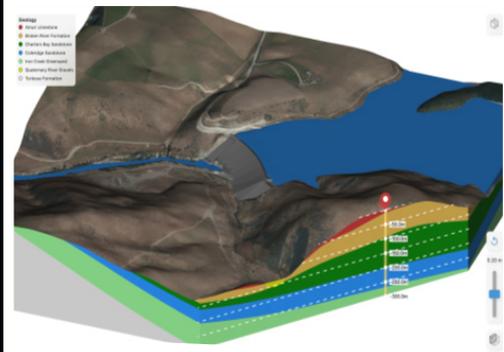
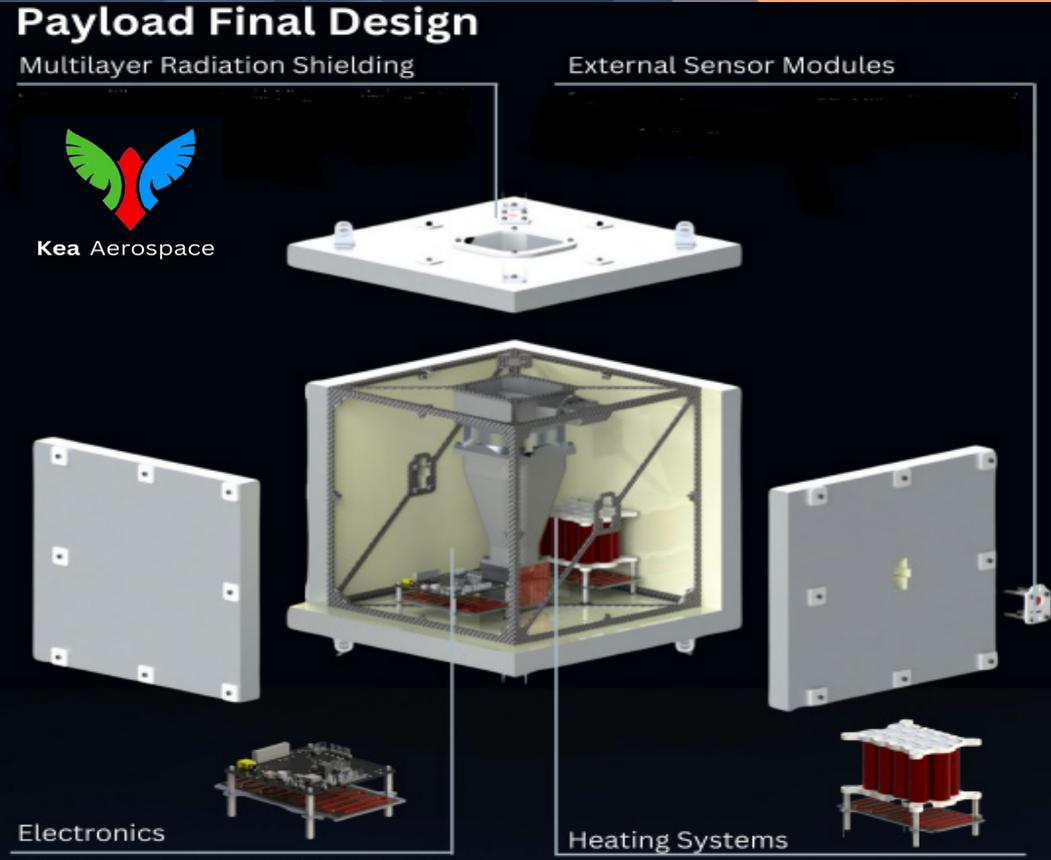
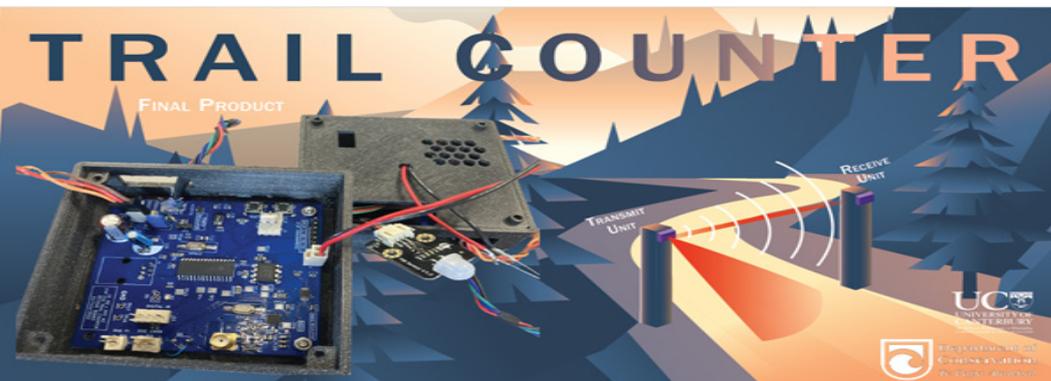


Final Year Projects

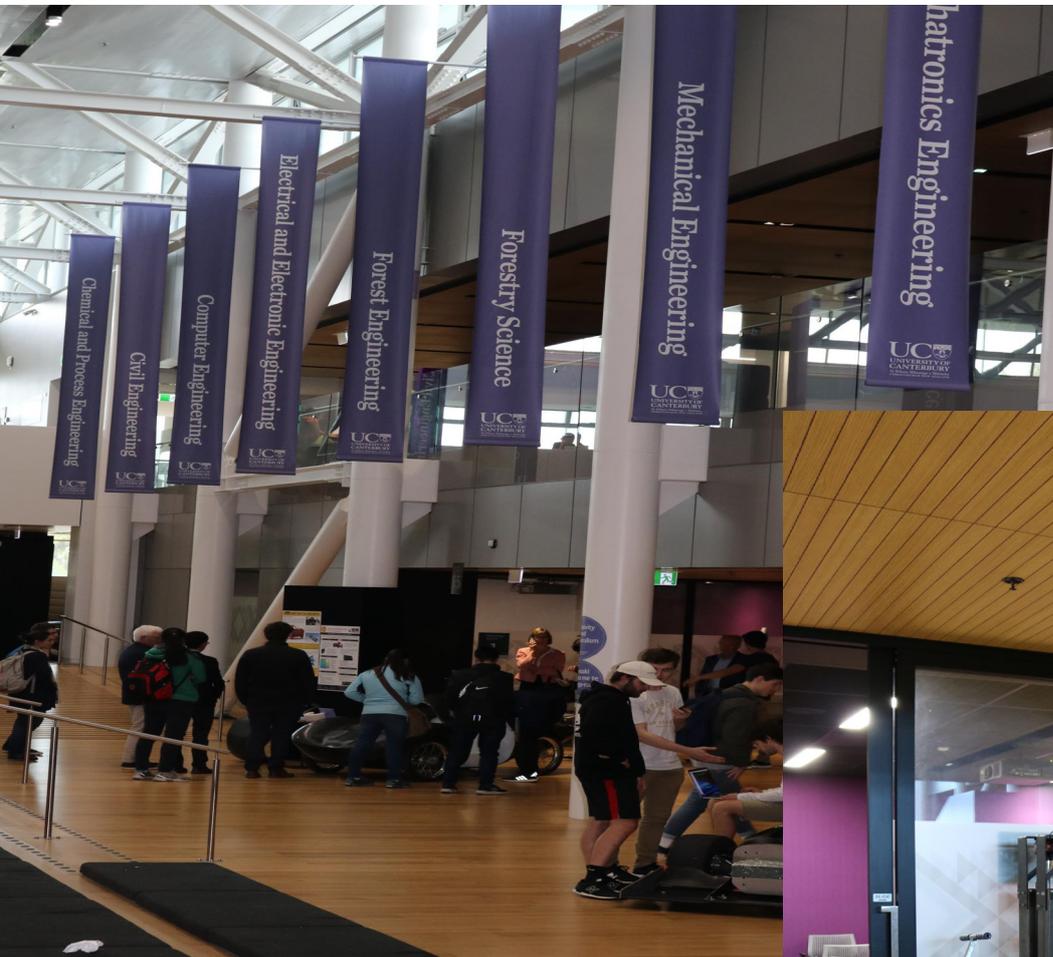
2022



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Note to new readers: Project sponsorship is a great way to participate in education, complete projects you wouldn't normally have time for, and get in-depth research or consultancy for your organisation. Students are available at many levels of study, in teams or as individuals and include all disciplines of Engineering

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Digby Symons	Sarah Kessans
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Student projects: Chemical and Process Engineering

ENCM495
Research Project
Chemical & Process Engineering

CALCIUM & ORGANIC ACID PRECIPITATION

Kelsey van der Schyff
Supervised by Ken Morison

Introduction

Ever wondered what kidney stones are made of? Or what those crystals are in your wine? Look no further than calcium precipitation. Calcium ions in solution precipitate in the presence of organic acids such as citric acid and lactic acid. The interesting part about this is that this process can happen very slowly and only under certain conditions. The aim of this experiment was to explore a few organic acid and calcium solutions and figure out under what conditions - namely pH and concentration - precipitate forms and how quickly. This research is relevant to many fields: the presence of citrate may help prevent calcium oxalate kidney stones, organic acids can be used to clean calcium phosphate fouling, and speeding up precipitation of calcium tartrate in wine may help removal in processing.

Method

Five organic acid solutions (citric, lactic, tartaric, oxalic, and malic acid) were prepared with the addition of calcium chloride. The pH and concentrations were adjusted until precipitation occurred within a day but not instantly. The conditions for which precipitation occurred were discovered. The pH was monitored, and pictures of the solutions were taken at regular intervals. The precipitates were photographed under a microscope to compare to literature examples. Calcium oxalate - which precipitated quickly and at low concentrations - was chosen to show how the conductivity changed as it precipitated over the course of an hour.

Results

The discovered concentrations and pH values needed for each organic acid and calcium solution to precipitate are shown in the below table. It often took many attempts at different concentrations and pH values in order to get the solutions to precipitate within a day - in most cases concentrations and pH needed to be increased significantly.

Acid	Acid concentration (mol L ⁻¹)	CaCl ₂ concentration (mol L ⁻¹)	pH
Citric acid ¹	0.395	0.624	7.27
Lactic acid	0.387	1.037	11.92
Tartaric acid	0.128	1.030	1.84
Oxalic acid	0.0174	0.00172	2.62
Malic acid	0.747	1.035	11.13

¹Due to its triprotic nature, the concentration of citrate (the fully deprotonated form of citric acid), which is the one that precipitates with calcium is too low when the solution is prepared with citric acid powder. Instead, sodium citrate powder was used.

Since precipitate formed quickly and at low concentrations for the oxalic acid solution, this was chosen to do a kinetics study. The conductivity and pH of the solution were measured over time as the solution precipitated over the course of an hour. These measurements are plotted below.

Literature comparison

Below is a comparison of the precipitate formed from the tartaric acid solution (left) and a picture of calcium tartrate under a microscope (right) from Vinlab (2019).

Below is a comparison of the precipitate formed from the final malic acid solution (left), the precipitate formed from an earlier malic acid experiment which took weeks to precipitate (right), and a picture of calcium bis (hydrogen-1-maleate) hexahydrate or Ca₂(H₂Malate)₆·6H₂O (bottom) from Sánchez-Vlaquez et al. (2005).

Future Work

Opportunities for further research on this topic include: discovering more organic acid and calcium systems that precipitate, developing models to predict the kinetics of precipitations for these solutions, investigating the nature of the differently shaped precipitates for the malic acid solutions under different pH conditions, performing further conductivity experiments, and more.

Conclusion

It was shown that whether or not a calcium and organic acid solution will precipitate and the rate at which it does so strongly depends on pH and concentration. Increasing these results in an increasing chance of precipitation occurring and an increasing rate of precipitation. This is because these things both increase the concentration of the fully dissociated form of the organic acid - which in most cases is the dye that actually precipitates with the calcium. The required pH and concentrations for solutions to precipitate within a day varied considerably between different organic acids.

In the above comparison, the older experiment on the right (which was performed at a lower pH of about 2.3) looks more like the literature example. This may be because of the higher concentration of H⁺, causing Ca₂(H₂Malate)₆ to form instead of calcium malate.

UNIVERSITY OF CANTERBURY

ENCM495

Student projects: Chemical and Process Engineering

UTILISING BREWER'S SPENT YEAST

A Brewing By-Product with High Potential



UC
UNIVERSITY OF
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6 Priory Terrace, Christchurch
8140, New Zealand

Sara Dooney
Supervisor – Rachael Wood

ENCH495 Research Project
Department of Chemical and Process Engineering

INTRODUCTION

Brewer's spent yeast (BSY) is a major by-product of the brewing industry, with current output primarily being stock feed or disposal. Preliminary research has demonstrated that yeast extract produced from BSY is high in nutrients and has potential for use as a cell growth media ingredient.

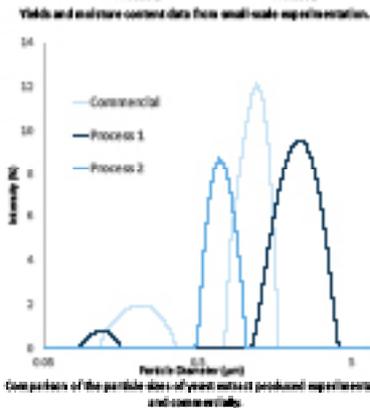
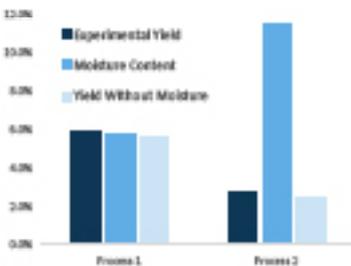
This project focuses on the production of yeast extract powder from BSY and investigates the potential for it to be utilised on an industrial scale. Economic analysis was undertaken to determine the feasibility of the process.



METHODS

Two methods of yeast extract powder production from BSY were used to determine the most efficient and cost-effective method. Both methods included centrifugation, separation, and spray drying, but differed by cell lysis techniques.

The yield, particle size, and moisture content of each powder were found to assess the efficiency of the process and stability of the product.

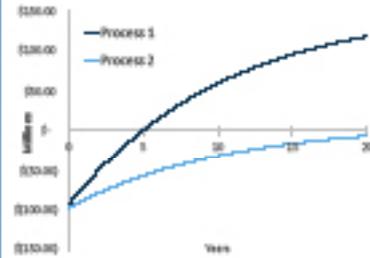
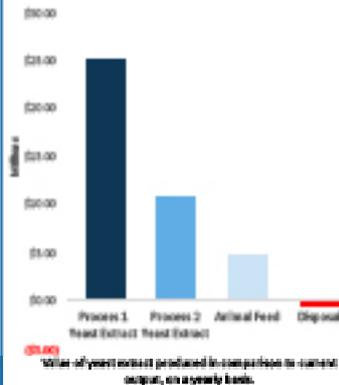


KEY FINDINGS

- Process one produced powder with a higher yield and lower moisture content.
- Process one took 22 hours longer than process two.
- The size of process one particles were larger than commercial and process two particles.
- Process one would pay back the cost of equipment in 5 years, compared to 25 years with process two.

ECONOMIC ANALYSIS

The current output for the BSY was compared to the value of the yeast extract, with both processes showing greater potential. Required capital expenditure was evaluated to give an understanding of the economic feasibility.

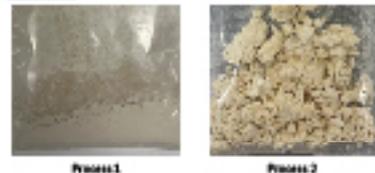


Cumulative value of a yeast extract production plant.

