
<td>Field:</td>
<td>Engineering/Environmental Science/Ecology</td>
</tr>
<tr>
<td>Division/School:</td>
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EXPECTED OUTCOMES:

1. The development of a pressure sensor tool to be used to measure forces experienced by shellfish
2. A pilot study to inform ongoing research projects and demonstrate capability to Regional Councils and Aquaculture NZ who will fund future research

STUDENT TASKS:

1. Design, development and fabrication of a pressure sensor tool.
2. Running experiments to determine forces generated by different vehicle types/speeds.
3. Some literature review to support the above tasks.

REQUIRED SKILLS:

1. Good understanding of mechanics and dynamics
2. Knowledge of sensors is desirable
3. Open to students from all engineering disciplines

PROJECT ABSTRACT:

Many of New Zealand's beaches are designated state highways and are subject to high levels of vehicle traffic. By law, speeds are limited to 100 km per hour and erratic driving (loss of traction and 'doing doughnut') is forbidden, although the extent to which this is enforced varies between beaches. There is evidence that driving vehicles on beaches can harm shellfish (e.g. cockles, pipi, tuatua and toheroa). This can be either directly through crushing, or indirectly through displacing or exposing shellfish, which increases the risk of desiccation or being eaten by birds. In both of these cases, the death of a shellfish is rapid and easily determined.

On the other hand, we currently have no understanding of the potential for sub-lethal impacts of vehicles on shellfish. If a shellfish is neither crushed nor exposed, is its health harmed in any way? At places like Ninety Mile Beach, shellfish are potentially driven over by thousands of vehicles each year. One of the challenges in answering questions around the sub-lethal impacts of beach traffic on shellfish is that we currently lack the tools to determine what a shellfish is experiencing when cars, motorbikes, tractors or buses drive over the top of them.
PROJECT ABSTRACT:

We think that the forces experienced will depend on the depth to which the shellfish is buried, the type of sediment in which it is buried, the weight of the vehicle and the speed the vehicle is driven.

Regional Councils around New Zealand are interested getting a better understanding of vehicle impacts as it is their mandate to manage driving on beaches and its impacts on biodiversity. To assist with addressing uncertainties around these impacts, the objective of this summer scholarship project is to develop a pressure sensor tool that can be deployed onto beaches and used to determine the forces experienced by shellfish as vehicles drive over them.

This project is a great opportunity to develop an engineering solution to help address an environmental management problem. You will be supervised by both engineers and marine ecologists, have the opportunity to drive cars up and down stunning west coast beaches and then discuss the results of your research to enthusiastic environmental managers.