CONCLUSIONS

Both processes successfully produced yeast extract capable of use as a cell growth media. Process one was found to be more efficient and cost effective. However, further research should be undertaken to reduce the production time. The implementation of either process would improve the sustainability of the brewing process and provide a further source of income.

YEAST EXTRACT POWDERS



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Chemical Hydrogen Storage

Study of phosphetane borane as a potential hydrogen storage system

Elsie Wadie

Supervisor: A/Professor Sarah Masters



Purpose

Climate change is a real and present threat to our planet. One way to reduce the impact of human activity on the climate is to find alternatives to fossil fuels.[1] Hydrogen offers a clean alternative, combusting to produce water. However, storage of hydrogen onboard everyday vehicles is difficult, with current options limited to pressurised or cryogenic tanks. Chemical systems could be used to store and release hydrogen as needed within a car instead.[2] Requirements for good chemical hydrogen storage are:

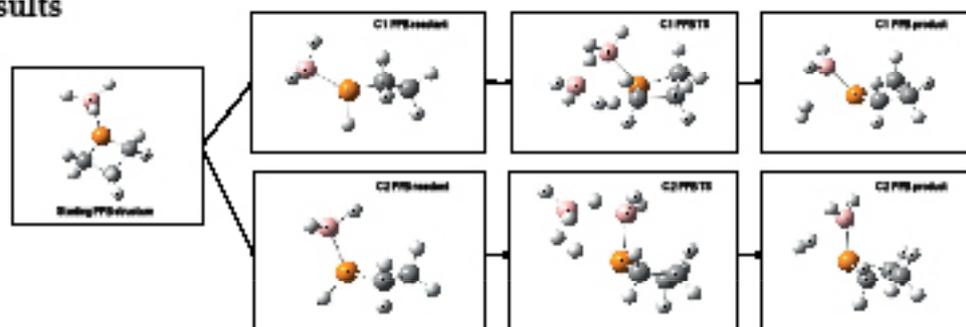
- Good volumetric and gravimetric capacity of H₂
- Good release and regeneration of H₂
- Good energy requirements (will H₂ be released with less energy than any other bonds are broken?)

In this project phosphetane borane (PPB) is being explored as one possible chemical storage system. Cyclic amine systems have previously been shown to show good hydrogen release when self catalysed by BH₃, therefore exploring the replacement of N by P provides valuable information regarding dehydrogenation processes for heterocyclic compounds.[3]

Computational Methods

Computers are capable of accurately predicting molecular structure and behaviour. Programs such as Gaussian 16 are used to determine the optimal structure of a molecule. The program searches for the minimum points on a potential energy surface with transition states between minima also being locatable. Various properties of phosphetane borane, such as the molecular structure, vibrational frequencies, transition states (TS), dissociation of the P-B bond, and thermochemistry were investigated using the HF, MP2 and M06-2X methods (to determine electronic energy) with the 6-31G*, 6-311G* and 6-311+G* basis sets (to determine electron location).

Results

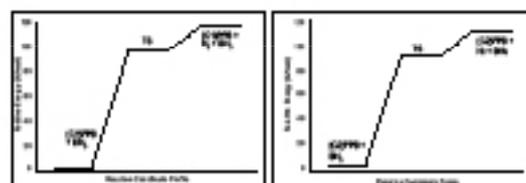


Optimised structures of the self-catalysed PPB dehydrogenation reaction steps for conformer one (C1) and two (C2).

Two conformers of phosphetane borane were located on the potential energy surface. The dehydrogenation profiles for both were explored further. Transition state calculations were completed, and it was found the dehydrogenation reaction where the BH₃ self-catalysed the process gave a reasonable transition state, indicating dehydrogenation would occur, while the uncatalysed reaction did not.

The reaction coordinate shows a barrierless reaction which indicates even though, with enough energy, dehydrogenation could occur it would likely cascade back to the reactant state.

This shows that phosphetane borane would not be a suitable candidate for chemical hydrogen storage.



Reaction coordinate profiles of the catalysed PPB (C1 & C2) dehydrogenation.

What Next?

The next step for phosphetane borane is to look into the cyclic stability of the molecule to assess the effect of saturation of the ring. Following this phosphetane silane should be explored, in this molecule the boron atom of the BH₃ Lewis acid is replaced with aluminium which is below boron on the periodic table. Properties to investigate include reaction barriers, and dehydrogenation pathways compared to bond dissociation.

Acknowledgements and References

I wish to thank my supervisors A/Professor Sarah Masters and Riana Mohamed Idris.

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- [2] Amaratilake, H., Baland, V., The hydrogen issue. *ChemTech* 2011, 4 (1), 23-36.
- [3] Masters, S. L., Fao, A. M., Essential B-H interactions in linear and cyclic donor-acceptor complexes: a review. *Chemistry in New Zealand* 2020, 48.

Endometriosis Invasiveness Modelling Not just a 'benign' disease

Imogen Cunningham supervised by Dr. Rachael Wood



Introduction

Endometriosis is a chronic inflammatory gynaecologic disease categorised by the presence of endometrial cells outside the uterine cavity (1). The pelvic region is predominately affected however there is clinical evidence of disease spread to nearly all organs and tissue, including the brain, eyes, and liver (2,3). Despite affecting an estimated 10-15% of reproductive age women, endometriosis remains unresearched and there is a concerning disparity between the disease presented in literature as 'benign' and the severe disease being treated in clinic (4).

The aim of this research is to model and quantify the invasive behaviour of endometriosis, using mammalian cell culture, to develop a more comprehensive understanding of the diseases pathogenic mechanisms. Additionally, this project aims to contribute evidence that highlights that endometriosis is not a benign condition but instead a serious invasive disease that deserves more public and professional awareness.

This research builds on work completed by Kaitie Ellis (Mech. Eng. student) and was conducted as part of final year CAPE research project.

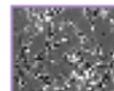
Cell Lines



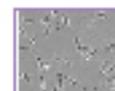
EEC-122
Endometriosis
Invasive



SW-1353
Bone Carcinoma
Invasive



MDA-MB-231
Breast Cancer
Invasive



NH3T3
Mouse Fibroblast
Non-Invasive

2D Invasion Modelling

Scratch Assay



1. Seed cells onto lower surface of well, add media and incubate
2. Once surface is covered remove media and scratch surface
3. Add new media and incubate
4. Image migration every 24 hours until scratch is closed

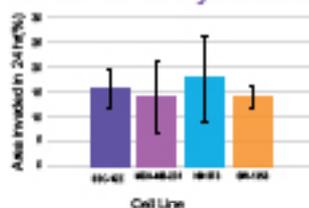
3D Invasion Modelling

Matrigel Transwell Invasion Assay



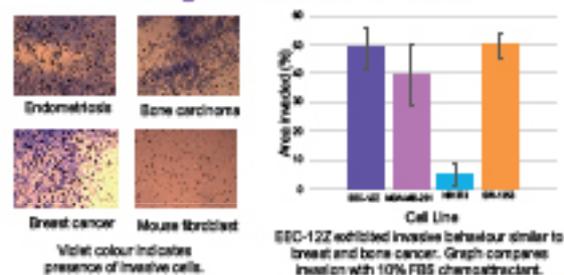
1. Place serum free cell suspension in top chamber and chemottractant media in lower chamber
2. Incubate for 48 hours. Invasive cells will travel down through Matrigel to the membrane layer
3. Remove the non-invasive cells and media before staining invasive cells violet for imaging and quantification

Scratch Assay Results



2D scratch assay/invasion quantification results are non-conclusive due to high errors.

Matrigel Transwell Results



Conclusions

2D invasion assay was not conclusive, due to high variance between repeats.

Invasive hypothesis was supported by the Matrigel invasion assay.

Invasive behaviour of endometriosis is comparable to some metastatic cancer.

Future Work

Incorporate immunocytochemistry staining to investigate invasive cell expression and probe the link between cancer invasion characteristics and endometriosis.

Repeat experiments utilising primary endometriosis tissue.

In vivo models need to be developed to confirm these findings.

Literature cited

1. American College of Obstetrics and Gynecology. Endometriosis. <http://www.acog.org/clinical/clinical-guidance/patient-education/2017/02/01/endometriosis>.
 2. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4411111/>
 3. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4411111/>
 4. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4411111/>

From Beer to Beef

Utilising spent brewers yeast as a growth medium for cellular agriculture

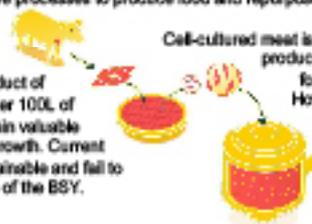
Paige Hansen, Rachael Wood



Introduction

Our current methods of food and beverage production are unsustainable and threaten global food security. As a result establishing alternative processes to produce food and repurpose by-products is vital.

Brewers Spent Yeast - BSY
BSY is the 2nd largest by-product of brewing with 2kg produced per 100L of beer. Yeast is known to contain valuable elements that stimulate cell growth. Current disposal methods are unsustainable and fail to utilise the valuable properties of the BSY.



Cellular Agriculture
Cell-cultured meat is a rapidly growing alternative food production method which offers potential for a more sustainable food system. However, current research has been hindered by the lack of suitable growth media.



Objective

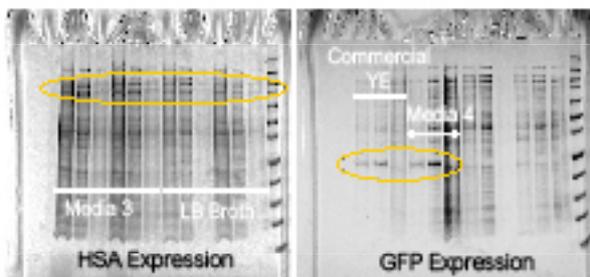
This research aims to verify the concept of repurposing spent yeast into a yeast extract for growth media by comparing its properties to commercial products. In addition to this it also aims to investigate the applications this growth media may have in cellular agriculture by characterising expression of human serum albumin.

Scope

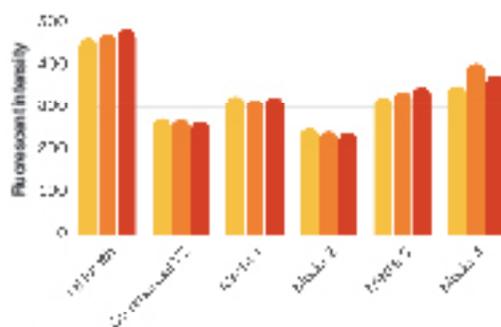
1. Compare the growth rate of E.coli TOP10 cells in commercial yeast extract against yeast extract derived from BSY.
2. Culture cells to test expressions of green fluorescent protein and human serum albumin in E. coli cells using yeast extract derived from brewers spent yeast.
3. Characterise expression and growth of green fluorescent protein and human serum albumin in yeast extract derived from brewers spent yeast.

Results

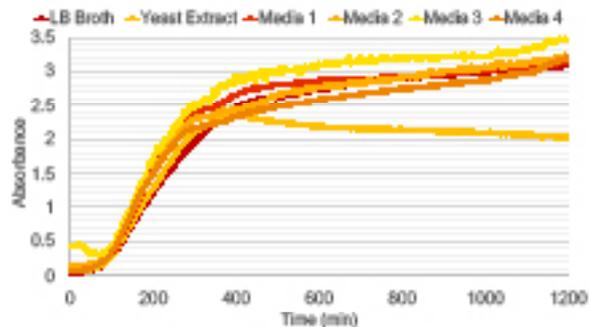
Verifying Expression of Green Fluorescent Protein and Human Serum Albumin



Quantifying Green Fluorescent Protein Expression



E. Coli Growth Rate



Conclusion

The results indicate that utilising brewers spent yeast as a growth media is a viable option. In some instances the BSY derived growth media was not only found to grow cells and express GFP and HSA at similar level to that of the commercial yeast extract it was better. When compared to other commercial growth media such as LB Broth, GFP was found to be expressed better in this medium while HSA was not. Interestingly, commercial LB Broth appears superior to commercial YE when compositionally they are the identical.

Future Work

The next stage of this research aims to focus on the purification of expressed HSA using a 3D printed chromatography column. This purified protein can then be further analysed to determine its solubility and its application in serum free media for cellular agriculture.

Student projects: Chemical and Process Engineering

UNIVERSITY OF SHEFFIELD
Project by: Josh McArdle, supervised by Matthew Watson (UC) and Megan Denczyk (Aspiring Materials)
UNIVERSITY OF SHEFFIELD

Development of Analysis Methods

Aim: Develop accurate and reliable methods for characterisation of products separated from the Aspiring Materials process.

Introduction:

Climate change is imminent. Decreasing its severity relies on reducing emissions, in particular carbon dioxide (CO₂). This is difficult for many processes, hence CO₂ removal will be essential for achieving 'net-zero' emissions.

Research at UC and abroad has developed a process with great potential for CO₂ removal and reduction. This process is set to be scaled up in the coming years.

The Process:

The Products:

Four main products - silica (SiO₂), iron oxides (Fe), magnesium hydroxide (Mg(OH)₂) and magnesium carbonate (MgCO₃).

Production of hydrogen gas from the process is also being researched.

SiO₂

Potential use to replace 30% of Portland cement, which accounts ~8% current global emissions.

Fe

Input into steel production, similar to cement accounts for ~8% global emissions.

Mg(OH)₂

Shown to geologically, chemically, and industrially mineralise CO₂.

MgCO₃

Potential use in construction materials or as soil additive.

Methods:

Analytical instrumentation was used to determine chemical structure of products and their compositions. Instruments used were X-ray diffraction (XRD), X-ray fluorescence (XRF), thermogravimetric analysis (TGA) and scanning electron microscopy (SEM). Each of these rely on generation, processing and evaluation of signals from a sample using a stimulus.

Hence accuracy of results relies on:

- Quality generation of signals from sample presented to instrument.
- Adequate processing of data with consideration of instrument limitations.
- Final evaluation of results and correlation of data between instruments.

General method for composition determination:

XRD for qualitative determination of molecules present in samples, XRF/EDS for quantitative compositions (excluding oxygen and hydrogen), TGA for correlation of these results and volatiles mass compositions.

Results:

Below shows XRD pattern of a SiO₂ sample and SEM image.

The broad peak shows the sample is highly amorphous so does not have an ordered crystal structure. This increases its ability to hydrate, which is of high importance if this material is to be used in cement. Below shows the compositional results for the same sample using XRF and EDS.

Element	OP	EDS
Si	91.03%	91.42%
O	8.97%	8.58%
Fe	0.00%	0.00%
Total	100%	100%

Fe sample shown through XRD to have magnetite (shown below), this is magnetic iron oxide phase (Fe₃O₄). XRF and EDS showed this to be 85 wt% pure. Fe samples had nickel composition ranging 1.8 - 2.4 wt%, hence potential for use in stainless steel production. SEM images of a Fe sample shown below.

Mg(OH)₂ sample shown through XRF and EDS to be 68 wt% Mg(OH)₂. Phase change: [Mg(OH)₂ -> MgO + H₂O] should reduce mass of sample by 21 wt%, TGA proved this (below left). DTA peak at 800 °C is potentially salt (NaCl) melting. XRD shows this present in sample also (below right). Other Mg(OH)₂ samples shown to have greater than 90 wt% pure.

References: Background image - Rich Street Morphology

Ru_xMn_{1-x}O₂ Catalysts for PEM Water Electrolysis

Glen McClea, Aaron Marshall



Abstract

Noble metal loading of PEM Water Electrolysis catalyst was reduced via Mn substitution, resulting in improved catalytic performance with increased Mn composition. However, it was determined that Mn is not an appropriate partial substitute for RuO₂ because of its instability in accelerated lifetime tests.

Introduction

The Proton-Exchange Membrane (PEM) is a promising technology for the production of Green Hydrogen. Current catalysts for the reaction contain expensive noble metal oxides such as IrO₂ and RuO₂. The catalyst's noble metal loading can be reduced via the partial substitution of RuO₂ with MnO₂.

Dimensionally Stable Anodes (DSA) with various Ru-MnO₂ compositions were synthesized and electrochemically tested to determine their catalytic performance and stability for PEM water electrolysis.

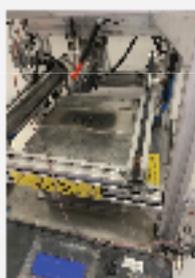
Methods

Catalyst Synthesis:

- Direct Thermal Decomposition of RuCl₃·xH₂O and MnCl₂·4H₂O on Ti substrate through atomized spray
- Annealed at 400 °C for 1 hour

Electrochemical Testing:

- Linear Sweep Voltammetry
- Cyclic Voltammetry
- Chronopotentiometry and AES



Results

Catalyst Performance:

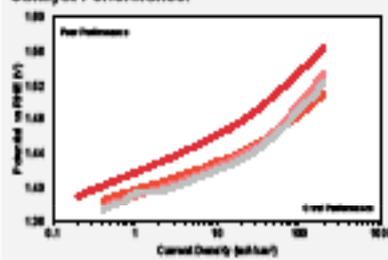


Figure 1: Polarisation curve of RuO₂, Ru_{0.9}Mn_{0.1}O₂, Ru_{0.8}Mn_{0.2}O₂ and Ru_{0.7}Mn_{0.3}O₂ between 0.2 and 200 mA/cm².

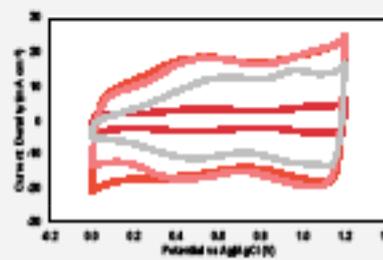


Figure 2: Cyclic Voltammetry of RuO₂, Ru_{0.9}Mn_{0.1}O₂, Ru_{0.8}Mn_{0.2}O₂ and Ru_{0.7}Mn_{0.3}O₂ at a 100 mV s⁻¹ scan rate.

Catalyst Stability:

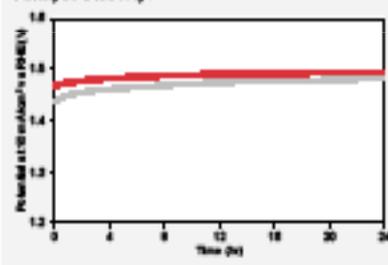


Figure 3: Accelerated lifetime test of RuO₂ and Ru_{0.9}Mn_{0.1}O₂ at a current density of 10 mA/cm² for 24 hours.

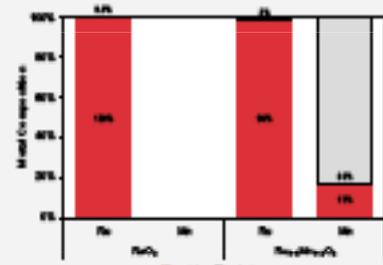


Figure 4: Remaining and leached metal composition of Ru and Mn in RuO₂ and Ru_{0.9}Mn_{0.1}O₂ after 24 hour accelerated lifetime test.

Conclusions

An increase in catalytic performance was observed with an increased Mn composition (Figure 1). RuO₂ and Ru_{0.9}Mn_{0.1}O₂ both appeared to show catalytic stability during a 24-hour accelerated lifetime test (Figure 3). However AES analysis revealed that up to 83% of Mn was leached from the Ru_{0.9}Mn_{0.1}O₂ catalyst during the accelerated lifetime test (Figure 4), this has not been reported in the literature. The stability and increased performance from this catalyst is therefore likely due to the remaining highly porous RuO₂. These porosity trends are shown in cyclic voltammograms (Figure 2). In contradiction to the literature, it is concluded that Mn is not an appropriate partial substitute in RuO₂ catalysts due to instability.



Literature

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Student projects: Civil and Natural Resources Engineering

COMPREHENSIVE ENGINEERING RESEARCH GROUP
BY A. GARDNER, C. WILK, S. WILSON, AND M. COLEMAN

INVESTIGATING SITE-CITY INTERACTION EFFECTS IN WELLINGTON

UNDERSTANDING THE INTERACTION BETWEEN VERTICAL STRUCTURES AND CITY SUBSTRATES IS ESSENTIAL FOR THE SIMULATION OF SEISMIC DAMAGE ON A REGIONAL SCALE. GROUND MOTION ASSESSMENTS IN URBAN AREAS OFTEN IGNORE THE REDISTRIBUTION OF SEISMIC ENERGY FROM SOIL-STRUCTURE EFFECTS, WHICH RECENT LITERATURE SUGGESTS ARE NOT NEGLECTABLE. THIS PROJECT INVESTIGATES THE SITE-CITY INTERACTION EFFECTS WITHIN THE WELLINGTON REGION, WITH EMPHASIS ON THE EFFECT OF DIFFERENT URBAN CONFIGURATIONS TO THE GROUND RESPONSE.

INTRODUCTION

To mitigate seismic damage in a metropolitan setting, an accurate prediction of earthquake site effects and structural response is required. There is evidence of strong ground motion amplification in densely urbanised areas, indicating there is an interaction between the soil, city and buildings.

This investigation uses data from the Wellington City Seismotele to analyse the "site-city interaction" (SCI) between two two-dimensional (2D) slices of the Te Aro and Te Aroa urban configurations. It seeks to explore how building parameters and arrangements can influence the structure-soil interaction, and other surrounding structures.

EFFECTS OF VARYING BUILDING CONFIGURATIONS

The amplification of ground motion from group building excitation and SCI effects is poorly quantified. The design of models representing numerous urban configurations was therefore completed in this analysis to investigate possible implications of these effects.

The Indicator Building Model consists of one 6 story concrete building, located at TERS station, which is a reference point selected at a central point in Wellington CBD, was composed. The building was idealised as having a density of 2000kg/m³, and having an elastic modulus of 1.6e10Pa. The Indicator model was used to determine how a single building interacts with the soil without the influence of nearby buildings.

To ensure the SCI effects could be isolated from the geological effects, a model with no structures was constructed. This was used as the primary reference case, ensuring any velocity variation due to above ground structures to be identified effectively.



To present the data gathered from all the models in OpenSees, the "TERS Ratio" was computed for each scenario. This is defined as the ratio of the velocity at the point of reference from the various configurations to the velocity at the point of reference in the No Buildings Model. As depicted in the figure below, SCI effects were exhibited at all frequencies where the TERS ratio is less than or greater than one.

The results obtained from the Indicator model showed the effects of a single structure to the ground response during an earthquake. The effect was minimal, however, provided a basis for further investigation to see further configurations would have more distinct responses.



It was determined that the configuration obtaining the highest velocities at the point of reference was the "All Buildings" Model. This indicated that the SCI effects that were being investigated in this project included both the interaction of the singular buildings with the soil, but also the interaction of the building themselves.

The other configurations were similarly assessed, which suggested different city layouts altered the ground response to a noticeable extent. To further analyse the results obtained from this dataset, more detailed models were created to determine which aspect of the analysis was contributing the most to the change.

EFFECTS OF VARYING GEOLOGICAL PROPERTIES

A Single Model was formed with rock as the only material in the bath, and the surface of the bath having flat topography. The Rock Only model included the original topography but the only material in the bath was the rock. This disregarded the potential site effects from the sediment layer causing the discrepancy in velocities. A Sediment City model was formed, giving the most replication of the Rock City model, however with the properties of the sediment as opposed to the rock.

The following conclusions were formed through the analysis of these models:

- SCI effects were not primarily caused by the rock or above ground structures.
- Topography in the model was not the primary contributor to the change in ground response.
- The sediment was the primary cause of the SCI effects.
- There has to be sediment present in the bath model in order for the urban configuration to matter.

METHODOLOGY

Two dimensional plane strain numerical models were used to simulate earthquake wave propagation through the Te Aroa Basin to examine the interaction between above ground multi-story structures and the soil. Two separate models were constructed for the slices taken across the basin. A variety of design cases were considered in the analysis of SCI effects to determine the significance of different basin, site and topographic effects and how different configurations contribute to the damage of a city.

The surface ground motion was recorded at the station located at Te Papa, the intersection of the two slices. This was analysed in two directions across the boundary of the Te Aro and Te Aroa basins, as shown in the figure below.



Wellington CBD showing location of TERS, and location of slices used in analysis.

To simplify the geotechnical conditions of the bath, shallow sediment has not been explicitly modelled, and instead the average properties of all of the sedimentary layers have been applied to the sediment as a whole, and the sediment rock content has been simplified.

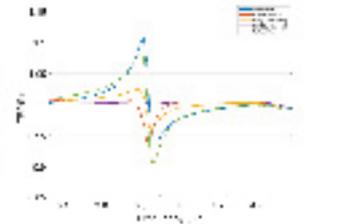


2D slices with features used for the model verification, displaying the mesh and cross-section used in analysis.

EFFECTS OF VARYING STRUCTURAL PROPERTIES

A model was created for all previously explored configurations with altered building properties to replicate better structures and residential areas more densely. The density and elastic modulus of the structures was selected based on the typical properties of timber.

The properties of the buildings changes the response, proving that the characteristics of the structures are important.



Ratio of Ground Response due to various timber urban configurations in Response of the Buildings Model for XZ1

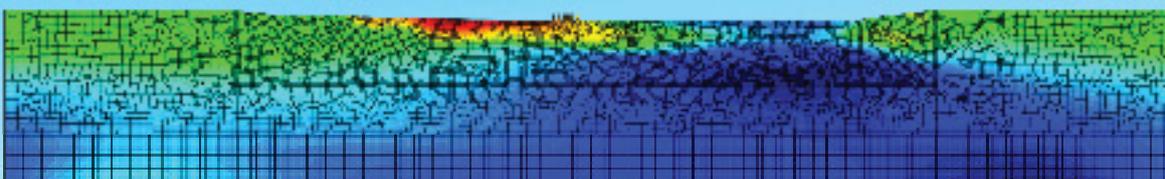
The results demonstrated that the influence of buildings with low densities is rather small since there is limited increase of the overall maximum amplification.

CONCLUSIONS

The results prove that the presence of the built environment influences the ground response when subjected to excitation. The key conclusions are as follows:

- The presence of structures changes the surface ground motion relative to the free field (No Building) response.
- The configuration of the city makes a difference in the response.
- The structural properties of the buildings also make a difference, as changing these changed the nature of the amplification.
- The geometry and topography of the basin also play a role.

The figure below shows the maximum modal displacement due to ground excitation and therefore indicates the areas of the basin which experience larger displacements. It shows that the largest change is directly next to the structures, which is due to the SCI effects that have been investigated in this project.



Virtual Reality Smoke? It'll break your stride!

Cameron Davis and Chelsea Sole

Background

Designing for the safety relies on accurately estimating movement speed. It is extremely difficult to observe the movement speed of occupants during a real fire. This means experimental studies are very important to investigate how visibility loss impacts movement speed. However, physical experimental studies of movement through artificial smoke can be very expensive.

Virtual reality could be a cheaper method to accurately simulate virtual smoke effects. Previous studies have found that virtual reality results for human behaviour in fire have similar validity to classical laboratory studies¹. However, most studies have not used the participant's physical preferred walking speed as their speed in the virtual environment.

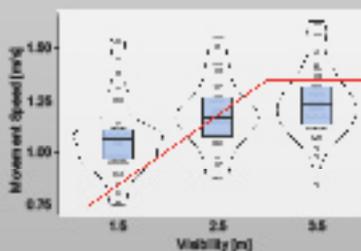


Figure 2. A plot of the movement speeds from all virtual reality smoke scenarios with the mean experimental data curve overlaid in red. The box shows the interquartile range (25-75% of datapoints), and the horizontal line in the box is the median. The outline shows the distribution of datapoints.

Comparison to past experiments

Participants tended to walk slower as their virtual visibility decreased. This general trend was expected based on previous experimental results². However, the virtual reality experiment results did not clearly fit the established data curve. On average at 3.5 m of visibility participants walked slower in virtual reality than in previous experiments. Decreasing the visibility in virtual reality also had less impact on movement speed than expected. This was probably because participants knew there were no obstacles, and so felt more comfortable walking in the low visibility environments.

Conclusions

Virtual reality smoke was shown to decrease the physical movement speed of participants. However, decreasing the virtual visibility did not have as much impact on movement speed as was observed in past real-world experiments. Increasing the realism of the virtual environment could decrease this gap between virtual and real-world smoke experiment results.

References

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Experimental procedure

Advertisements were posted on Facebook and campus noticeboards. Most of the 42 participants were university students, and 76% indicated they had prior experience with virtual reality. A \$5 cash voucher was offered to each person following the experiment.

Experiments took place in the Civil and Natural Resources virtual reality lab. A wireless self-contained head mounted display was used to immerse participants in a virtual version of the lab. There were five experiment scenarios: without virtual reality, virtual reality with no smoke, and virtual reality with smoke reducing the visibility to 3.5 m, 2.5 m, and 1.5 m. Each participant experienced the smoke scenarios in a different random order and repeated their first smoke scenario at the end.

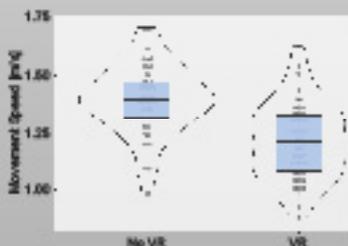


Figure 3. The unimpeded movement speed without the head mounted display compared to the unimpeded movement speed in the virtual lab. The box shows the interquartile range (25-75% of datapoints), and the horizontal line in the box is the median. The outline shows the distribution of datapoints.

VR slows people down

A Welch's Test was conducted with the null hypothesis that participants' unimpeded movement speed would not be significantly faster in the real lab than in the virtual lab. This returned a p-value of under 0.1%. Since the p-value was less than 5% a significant difference in speed was shown, and the null hypothesis was rejected. This was confirmed by plotting the two samples, as while the data range overlaps slightly both medians are clearly outside the other's interquartile range. The reason for participants walking slower in the virtual environment was probably unfamiliarity with the situation.

Acknowledgements

Daniel Nilsson and Humayun Khan for supervision and support throughout the project.

Civil and Natural Resources department for funding inducement.

This experiment was approved by the Human Research Ethics Committee of the University of Canterbury (HREC 2022/476/R).

Objectives

- Determine the relationship between physical movement speed and virtual environment visibility.
- Compare movement speed through smoke in a virtual environment to existing experimental data.



Figure 1. The participant's view of the virtual lab with no smoke (top left), 3.5 m (top right), 2.5 m (bottom left), and 1.5 m (bottom right) visibility.

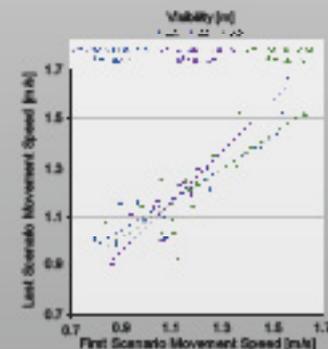


Figure 4. The correlation between the first and last trial of each visibility level with the linear trendline equations and R^2 (goodness of fit) values provided.

Was there a learning effect?

Participants in the 2.5 m smoke scenario did not significantly change their speed between their first and last trial. However, they tended to walk slower on their first round of both the 1.5 m and 3.5 m scenarios. The reason for being slower in the first 1.5 m scenario is likely due to the contrast effect, as participants tended to think the last 1.5 m scenario was the worst after experiencing the other scenarios. The linear trendline fits the 1.5 m and 2.5 m scenarios well, but not the 3.5 m scenario. One reason could be that participants felt more relaxed on their second 3.5 m trial, so there was more variation in their walking speeds.



DNI04

Student projects: Civil and Natural Resources Engineering

TA/CO: Isabella Ryan, Charlotte Duke

HYDRAULIC BARRIERS TO NATIVE FISH MIGRATION

UNIVERSITY OF
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Tel: 03 378 7400

PURPOSE STATEMENT

Understand the backwatering effect, caused by fyke nets and stop nets, as it relates to fish passage.
Create a device that reduces the backwatering effect in culverts.

BACKGROUND

There are eighteen species of New Zealand native fish which migrate as part of their lifecycle. Fish passage is an important consideration in New Zealand streams, however, hydraulic barriers such as culverts pose challenges to fish passage as they are designed only to transport water out of a system quickly and efficiently. Fish passage solutions have been developed and tested under laboratory conditions, meaning their success in the field is relatively unknown. One method of testing the success of fish passage remediations in-situ is mark and recapture trials.

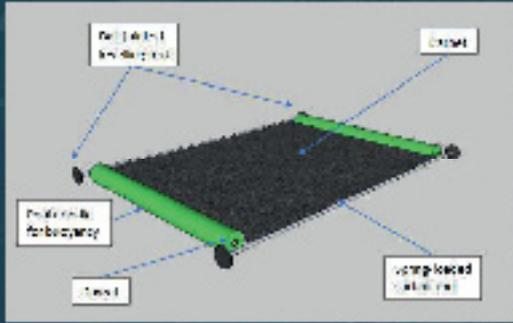
In mark and recapture testing, a stop net is placed at the upstream and downstream end of the culvert to isolate the test environment. However, by adding this barrier, the hydraulic properties of the reach are affected, creating a backwater effect, particularly in reaches with high debris loads. Backwater rise is where the water in the reach is backed upstream, creating an area of deeper water. This poses an issue as the testing is supposed to be done in natural hydraulic conditions. This research involves the design of a 'no-backwater' device which allows for mark and recapture trials that do not disrupt the culvert hydraulics. The device has been designed and tested to determine whether it is effective in minimising backwater rise.

DESIGN OF PROTOTYPE

From previous studies, it has been found that the backwater rise caused by obstructions in the flow can potentially be mitigated by a carpeting effect. In a natural stream, a carpet of debris can form around an obstruction, which can decrease the rise of backwater. This carpet effect is the basis of our design for this prototype.

The prototype for the no-backwater device has been designed to mimic this carpet effect. It consists of several main components as shown on the figure on the right. The curtain rods provide structure to the device, with the spring-loading making them adjustable, securely fitting in a range of culverts. The rods have the added attachment of ball-jointed levelling feet, which can be adjusted to grip onto the sides of the culvert. The frame also consists of two dowels, covered by pool noodles to provide buoyancy, keeping the device on the surface of the water. A sheet of material is stretched across the frame. This component is designed to mimic the carpet effect.

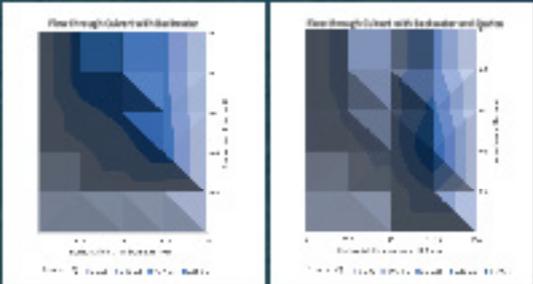
PROTOTYPE



TESTING AND RESULTS

The device has been tested in a range of culverts throughout Christchurch to verify its effectiveness at minimising backwater rise. A backwater was created using a net at the culvert outlet. The velocity, stream depth and change in height (backwater height) were recorded. The no-backwater device was then placed in the stream, upstream of the net. The velocity, stream depth and change in height were recorded again.

The results show a 26.6% reduction in the backwater caused by a net. This is because the no-backwater device acts as a carpet, efficiently directing flow through the net. The flow profiles both before and after intervention show different flow behaviours. Before the device is installed, the flow profile shows the expected flow behaviour for an open channel; the flow is fastest at the water surface and approaches zero towards the sides of the culvert. After the device is installed, the flow behaves more like a pipe. The no-backwater device introduces a surface at the top of the flow (flow at this surface is approximately zero), meaning the fastest flow occurs in the middle. Additionally, the overall flow is reduced (including an area of high flow in the centre), contributing to the reduction in backwater.



FUTURE METHODS

The no-backwater device is intended to be used in-situ to reduce the backwater caused by fyke nets and stop nets. This will improve the accuracy of mark and recapture trials by ensuring that fish have near-normal conditions to ascend a culvert by reducing changes to culvert hydraulics.

The results show that the device alters the flow behaviour at the backwater location. The purpose of the device is to minimise changes to flow behaviour in culverts. To prove its effectiveness, further testing should be conducted to model the flow throughout the culvert reach. This would show that the flow is only altered at the device location.

Supervisor: Prof. Tony de Vries

Special Thanks To: Stephanie Patchett, Aude Thierry, Fabio Silveira, and Alisha Olney.

Final Year Projects Showcase - University of Cumbria - October - October 2022

Physical and Mechanical Properties of Gravel-Glass-Rubber Mixtures

Authors: S.J. Christian and L.D. Goldingham Project Supervisor: G. Chilaro



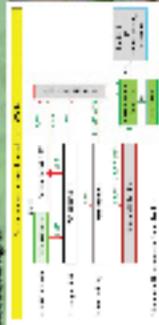
GC101

Background

Construction geotextiles has been historic ally a primary engine-based industry, however, the secondary use of materials is becoming more prominent in the construction industry. Any form of secondary use reduces the need to mine primary resources, reduces waste and increases sustainability. Gravel, recycled glass, recycled rubber and foams (GRGMs) can reduce the amount of virgin materials in construction applications.

Objective

The objective of this study was to experimentally determine the strength characteristics of different volumetric glass content (VOC) GRGMs under direct shear testing, and to assess whether GRCMs can be employed as a structural fill for use in road rehabilitation and building foundations. Researchers have established that gravel-rubber mixtures are available based on their levels (Fig. 1).



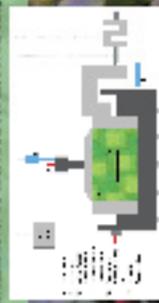
Materials

Figure 3 shows the available types of all mixtures based on volumetric rubber (VR) content, while the proportion of gravel (GV) and glass beads (GB), green glass (GG) and natural glass (NG) was varied. 100% VOC mixtures were also tested to determine their characteristics. The following VOC were used:

VOC	1	2	3	4	5	6	7	8	9	10
GV	100	95	90	85	80	75	70	65	60	55
VR	0	5	10	15	20	25	30	35	40	45
GB	0	0	0	0	0	0	0	0	0	0
GG	0	0	0	0	0	0	0	0	0	0
NG	0	0	0	0	0	0	0	0	0	0

Apparatus

A schematic illustration of the direct shear box used in this study is shown in Fig. 3.

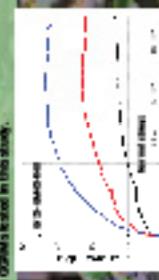


Methodology

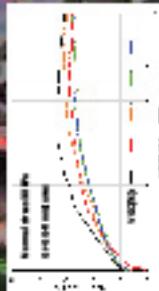
Isotaxite (split) tests (10) of individual materials. Determine particle size distribution curves of G, V, GG, GB and GGM materials. Prepare 30 mixtures at various VOCs of 0%, 15%, 30%, 45%, 60%, by mixing the G, V, GG and GM subgrants, while having constant 40% volumetric rubber content. Conduct compaction tests of the GRGMs to find the maximum dry unit weight of each mixture. Conduct direct shear tests under normal stresses of 10, 20 and 100kPa to obtain the friction angle of the GRGMs. Results and Discussion

Direct Shear Tests

Figure 4 reports the direct shear behaviour for G15-GM45-60. It can be seen that the peak shear stress increases with increasing normal stress level. Similar trends were observed for all the GRGMs tested in this study.

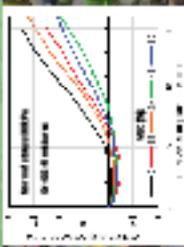


The direct shear response of GRGMs with 10% shear under 10 kPa normal stress is shown in Fig. 5. The peak shear stress decreases with increasing VOC; this is mainly due to the combinations of glass particles compared to hard-coated gravel. Similar trends were observed for GRGMs with 20 kPa under 60 kPa normal stress as well as 100 and GM under 10 kPa normal stress. This behaviour had a significant impact on the strength of the mixtures, as at 100 kPa normal stress at this effect was a small reduction for shear stress paths.



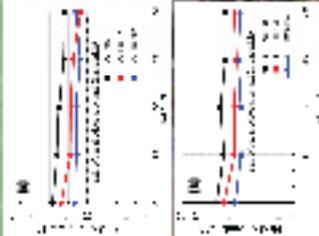
Volume ratio R response

Most test procedures for granular materials with initial contraction followed by dilation; this is consistent with the behaviour of dense soils. As GRGMs were compacted to 90-95% of maximum density, this is expected. As indicated in Fig. 6, the level of dilation occurred during retesting was due to the high variability observed as compared to gravel grains.



Friction Angle at Different Normal Stress Levels

For the sake of comparison, the friction angle of each mix was also determined at different normal stress levels. A graph of the friction angle decreased with increasing normal stress. This is because the mixtures experience more contractive behaviour under higher normal stresses. As shown in Fig. 8(a) and 8(b), irrespective of the normal stress level, all GRGMs with 0% and 60% have similar strength to be used as structural fills for typical geotechnical applications.



Conclusions

In this study, the strength of gravel-rubber-glass mixtures (GRGMs) was evaluated by direct shear tests. It is found that GRGMs can have friction angle greater than 10°, indicating that GRGMs can substitute structural fill materials for many geotechnical applications.

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2) O'Leary, G., Palermo, A., Tumbak, S., Howard, A., and Berwick, L., (2021), "Optimisation of road sub-grade based on structural fill" in *Proceedings of the Institution of Civil Engineers, Geotechnical Engineering*, 168(1), 30-41.

Acknowledgements

We would like to thank our project supervisor Dr Gabriele Chilaro for the guidance and knowledge shared with us regarding this project. We are grateful for the help with the use of the shear box and the help for solving technical problems, especially Francesco and Sam for their assistance in the laboratory.

Modelling a Pathway to a Net-Zero Carbon Community: A Case Study of Christchurch

By A. Harris V. Slegers, Sapanthori L. Isahery



OBJECTIVES

Research objectives were to model a pathway to net-zero carbon emissions for an urban community by 2050. The objectives were to model a pathway to net-zero carbon emissions for an urban community by 2050. The objectives were to model a pathway to net-zero carbon emissions for an urban community by 2050.

BACKGROUND

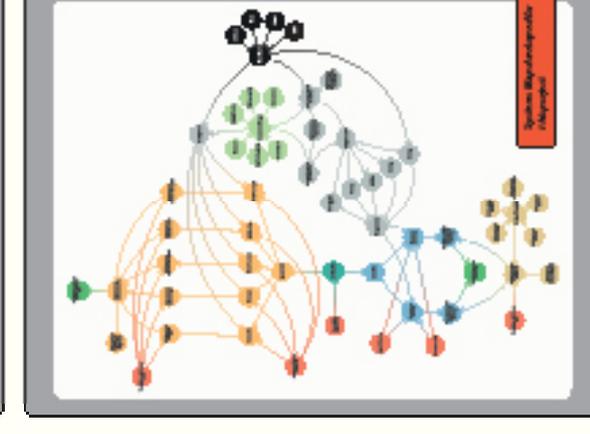
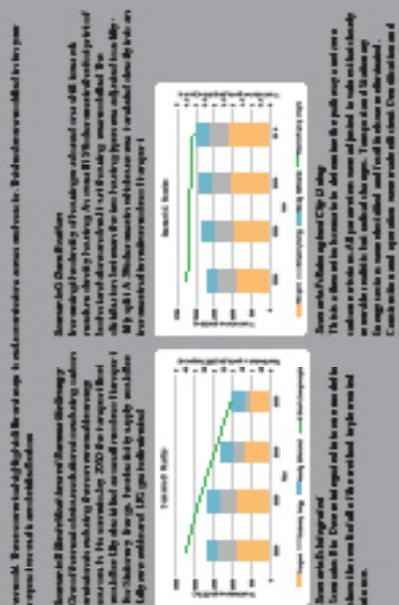
The Christchurch City Council (CCC) is a local government body in New Zealand. The CCC is a local government body in New Zealand. The CCC is a local government body in New Zealand. The CCC is a local government body in New Zealand. The CCC is a local government body in New Zealand.

METHOD

The research was conducted using a combination of secondary data analysis and primary data collection. The research was conducted using a combination of secondary data analysis and primary data collection. The research was conducted using a combination of secondary data analysis and primary data collection.

SCENARIOS AND RESULTS

Four scenarios were developed: Business as Usual (BAU), Green Building (GB), Smart Growth (SG), and Net-Zero (NZ). The results show that the NZ scenario is the only one that achieves net-zero carbon emissions by 2050. The results show that the NZ scenario is the only one that achieves net-zero carbon emissions by 2050.



VALIDATION

The model was validated against secondary data and primary data. The model was validated against secondary data and primary data. The model was validated against secondary data and primary data.

LIMITATIONS

The model has several limitations, including the use of secondary data and the assumption of constant energy prices. The model has several limitations, including the use of secondary data and the assumption of constant energy prices.

CONCLUSION

The research concludes that a pathway to net-zero carbon emissions for an urban community is possible. The research concludes that a pathway to net-zero carbon emissions for an urban community is possible. The research concludes that a pathway to net-zero carbon emissions for an urban community is possible.



LEIDA

Student projects: Civil and Natural Resources Engineering



PROBLEM STATEMENT

What are the effects of reconditioning asphalt pavement structures?

BACKGROUND

Asphalt pavements used in highways and airfields are subject to static loading conditions. These loads require sample sizes to be much larger than those used for conventional laboratory tests. In New Zealand, an average 100 mm thick asphalt pavement is subjected to a wheel load of 150 kN. To achieve this, the specimen must be made together into larger cores of 300 mm thickness. The cores are reconditioned into larger cores, and its effect on a pavement's mechanical behavior is investigated in this project.

METHODOLOGY

- Specimen production
 - Twelve of the Mixture Asphalt (HMA) were tested in this project. For each asphalt mixture, new samples were prepared to be compared to reconditioned asphalt mixtures that had previously been treated and permanently deformed.
 - For the reconditioned samples, the specimens of each asphalt mixture were reconditioned at 25°C. This gave sufficient porosity to reconstruct and smooth the surfaces.
 - Using the same design and procedure, new samples of each asphalt mixture were prepared at 55°C after the reconditioning process. The samples of the asphalt mixtures were prepared from the asphalt plant and the site.
 - Cores were cut from these samples to a diameter of 200 mm. The radius of the samples was produced at 100 mm diameter of 15 mm and 13 mm.
 - The mixing composition used for three or four observations. This first includes Mixture A or Mixture B. The second observation is the sample number, the third includes whether the sample has been reconditioned or is new, and the fourth includes whether it is from the site or their laboratory.
- Experimental procedure
 - The bulk specific gravity (G_m) of the mix was found by measuring the dry saturated, and saturated surface dry (SSD) weights and separating them into a known equation [ASTM D155].
 - Indirect tensile strength tests were done by loading specimens across the vertical plane at displacement rate of 0.20 mm/min. The peak load at failure was used to calculate the indirect tensile strength of the specimens (ASTM D693). This test is done on both 150 mm and 150 mm thick specimens.



Figure 1. Indirect tensile strength test for indirect tensile strength. The load cell and displacement transducer are used to measure the indirect tensile strength.

RESULTS

- Indirect Tensile Strength Test
 - The reconditioned BT strengths are typically higher than that of the new mixes.
 - The BT strengths of MHA are higher than that of Mixture B.
 - Similar trends are observed for the stress-strain curves of the 150 mm and 300 mm samples.

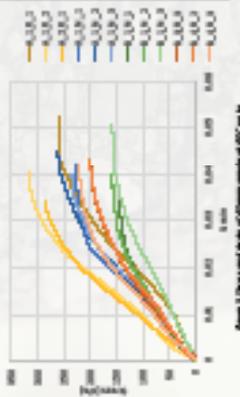


Figure 2. Stress-strain curves for reconditioned asphalt samples.

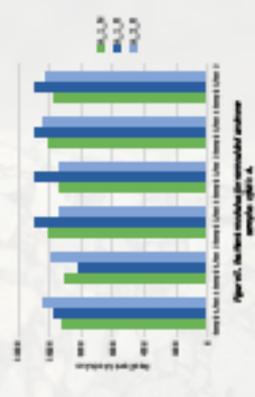


Figure 3. Indirect tensile strength for reconditioned asphalt samples.



Figure 4. Indirect tensile strength for reconditioned asphalt samples.

Indirect Tension Test for Reconditioned Modulus

- Figure 5 shows the reconditioned modulus for reconditioned MHA is higher than new Mixture A.
- Figure 6 shows the reconditioned modulus of reconditioned MHA to have no effect on the reconditioned modulus of the new Mixture B.

Figure 5. Indirect tensile strength test for reconditioned modulus.

DISCUSSION

The indirect modulus characterizes the stiffness of a pavement structure. Mixture A tended to show an increase when reconditioned. The average indirect modulus increased from 2000 MPa to 2100 MPa.

Mixture B showed an increase in indirect modulus, however, the difference was smaller than that observed for Mixture A. This suggests that the pavement stiffness is less affected by reconditioning for other pavement mixes.

The indirect tensile strength (ITS) is a measure of strength, fatigue resistance, temperature cracking, and rutting. The ITS of the reconditioned samples was higher for the reconditioned specimens. For the 150 mm specimens, there was an average increase of 200 MPa in Mixture A and a 400 MPa average increase in ITS for Mixture B. Similarly, the 300 mm specimens showed an increase in ITS when reconditioned, with Mixture A having a larger increase relative to Mixture B. This indicates that the ITS strength will be more influenced by reconditioning for other mixes.

CONCLUSIONS

This project investigated the effects of reconditioning on a pavement's mechanical properties. It was found that pavement mixes, when reconditioned, would experience increases in their indirect modulus. The magnitude of the increase depends on the stiffness of the mix, with higher stiffness mixes showing higher increases after reconditioning. The increase in the reconditioned indirect tensile strength of reconditioned asphalt pavement tends to lead to a general increase in the pavement's strength and stiffness.



Figure 6. Approximate size of the load amount of force used in the project.

REFERENCES

- ASTM D693. Standard Test Method for Determining the Indirect Tensile Strength of Asphalt Mixtures by Indirect Tension Test. ASTM D693-2013.
- ASTM D155. Standard Test Method for Bulk Specific Gravity of Asphalt Mixtures. ASTM D155-13.
- AASHTO 1202. Standard Method of Test for Indirect Tensile Strength of Hot-Mix Asphalt. AASHTO 1202.

IMPRINT

CARBON EMISSIONS CALCULATOR



WHY COUNT CARBON?

- More people are working remotely and an understanding of environmental impact is needed.
- Organisations are striving to adopt sustainable working environments.
- A method to compare the personal carbon footprints of working remotely to working in office would be useful in validating sustainable working decisions.

OBJECTIVES

- Design a model to calculate the emissions created by individuals when working from home and working in the office.
- Create a user friendly web application to actualise the model

MODEL

Total emissions =



Traveling to work
Commuting is the largest emissions contributor to working from the office.



Virtual meetings
Internet connection type, meeting lengths, and camera use are factors of the emissions created during online meetings.



Home heating
Heat pumps, electric oil heaters, gas heaters, and fireplaces all emit carbon at different rates.

WEB APPLICATION

The required input parameters are:

- The number of days working from home and from the office
- Commute distance and travel modes
- Online meetings:
 - Duration
 - Use of camera
 - Internet connection type
- Frequency of heating in winter and what heating technology is used.



Results are displayed to the user in approximate kilograms of carbon dioxide created in a year and the number of fully developed trees required to offset the greenhouse gases.



USABILITY SURVEY

21

Participants

8.7/10

Intuitiveness score

114s

Average completion time

44s

Standard deviation



Computer Science &
Software Engineering

Student
Ronan Avery

Industry supervisor
Melissa Keys

Academic supervisor
Andreas Willig

AUTOMATED 3D SCENE RECONSTRUCTION

FROM 360-DEGREE VIDEOS

Henry Barrett

BACKGROUND

FACILITYtwin®, a digital twin platform developed by Beca, helps owners and managers of manufacturing and utilities facilities get easy access to the data they need to make **better decisions** about their assets through **360-degree photo virtual tours**. The creation of 360 tours is limited because the virtual tours are "flat" in that they use **2-dimensional** 360 degree photos.

Neural Radiance Fields (NeRF) allow for the creation of complex **3D models** from **regular photos** using **neural networks**.

The technology offers an advantage over traditional **photogrammetry** tools, which often require expensive **LIDAR** equipment, **time**, and **experience** to capture a scene.

OBJECTIVES

- Generate a **3D model** from **360 photos** or **videos**
- Produce a **3D "doll house view"**
- **Place locations** of the photos into the **3D scene**



PROCESS

An automated processing pipeline was developed that simplifies the creation of 3D models from 360 degree photos or video.

- 

Capture 360 video

Minimise motion blur + Ensure each object in the scene is observed multiple times from different directions.
- 

Decompose frames

Extract still frames from video. + Take revolving perspective projections from equiangular images
- 

Triangulate camera positions

Structure from motion on images using COLMAP + Bundle adjustment using known constraints
- 

Train neural model

Using NVIDIA's Instant Neural Graphics Primitives NeRF implementation + network learns to represent scene

RESULTS

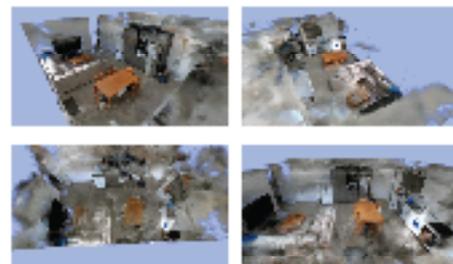
Novel Views

Dataset used is of a living room featuring a **single large open space** (furnished) and **simple geometry**, similar to that of a **large open facility**.

The model is able to be **cropped** to allow for viewing from completely **novel perspectives** such as a **dollhouse view**.

When viewed from these perspectives, **visual quality is reduced** due to **floating artifacts**.

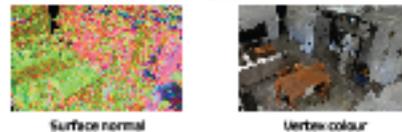
Consistent lighting and **dynamic noise** help to reduce the presence of artifacts.



Mesh

Exporting **NeRF** model to **mesh** provides **easier integration** into other systems at the cost of **visual quality**.

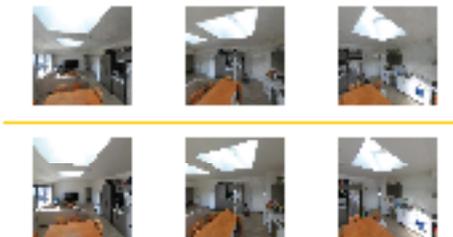
Surface geometry is not accurately captured, **lowering the quality** of generated meshes.



Training View

Model accuracy is measured to be **30 dB** (PSNR) on training images captured from a **1m12s** video (144 total frames).

Trained models were able to provide **better visual quality** when viewed from positions **close to training views**.



Ground Truth

It is found that **NeRF** is better suited for **"inside-out"** reconstructions, where cameras all point inward towards a **single subject**. For **"outside-out"** reconstructions, such as **indoor scenes**, a **greater number of observations** (or **pan images**) are required.

Skill Tracking and Recommendations for {code:WOF}

1. Background

Code:WOF is a digital tool developed by the University of Waikato for the Computer Science Education Research Centre. The tool is designed to help students track their progress in learning computer science skills and to receive personalised recommendations for learning resources.

2. Problem

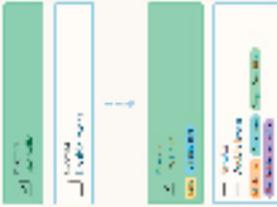
Code:WOF is a digital tool developed by the University of Waikato for the Computer Science Education Research Centre. The tool is designed to help students track their progress in learning computer science skills and to receive personalised recommendations for learning resources.

3. Solution



a) Question Categorisation and Skill Sets

- The tool categorises questions and problems into skill sets based on the skills they require. For example, a question about data structures would be categorised under 'Data Structures'.
- Each skill set is associated with a set of recommended learning resources.



b) Skill and Level Tracking

- The tool tracks the user's progress in learning each skill and level. For example, a user who has completed a course on Python would be marked as 'Completed' for that skill.
- The tool also tracks the user's level of proficiency in each skill. For example, a user who has completed a course on Python would be marked as 'Intermediate'.



c) Question Recommendations

- Using the user's current level of proficiency in each skill, the tool recommends questions and problems that are appropriate for their level.
- The tool also recommends learning resources that are relevant to the user's current level of proficiency.

4. Evaluation and Future Work

The tool was evaluated using a survey of students who used the tool. The survey results showed that the tool was effective in helping students track their progress and receive personalised recommendations.

The tool was also evaluated using a survey of lecturers who used the tool. The survey results showed that the tool was effective in helping lecturers track their students' progress and provide personalised support.

Author: Griffin Baxter
Contact: griffin.baxter@waikato.ac.nz

Try it out at code.wof.co.nz

University of Waikato
Computer Science & Software Engineering

Dr. Andrius Zilichauskas
PhD, Bachelor's degree

Faculty of Applied Sciences, Computer Science Department, Vilnius University
BLOODSTAIN PATTERN ANALYSIS
2020, 2021, 2022

University of Turku
 ESR-32

ABSTRACT

This project involves a novel method for bloodstain pattern analysis. The method is based on a deep learning architecture, which is trained on a dataset of bloodstain images. The method is able to detect and classify bloodstain patterns, and it is able to provide a confidence score for each prediction. The method is able to detect and classify bloodstain patterns, and it is able to provide a confidence score for each prediction.

100% - 100% 100% 100% 100%

TRAINING

The training process involves a deep learning architecture, which is trained on a dataset of bloodstain images. The method is able to detect and classify bloodstain patterns, and it is able to provide a confidence score for each prediction.

Loss

Training Accuracy

Training Accuracy: 0.8500, Validation Accuracy: 0.7500

RESULTS

The results of the training process are shown in the table below. The table shows the accuracy, precision, and recall of the model for different models.

Model	Accuracy	Precision
Model A	0.8500	0.8500
Model B	0.7500	0.7500

Model A: 0.8500, Model B: 0.7500

PREPROCESSING

1. **RAW IMAGE**
The raw image is a photograph of a bloodstain on a surface. It is a grayscale image with a resolution of 1000x1000 pixels.
2. **BINARY THRESHOLDING**
The image is converted to a binary image using a thresholding function. This step is used to remove the background and to highlight the bloodstain.
3. **DILATION**
The binary image is processed using a dilation function. This step is used to expand the boundaries of the bloodstain, which helps to fill in the gaps and to smooth the edges.
4. **ROBUST CORNER**
The corners of the bloodstain are detected using a robust corner detection algorithm. This step is used to identify the corners of the bloodstain, which are used for pattern analysis.

E/S/R

Faculty of Applied Sciences

ACTUAL

Excitation

PREDICTED

Excitation

CONFIDENCE

0.975245

Post-Quantum Ternary Trees

1. Background

- Digital signatures allow us to verify that the information has not been tampered with.
- Current signature creation schemes will be at risk because of quantum computers.
- Imposters will be able to discover the private keys used to sign data and then send their own signatures.
- Two solutions for post-quantum signature creation are:
 - the Merkle Signature Scheme (MSS)
 - and the eXtended Merkle Signature Scheme (XMSS)
- These use binary tree leaves to combine keys from a one-use quantum secure signature scheme.
- This allows multiple signatures to be created and verified from one public key.
- Because of the tree leaves, each tree can only sign a limited number of messages.

2. Objective

The main objective of this project was to use an alternative tree structure in MSS and XMSS that an IoT sensor device would use to:

- create a new tree every day
- send 24 signed messages (one every hour)

This alternative tree structure known as "ternary" involves every node in the tree having three children.

This reduces the number of unused leaves for the IoT device as a binary tree would need to have $2^5=32$ leaves, whereas the ternary only needs $3^3=27$.

3. The Signature Schemes Compared

Binary

MSS
Public Key
Leaves

XMSS

Merkle Tree with 32 Leaves
L-Tree
Public Key
Leaves
Height of 5
Height of 4

VS

Ternary

MSS
Public Key
Leaves

XMSS

Merkle Tree with 27 Leaves
L-Tree
Public Key
Leaves
Height of 3
Height of 3

4. Results

Total Time to Create a Tree, then Sign and Verify One Signature

Signature Size of Each Scheme

Memory Needed to Store a Full Tree

Eight algorithms were created, the "Generated" algorithms stored only the information needed to recreate the entire tree. The "Stored" schemes used more memory to save the tree for later use. Two Raspberry Pi virtual machines were used to collect 1000 rows of data for each metric. Memory and CPU usage were also collected but no discernable difference was found.

5. Conclusion

On average, each ternary algorithm performed faster than its equivalent binary algorithm. The ternary scheme's reliance on fewer nodes shows its suitability to an IoT sensor that only needs 24 messages signed per day.

Student
Finn Bright
Supervisor
Clementine Gritti

UCA-Computer Science & Software Engineering

Automating, Monitoring and Logging in a Docker Swarm



1. Background

The University of Canterbury Computer Science Education Research (UCCSER) team is responsible for developing tools and software to help further computer science and software engineering studies at schools across the globe. One of the ways UCCSER encourages this is by providing a range of websites that both teachers and their students can use to further their learning in computer science topics both in and out of class.



2. Problem

The aim of this project was to support the development of the University of Canterbury Computer Science Education Research websites by providing an automated deployment pipeline with monitoring and log management on a Docker swarm. Automation was a key improvement to be made, as previously each update had to be deployed manually. By automating the deployments of tools and software on the UCCSER swarm the team were wanting to improve the efficiency of their deployments and reduce downtime.

There was also a need to improve the monitoring and logging processes being used. This would allow for the team to keep track of:

- 1 Logs in a centralised system
- 2 Website downtime
- 3 Alerts if/when they occur



3. Solution

Automation: Swarm Stack Updater

Automation was implemented by investigating current tools for Docker and creating an automated tool that could be run periodically on the swarm to search for and identify whether any deployed software stacks were out of date. This was built from the ground up with the idea that it could be deployed on any swarm and used to potentially update any stack that is deployed there.

Logging and Monitoring: Elastic Stack

A custom logging and monitoring stack was deployed to allow the team to view and organise their logs and common metrics as well as be alerted when any errors or issues occur. This was done by using Elastic Stack. This stack comprised of a range of tools that are deployed together to create a fully functional monitoring and logging stack as well as a range of other features.

4. Future Work

While the objectives for this project have been reached there are still some future goals that can help to develop project. One of these goals is the improvement of the Swarm Stack Updater to use Golang which is the native language that Docker is built in. By changing to this language the tool can be developed to work natively with Docker and be more efficient.



Acknowledgements



Competence & Software Engineering



COMPUTER SCIENCE EDUCATION

About

Samuel Burtenshaw

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Supervisor: Prof. Tim Bell



[1] <https://www.csfeldguide.org.nz>

[2] <https://www.codewof.co.nz>

[3] <https://www.dthm4kalako.ac.nz>

[4] <https://www.cisunplugged.org>

SICLOPS

A Deep Learning AI for the
Creation of Generalised Datasets

In collaboration with
Computer Concepts Ltd.

CCL

Problem and Proposed Solution

Instance segmentation models often combine elements of object detection (such as Ultralytic's YOLOv5) and semantic segmentation (such as U-Net models), and require a high number of quality labelled training images, costing teams time and money to establish.

A pipeline could be used to automate dataset creation; by iteratively re-training an instance segmentation model on its suitable predictions, we could create a tool to minimise the time and human interaction needed to generate these datasets.

Instance segmentation finds and labels the pixels of each instance



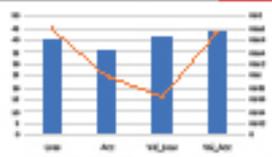
Object detector used to find the instances

Semantic segmenter used to assign pixels to instances

Additional Time-Saving Techniques

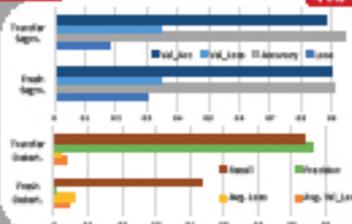
EARLY STOPPING

- Ceasing training when validation loss stopped improving provided metrics close to the original training period



TRANSFER LEARNING

- Utilising a pre-trained model provided noticeable improvements to the detector model



LABELLING STRATEGIES

- Training using both the full image and crops of instances provided better results than training on just the image's instances

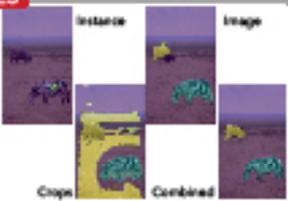
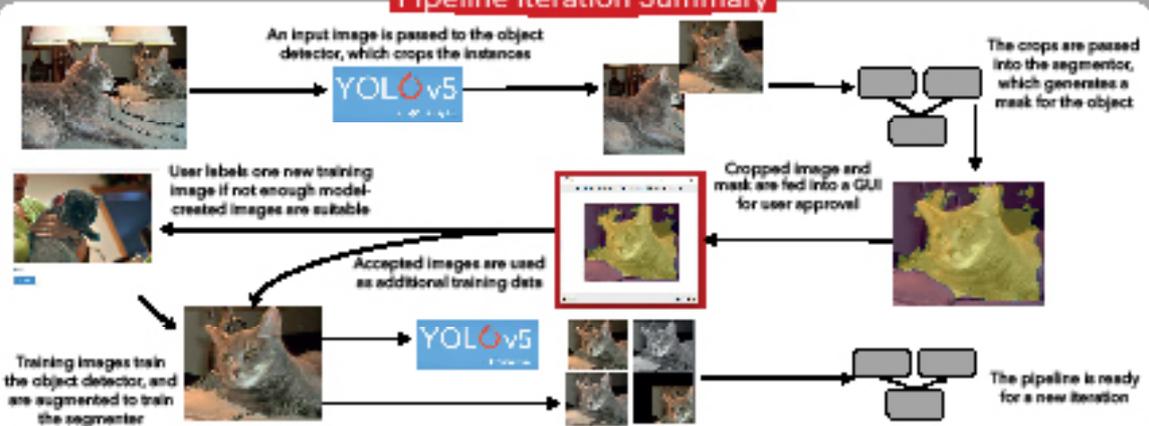


IMAGE AUGMENTATION

- Greyscaling and changing the image's translation and saturation resulted in the highest improvements to loss



Pipeline Iteration Summary



Training Results

Test Parameters

- 100 training images of cats from COCO dataset
- 100 test images of cats from COCO dataset
- Pipeline run for 5 iterations

Test Results

- Instances were detected in 87% of test images
- 95% of the instances in these images were found
- 71.74% of detected instances had suitable segmentations supplied
- The object detection model had 92.23% accuracy overall



Computer Science & Software Engineering

Knowledge and the Imagination

Industry Supervisor
Academic Supervisor

Dan Chapman
William Fulton
Fabian Gilson

MEASURING BONE HEALTH FEATURES

IMAGE SEGMENTATION WITH MINIMAL USER INTERVENTION

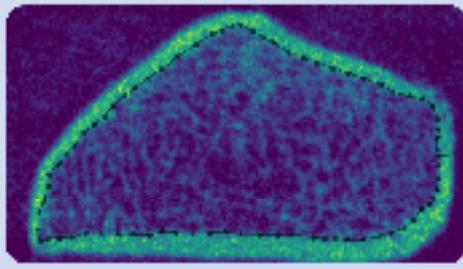


MOTIVATION

- Manual segmentation by drawing polygons can take up to several minutes per dataset.
- With this solution, the speed and accuracy of segmentation can be significantly improved.

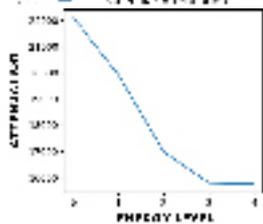
OBJECTIVES

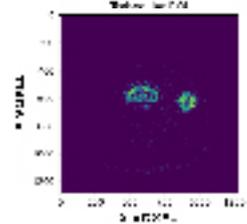
- Reduce user input required for segmentation.
- Compare different segmentation approaches.
- Reduce time taken to segment trabecular bone from CT scan slices.



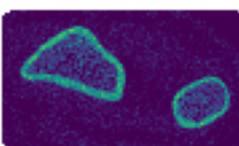
SOLUTION

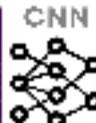
- The initial solution was to use the attenuation values of each voxel over five energy levels.
- This solution included manually selecting a trabecular region for the attenuations to be calculated from.
- Voxels within the selected trabecular regions in the other slices were within the threshold at all energy levels.





- The preferred solution was to use a range of convolutional neural network models for segmentation.
- This included creating training data, building a few models, then training the models.

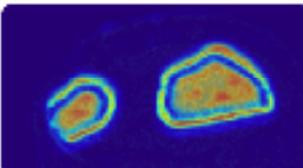






EVALUATION

- Gradient-weighted class activation mapping was used to map important regions.
- This heat-map shows the CNN's importance learning and is focusing on key features.
- The datasets used to train the models were also manually segmented by a MARS employee who used their manual regions of interest (ROIs) to calculate bone health features.
- By using the trained models to find ROIs for these datasets the bone health features could be calculated in the same way.
- By comparing these results the accuracy of the models were examined.



RESULTS

449 MODEL TRAINED RESULTS AFTER 10 EPOCHS

Model	Accuracy	Precision	Recall	F1 Score
U-Net	0.92	0.92	0.92	0.92
U-Net	0.92	0.92	0.92	0.92
U-Net	0.92	0.92	0.92	0.92

- The best ROIs are combined with the thresholding algorithm defined in the initial solution to give a range of masks like the image above.
- Using MARS Vision to measure bone health features for the ROIs was also tested.



Results are compared to other datasets with similar characteristics

Segmentation Method	Time	Accuracy	Quality
Manual	10	0.92	High
Model	1	0.92	High

- Based on the results it has been determined that the models are segmenting the trabecular region of the bone so it is easy



Computer Science &
Software Engineering

STUDENT
OLIVER CRANSHAW

INDUSTRY SPONSOR
MARS BIOMAGING

ACADEMIC SUPERVISOR
JAMES ATLAS

Scott Base seal monitoring

How to count 332 seals in two seconds using **neural networks**



Goals

-  Receive, process and store raw images from two timelapse cameras taken over the 2021-2022 Antarctica Scott Base summer
-  Machine learning processing of timelapse images to provide seal population counts per image and spatio-temporal data
-  Report findings (population counts, spatio-temporal data), opportunities and technology advice to Antarctica NZ for future monitoring

Seal CNN

Team over Nov 21 - Feb 22

A Convolutional Neural Network (CNN) is a deep learning model inspired by how our human brain is wired.

Transfer learning was successfully used to boost the model's accuracy and testing speed. While the ResNet architecture was chosen for its ability to detect small-scale & dense objects

A ResNet CNN model was developed and trained to recognise the Weddell Seal that surround Scott Base. The model was trained using a mixture of previous season images and images



The model performs well with a mAP@0.5 of 0.438 and detecting up to 300 seals in under two seconds.



332 Seals!

Snowstorm CNN

Snowstorms are common in Antarctica and affect the visibility of the surveying cameras. Images with reduced visibility affect the performance of the Seal CNN and result in low counts.

These false counts can be identified by a second CNN that recognises images of snowstorms.



A ResNet model was trained using 2018-2020 data and achieves a 97.8% accuracy and a F1 score of 97.5%.



Findings

Analysis

A maximum number of 332 Seals were detected with a 30% threshold.

By calculating the Fourier Transform on the seal counts, the temporal frequency was isolated i.e. one cycle per day.

Advice

The latest images have poor composition with the Scott Base only consuming a small amount of the frame. A combination of optical zoom and camera repositioning should take place to increase the details captured of the seals, therefore better distinguishing or over-apping seas.

The cameras should also avoid shooting in a RAW format to minimise pre-processing.



Computer Science & Software Engineering



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3D Reconstructions of Tumour Resections Using Cross Sectional Images



Computer Science & Software Engineering

Mitchell Freeman

Supervisor: Ramakrishnan Mukundan

Background

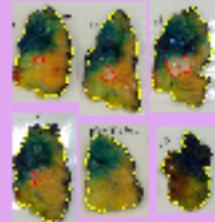
Physical resections of tumours are traditionally stored as cross-sectional slices in glass slides for histopathological examination. Recent technological advances in the field of digital pathology have made it possible to obtain high-resolution whole slide images (WSIs) of tissue specimens. 3D reconstruction of these resections into a three-dimensional view will allow pathologists and surgeons to use information such as extents of surgical margins in different directions useful for diagnosis and treatment. This project aims to develop and evaluate methods for three-dimensional reconstruction of tumour resections from images of breast conserving surgery specimens.

Objectives

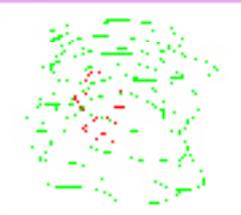
The main objective of this project is to develop a method for reconstructing and rendering three-dimensional mesh surfaces representing a tumour resection using only a few images of cross-sectional slices. Four different feature methods of spline interpolation were considered. The first was 2D multi-frame splines. This provides a simple method for a non-linear method. It is possible to generate a mesh using the results of the spline. A surface of the spline Cardinal splines, provides a third parameter to alter the resulting spline. This spline has a control volume that controls how wide the curve is near the control points. Another method is Kochanek-Bartels splines, which provide three parameters, tension, continuity, and bias. Tension is equivalent to a Cardinal spline's control volume. Bias controls how near a control point is to the curve. And continuity controls how smooth the spline is.

Process

Initially 3D reconstructions were made using gradient-based methods, could be created for point correspondence and to compare and evaluate the different types of splines. The goal was to find that Kochanek-Bartels splines were most useful for creating 3D reconstructions from sparse data, since this was done real world data was used.



Cross sectional images (shown from left to right) are annotated by a pathologist outlining the sections of interest. The tumour and the corresponding slices.



The individual whole slide images are converted into a 2D mesh. Each way of process are are stacked on top of each other.

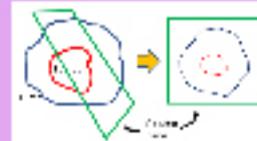


The stacked layers are connected together using Kochanek-Bartels splines using parameters like tension (2.0), bias (0), continuity (0.02).

1. <http://www.kochanek.com/kochanek-bartels-splines.html>

Ongoing Work

The resulting 3D reconstructions are currently being presented to a pathologist for review and subjective evaluation to determine accuracy. Additionally, a method for locating the cross-sectional slices from a reconstruction using a rotating plane is being developed. This will allow pathologists to visualize surgical margins from any angle.



Future Work

There are still multiple areas that can be worked on to extend the current method. One of the main pathologists needs to manually annotate the whole slice images. This process would be improved by being able to automatically select regions of interest with only a few annotations. Another improvement would be supporting multiple nested regions of interest. When looking at whole slide images of breast tumour samples, the regions of interest are the tumour and the tissue around the tumour. This method would be useful in different disciplines. A likely more regions would be required. To do this, the method would need to correlate contours between layers, likely using a pairwise distance comparison.

UNDERWATER BLUE LIGHT (BIFI) COMMS FOR UNDERWATER DRONES



Background

- Autonomous Underwater Drones are in development at the University of Canterbury as part of the MBIE SFTI Precision Farming Technology for Aquaculture project.
- A communication protocol is being developed to allow the drones to send video data back to an operator on the surface.
- An existing protocol (BIFI) uses blue LEDs to transmit/receive data underwater.

Objectives

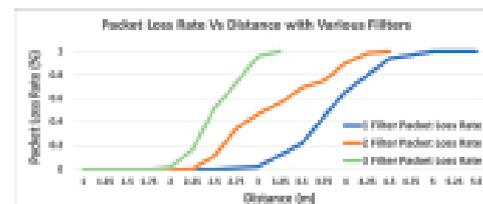
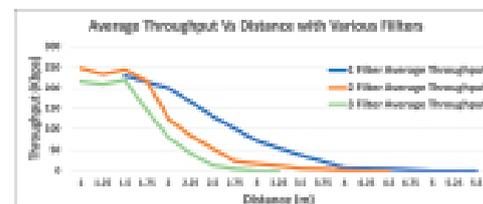
- Make the delivery of the video data more robust by extending the existing BIFI protocol to implement medium access control and link layer protocols to support standard error discovery and repair.
- Test the protocol at a range of distance and levels of interference to determine its performance in regards to packet loss and throughput

Solution

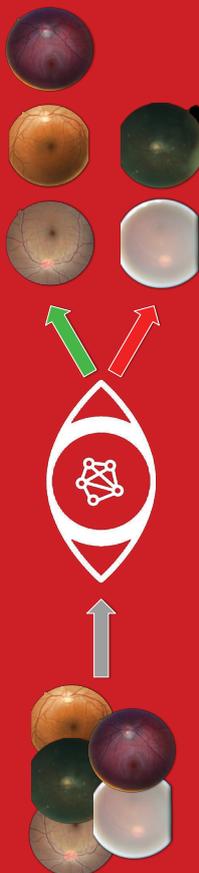
- The proposed solution uses a combination of the Selective Repeat ARQ protocol and ALOHA protocol to increase robustness to errors.
- Selective Repeat ARQ introduces retransmissions for packets that were damaged or lost in transmission increasing reliability as data is less likely to be truly lost.
- The ALOHA protocol introduces a short random backoff after failed transmissions which decreases the chances of a subsequent transmission also failing.

Results

- The protocol was tested above water as the equipment is not waterproof. Paper filters were used in place of water to simulate turbidity (the scattering of light in water).
- Tests were performed with 1, 2, and 3 paper filters to simulate various levels of turbidity, with more filters representing murkier water.
- The below graphs show the performance of the protocol in terms of average throughput (how much data is delivered per second) and packet loss rate (packets lost even after a number of retransmissions)



Deep Learning for Retinal Image Quality Assurance



Deep neural network can provide real-time result for retinal image quality assessment.

There are no useful dataset for the neural network to learn, so we created a labelling platform

Take a picture to view the full paper



Deep Learning for Retinal Image Quality Assurance

We created two convolutional neural network assess the quality of retina images

Convolutional network architecture:

- VGG16
 - Trained from scratch & transfer learning
 - Batch size 16/8
- EfficientNetB4
 - Transfer learning
 - Batch size 8

Platform:

- Web app:



- Android (apk):



Dataset:

- Training: Private dataset from collaboration between University of Otago and Canterbury District Health Board
- Testing: DRIMDB

Result:

VGG16 Large:

	precision	recall	f1-score	support
0	0.98	0.93	0.95	1786
1	0.93	0.97	0.95	1583
accuracy			0.95	3369
macro avg	0.95	0.95	0.95	3369
weighted avg	0.95	0.95	0.95	3386

VGG16 small:

	precision	recall	f1-score	support
0	0.93	0.52	0.67	1786
1	0.64	0.96	0.77	1583
accuracy			0.73	3369
macro avg	0.79	0.74	0.72	3369
weighted avg	0.8	0.73	0.72	3386

EfficientNetB4:

	precision	recall	f1-score	support
0	0.98	0.65	0.78	1786
1	0.72	0.99	0.83	1583
accuracy			0.81	3369
macro avg	0.85	0.82	0.81	3369
weighted avg	0.86	0.81	0.81	3386

Author: Nathan Huynh
Supervisor: Andrew Bainbridge-Smith





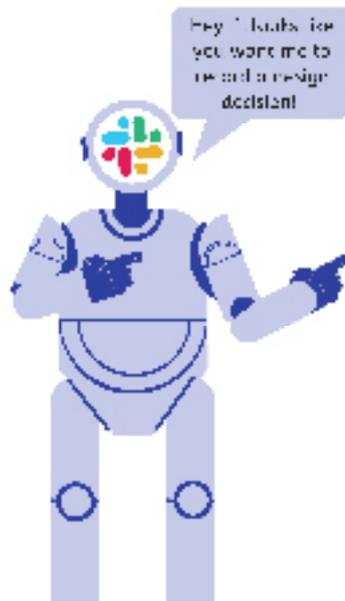
Computer Science & Software Engineering

Recording Design Decision in Slack

Student: Zachary Kaya Supervisor: Dr Fabian Gilson

1 Problem

In agile software development, design decisions are often **secretly** documented or **not documented** at all.

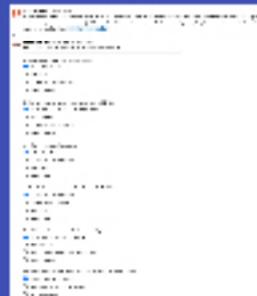


2 Solution

Messages sent by developers in **Slack** can **contain** valuable rationale and design **decisions**.

Therefore, the current **solution** is a **Slack bot** that **records** design **decisions**. The Slack bot prototype:

- **stores** recorded design decisions in a **MariaDB** database
- allows **searching** and **editing** of decisions
- **outputs** recorded decisions to a linked **GitLab** **wiki**
- can be used in **multiple** Slack **workspaces**
- **classifies** design **decisions** based on the **WH(Y)** model



3 Evaluation Preliminary findings from a **user study** include:

- The **accuracy** of the **classifications** made by the bot can be **improved** using the **recorded** design **decisions** from the **user study** as a **training set**.
- It is somewhat **easy** to **record** and **search** decisions. However, it is more **difficult** to manually **classify** design **decisions**.
- The presence of the Slack bot **may encourage** users to **document more** design **decisions**, with recorded **decisions** being of **high quality** i.e. they provide sufficient context and details.



Computer Science & Software Engineering



Tech Stack



Learn More



AUTOMATED 360° PHOTO TOURS WITH VSLAM

JOSEPH KELLY

Supervisors: Dr. Fabian Gilson (UC CSSE); Sam Houghton, Stephen Witherden, Heath Simone (Beca, Industry Partner)

PROBLEM

FACILITYVIEWER, a digital twin platform developed by Beca, helps owners and managers of manufacturing and utilities facilities get easy access to the data they need to make better decisions about their assets.

An important part of this is the contextualisation of assets using 360-degree photo virtual tours. After visiting a site and taking a series of 360-degree images, someone must manually enter the locations of the images on a 2D map - a significant time cost.

OBJECTIVES

- 1 Identify the relative 3D location of 360° photos of a facility using VSLAM
- 2 Automatically place geotags between photos in a 360° tour of a facility
- 3 Automatically generate a "mini-map" image and mark the location of each 360° image on a map of a facility.

SOLUTION

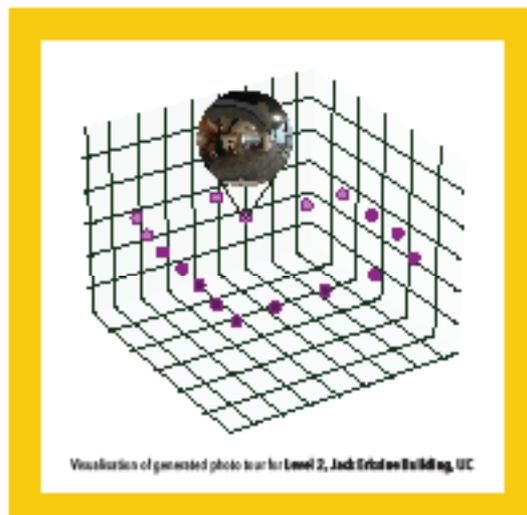
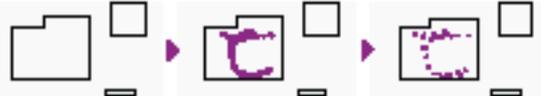


RESULTS

Photo tour generation with indoor-to-outdoor environment change and multiple overlaps



Photo tour generation with indoor environment light-on to light-off lighting change



Visualization of generated photo tour for Level 2, Jack Ertel Building, UC



Computer Science & Software Engineering



GAMIFIED SCRUM RETROSPECTIVES

BACKGROUND

Gamification in education aims to enhance student performance by utilizing game mechanics and elements in learning activities.

Scrum retrospectives are used in software projects to reflect on work completed and make improvements for future work.

This study aims to assess the viability of a collaborative gamified retrospective tool in software development education.

OBJECTIVES

Identify suitable game elements that foster motivation and engagement in a collaborative environment.

Design and implement a scrum retrospective game using the previously identified game elements.

Evaluate the game in an educational context by trialling with undergraduate software engineering students.

APPLICATION



Individuals earn points for submitting answers to questions.



Team members collaborate to categorize their answers.



Individuals points are combined to give a team score to compete with other teams on the leaderboard

RESULTS

Scores, awards, avatars, leaderboards and progress bars are the most common game elements used in gamification.

Teams, collective scoring and inter-team competition stand out as key elements that promote collaboration.

CONCLUSION

Gamification can provide a more engaging and motivating environment than traditional learning.

Promoting collaboration is most effectively achieved through elements such as team play, collective scoring and inter team competition.

 **Computer Science & Software Engineering**

Student
Seth Kingsbury

Supervisor
Miguel Morales

DTHM for kaiako

Event Registrations Management

Hayley Krippner | Supervised by Prof. Tim Bell

Context

DTHM4Kaiako is a website designed for **Digital Technologies and Hangarau Matihiko** in the central and southern teachers in NZ.

Its Events section addresses **professional development** events for these educators.

Motivation

DTHM event organisers need to efficiently manage event registrations.

Why a custom solution?

- A future goal is for registration systems to contain complex structured custom event session questions. A strong yet flexible foundation is needed for this.
- Partnering with registration management software does not provide suitable customisation.
- Having participant data self-contained within the website allows for **streamlining** the registration process by auto-filling registrations.

Solution

Within DTHM4Kaiako's Events section:

- Events and event registrations management system** for event organisers was created.
- Registration forms** were designed. Educators can view and update these forms, and even withdraw completely from events themselves.

Evaluation

A **think-aloud study** via Zoom was conducted to assess if:

- the registrations management system contains the core actions and these could be executed efficiently
- the registration process was streamlined

5 EDUCATORS experienced in organising events were interviewed

9 HOURS of interview video recordings of the tasks required were analysed.

Outcomes

- 100%** of participants felt that the registrations management system enabled them to conduct their tasks efficiently and all core actions were present.
- 100%** of participants felt that the registration process was quick.
- 80%** of participants made suggestions to improve the user interface.

Computer Science & Software Engineering

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 Prof. Tim Bell: tim.bell@canterbury.ac.nz
 Website: www.dthm4kaiako.ac.nz

Query Competition (QC)

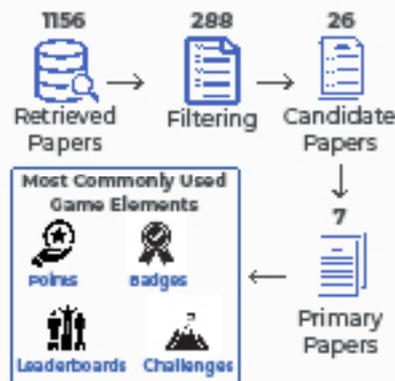
Gamification in Educational and Industrial Contexts: Play & Learn

Background

- QC is a newly developed SQL learning platform for students to compete in tournaments answering SQL queries.
- **Gamification** is the application of **game-based elements** in **non-game contexts**.
- Gamification has become popular in all areas of education.
- There is a **lack of empirical evidence** hindering its acceptance as an effective learning and teaching strategy.

Objectives

- **Identify** commonly used **game elements** in CSSE education.
- **Extend** QC to include identified game elements.
- **Understand** the impact game-based elements have on students learning SQL in **three different environments** (Normal, Gamified, and Competitive).

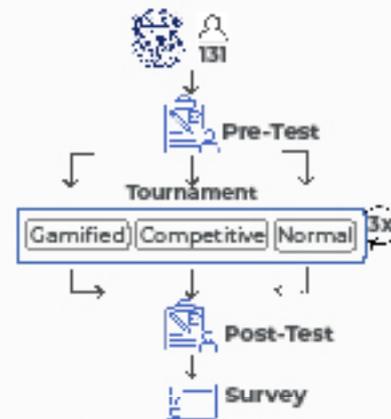


Systematic Literature Review

Method



Development



Empirical Study

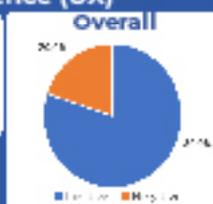
Results

User Experience (UX)

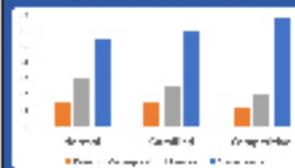
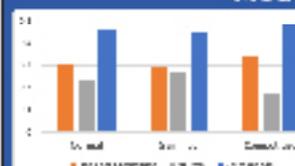
	Positive	Negative
Normal	72.73%	27.27%
Gamified	68.58%	31.42%
Competitive	65.29%	34.71%

Sentiment Analysis of participants' feedback

*"Very good, it is like a game."
"I liked it a lot, it would be useful for other courses too."
"I liked this activity, I could apply all I have learned during the course."*



Motivation



Conclusion

The use of QC resulted in a highly positive UX and an improvement in student motivation.

- The most commonly used gamification elements in CSSE education were identified.
- QC was validated using 131 participants from the Universidad Nacional Autónoma de México.
- The study isolated three different environments allowing an individual comparison between game elements.
- No significant differences in performance were found.



Computer Science & Software Engineering

Edward Langlands
Supervisor: Dr. Miguel Morales Trujillo



Universidad Nacional Autónoma de México



QUESTION TRACKING SYSTEM FOR MOODLE

Computer Science & Software Engineering

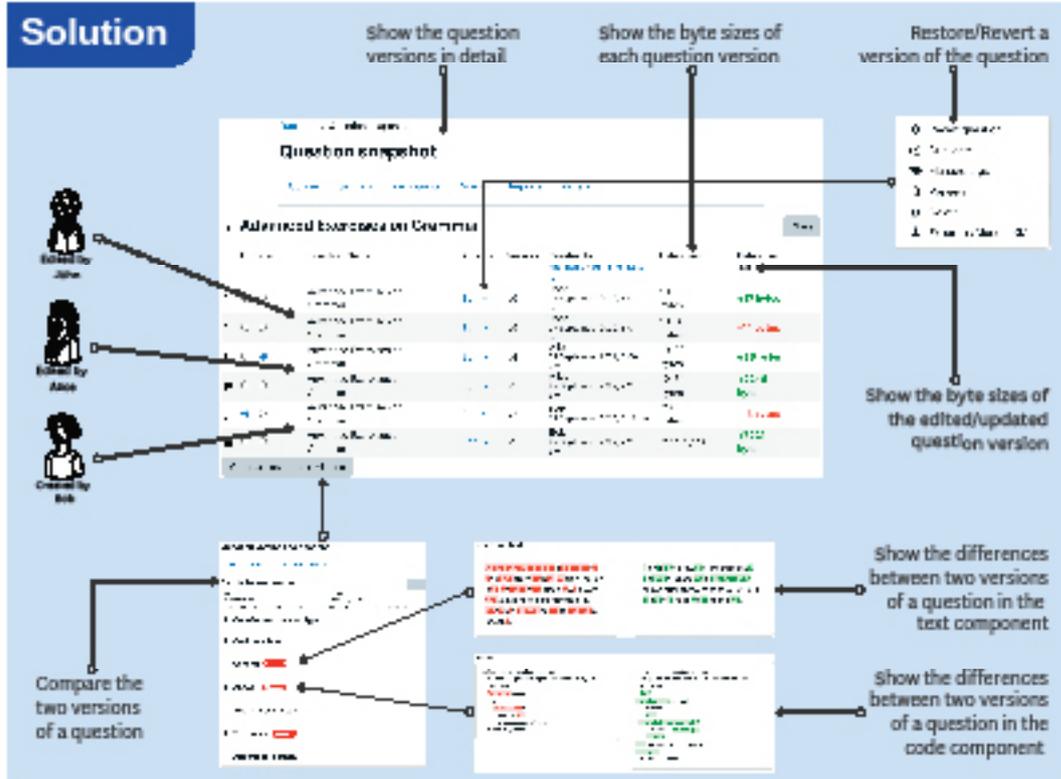
Motivation

• Moodle is a web-based learning content management system, used at the University of Canterbury. It has a question bank system where teachers can create and edit questions. However, the existing question bank system does not have the ability to trace question history, which results in confusion sometimes, especially when tracking historical changes of the question.

Objective

- Teachers can track all historical versions of a question.
- Teachers can restore/revert a version of a question.
- Teachers can compare two versions of a question.

Solution



Result

- The following data is from 6 lectures/tutors' evaluations:
 - 66.7% of the users think this Question tracking system is very useful.
 - 33.3% of the users think this Question tracking system is sometimes useful.
 - The most popular feature is "Compare two versions of a question".

Future Work

- A further step would be to enhance the feature that allows the user to compare two versions of a question. First, comparisons for a wider range of questions can be provided. Next, the algorithms for text comparison can be refined to improve their accuracy.

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Tech Stack



BARRACUDA

Connor Macdonald

Supervisors

Fabian Gilson
Phillip Duncan-Gelder

Problem

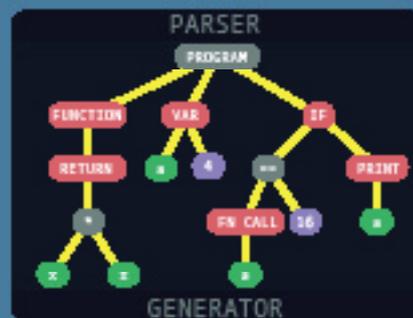
Currently to leverage the GPU, researchers must either write in a low level language such as C, a task which is difficult for those who are not native programmers, or use a domain specific API that may not be versatile enough. This impedes the speed at which research is conducted and can create an unnecessary barrier to entry, especially for work in unrelated domains.

```

1 fn square(x) {
2   return x * x;
3 }
4 let a = 4;
5 if square(a) == 16 {
6   print a;
7 }
    
```

Solution

Barracuda is a high level language designed to be run and executed on the GPU. Being a high level language it is able to offer a simple model for writing and running code on a GPU. The language tools aims to provide researchers with minimal barriers when conducting research. Additionally the toolkit has been written to allow simulation framework developers an easy user scripting language to hook into their models.



How

The Barracuda compiler parses source code into an intermediate representation called an Abstract Syntax Tree. This tree is then traversed by the generator to form the low level bytecode instructions that are interperable by the Barracuda virtual stack machine. The bytecode can then be run in parallel on GPU cores running the virtual machine.



Computer Science &
Software Engineering

ENVIRONMENTAL DATA VISUALISATION TOOL

MOTIVATION

- We live in a **data rich world**, where often, access is **technical**.
- With open access comes more **innovation**.
- Currently no **simple way** for general users to **visualise** Envlib's wealth of data.

OBJECTIVES

- A **correct and accurate** visualisation of data provided by Envlib.
- A **filter system** for accessing different times, heights and locations to look at particular weather events.
- Access to **alternative / multiple datasets** provided by Envlib.

xarray | www.envlib.org | tethysts.readthedocs.io

SOLUTION

- Custom API layer that **preprocesses data** from Envlib (tethysts), enabling customised outputs better suited to geographic representation across time.
- A **traversable map** through all dimensions. Lat, Lon, Height, and Time.
- Multiple **visualisation methods**. A heatmap for most data and a wind speed / direction vector layer for wind data.
- Multiple **available datasets** for visualisation.
- All of these to bridge the gap between complex data and simplicity through visualisation.

FUTURE

- Additional datasets.
- Host online for all to access.
- Additional layers for visualisation.
- Rework filter system for more clarity.
- Additional computed parameters like a fire weather index.

Computer Science & Software Engineering

STUDENT
Darcy Maddren

SUPERVISORS
Assoc. Ben Adams, Marwan Katurji, Jaiwei Zhang

Post-Quantum Datagram Transport Layer Security

Background

Quantum computing is a threat to the current status quo of secure cryptographic communication. It is known that once quantum computers become widely available in the not-so-distant future that the current communication protocols will no longer be acceptable.



One affected scheme is the Datagram Transport Layer Security (DTLS) protocol which is commonly used within Internet of Things (IoT) devices.

Objectives

Prior research has identified that of the existing post-quantum cryptographic schemes, there is significant increases in one or more of computational, memory, or communication costs when compared to traditional schemes

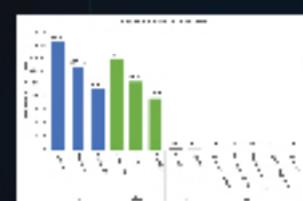
Investigate:

- Post-Quantum Digital Signature Schemes
- Post-Quantum Key Encapsulation Mechanisms
- The computational, storage, and communication costs on IoT devices when using these schemes
- A fully post-quantum implementation of the DTLS 1.3 protocol.

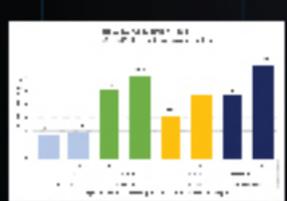
Results



Dilithium and Kyber were selected as the best digital signature and key encapsulation mechanism respectively due to excellent performance in signing, verification, and key exchange, all while being small in terms of storage size.



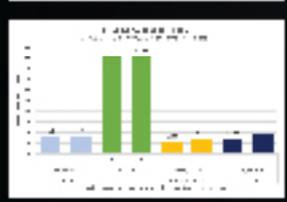
Computational costs are significantly less when using the Dilithium + Kyber post-quantum scheme, however this is offset by the additional memory required.



Connection times are slightly increased when using the post-quantum scheme compared to traditional RSA and ECDHE without client side authentication.

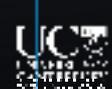


The usage of the post-quantum digital signature scheme, Dilithium, during the handshake results in a significant increase in the amount of packets sent to establish a connection.



Surprisingly, with client authentication, connection times are significantly faster when using the post-quantum DTLS 1.3 protocol.

Callum McLoughlin, Dr. Clémentine Gritti



Computer Science & Software Engineering

Software Quality Tools in the Wild

Michael Morgoun
Supervised by Miguel Morales

Context

Software quality is a crucial factor in the development of software. It can impact not only the functional use of software but also the satisfaction of its users and the longevity it has as a product.

The usage of tools is one of many ways of measuring/improving software quality and yet there is a lack of empirical research done on software quality tools in the industry.

Research Questions

RQ1 - What are the most popular software quality tools in the industry?
RQ2 - How do software practitioners define software quality?
RQ3 - What metrics do software practitioners use to measure/assess the quality of what they're developing?

Method

Interviews

Semi-structured interviews would give qualitative answers which would provide a deeper insight into the perspective of the interviewee.

Interviews were to target experienced software practitioners working in the industry with at least a few years of experience.

Survey

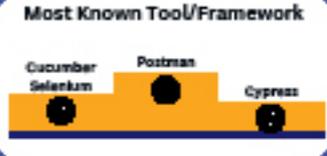
Instead of qualitative answers, surveys would give mostly quantitative answers.

Surveys were to target any software practitioner that had any experience in the industry.



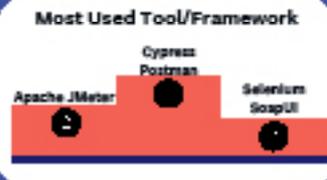
Results

Most Known Tool/Framework



According to the survey, the most known tool was Postman, 2nd was a tie between Cucumber and Selenium followed by Cypress.

Most Used Tool/Framework



The most used tools was found to be a tie between Cypress and Postman in 1st place, 2nd was Apache JMeter and third was another tie between Selenium and SoapUI

Testing-related tools/frameworks were found to be the most common genre of tools being used. This is opposed to other genres such as management. The interviews showed that almost all participants used Jira and yet the surveys didn't express the same popularity.

"It definitely is a quality tool. It's not something that I would traditionally have associated with it, but it's part of that whole development workflow" - Interviewee

Software Quality Attribute Word Cloud



All of those interviewed were asked for the most important software quality attribute through the perspective of a developer, a company executive and a user. It was found that overall the perceived most important software attribute was both maintainability and reliability.

"I've worked in this codebase for probably five years and for me it's really important that it's a nice place to work because I live in this code base every day." - Interviewee

UC
UNIVERSITY OF CALIFORNIA
SAN DIEGO

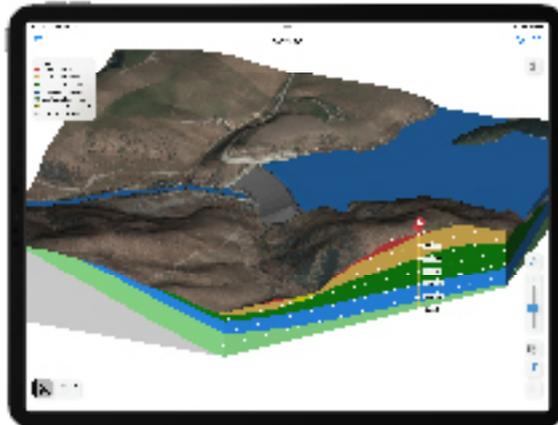
Computer Science & Software Engineering

Student projects: Computer Science & Software Engineering



SEEQUENT SITEVIZ GEOLOGY IN-SITU

Rio Ogiño



THE PROBLEM

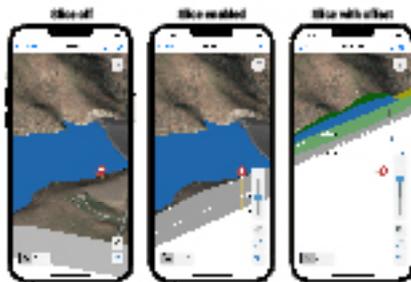
Although geoscientists have powerful geologic modelling tools, they typically have no way of bringing these models to the field other than through paper 2D cross-sections.

Seequent Siteviz attempts to solve this by giving users access to interactive 3D models of their existing Leapfrog models on their iPhone or iPad.

By taking advantage of the on-board and accessory sensors, Siteviz is able to provide users with the most relevant and accurate representation of the scene.

This not only makes models more approachable and understandable to geoscientists, but also for other on-site stakeholders such as landowners or managers who may have a limited understanding of geology.

FEATURES



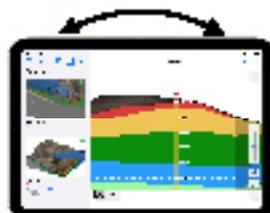
SLICE

Slicing is the most fundamental feature of Siteviz, giving you the ability to create a vertical cross-section central around your current position and heading and visualize the geology beneath your feet.

Compared to PDFs or paper printouts that can only be pre-rendered at a few specific positions and two dips, Siteviz provides access to more relevant and accurate cross-sections.

SLICE OFFSET

Push or pull the slice plane forwards or backwards, giving you the ability to visualize inaccessible geology, such as mining pits or cliffs. When enabled, the cross-section's orientation is locked, preventing accidental rotation from occurring.



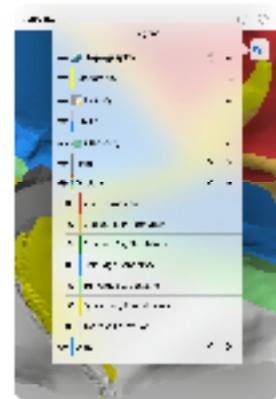
LOCK ON SLICE

When enabled, the scene follows the rotation of your iPhone or iPad, giving you the most relevant view of the scene at the geology directly below and in front of you.



FIXED LEGENDS

Fixed legends to provide persistent access to one or more legend groups, ensuring you never forget what each colour represents.



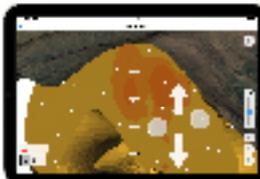
LEGENDS

View legend information with the ability to expand and collapse sections and selectively hide elements in the scene, allowing you to focus on only what is currently important to you.



PAN AND ZOOM

Push with two fingers to zoom in and out, or move both fingers together to pan around the scene, giving you the ability to view deeper geology and pinpoint exact location depths.



VERTICAL SCALE

Stretch the vertical axis to exaggerate gradients and increase the distance between locations, making visualisation much easier in flat areas or in large but shallow models.



PRECISION GNSS WITH TRIMBLE

When connected to a Trimble GNSS or other supported device through the Trimble mobile interface, Siteviz is able to determine your position to an accuracy of up to 2cm.

*Requires Trimble Central subscription



CENTRAL

Integrate with Seequent Central, giving users access to their existing Leapfrog models on their iPhone or iPad.



COORDINATE SYSTEM SUPPORT

Siteviz uses the ESRI library to provide support for thousands of projected coordinate systems, providing geoscientists and other professionals the flexibility they need.



OFFLINE ACCESS

Siteviz automatically downloads any scenes you open, giving you access to the same data in the field, even in remote work sites without Wi-Fi or cellular service.

FUTURE WORK

Future work lies in two main categories: feature parity with Seequent Central's web-based views; and the addition of unique features that take advantage of the mobility and sensors available in a mobile device.

The former includes support for more Leapfrog elements and editing features such as transparency, fill hole labels and rulers.

The latter may include features such as geotagged annotations and photos, public scenes accessible through links and QR codes, and predictive vertical positioning when connected to an external GNSS unit.

ACKNOWLEDGEMENTS



Staff Supervisor: Fabian Gilson



Project Supervisor: Tim Schurr
Senior Developer: David Knight



DIFFERENTIAL PRIVACY TOOLS FOR SMART CONTRACTS

MOTIVATION

- There does not exist a way to securely and anonymously view differentially private summary statistics for data stored in Smart Contracts on a blockchain.
- Current differential privacy solutions exist for Smart Contracts on Ethereum, which has a public ledger.
- The Secret Network provides a way for encrypted on-chain data to be decrypted and operated on without being revealed to validators and the public.



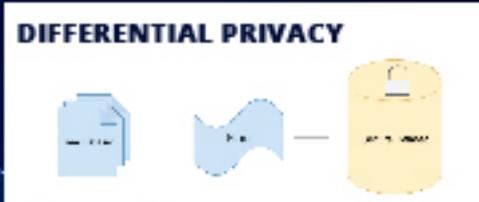
SMART CONTRACTS



OBJECTIVES

- Implement differential privacy algorithms for Smart Contracts on the Secret Network.
- Build a frontend web application so users can view differentially private summary statistics for data stored in Secret Contracts.

DIFFERENTIAL PRIVACY



FINAL SOLUTION

Model and Backend

- The Substrate fixed Rust library was used to represent real numbers as fixed-point numbers. These were converted to strings and stored as bytes.
- An entropy pool of bytes was used to build a secure random number generator.
- The Laplace Mechanism produces a noisy number.
- Functions were created to get the differentially private mean and count for data stored in the Smart Contract.

Web Application

- A frontend web application was created. Users can view differentially private count and mean statistics, for data stored in the Secret Contract.
- Users connect their Keplr wallet so they can interact with the application.
- Users can input data into the Secret Contract using this application.







Computer Science & Software Engineering

STUDENT
KYE OLDHAM

SUPERVISOR
BEN ADAMS

TECH STACK



Automated Extraction of Jumping Spider Behaviour from Experiment Footage

Motivation

Biologists in our School of Biological Sciences are currently studying the behaviour of jumping spiders. This can be applied to other invertebrate, spider, beetle or the vision to other, more complex predators.

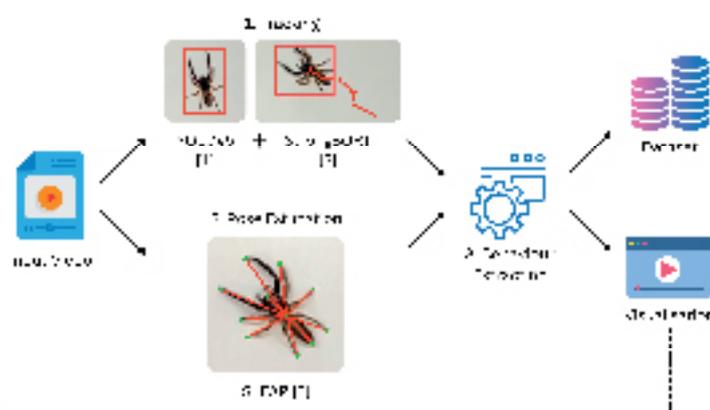
The research involves choice test experiments, with one predator and two targeted null.

Manually reviewing footage of these experiments is a time-consuming process as it involves watching every instance of the behavioural features the researchers wish to study.

Objectives

- Develop a system to automatically perform tracking and pose estimation of jumping spiders using experiment footage.
- Use this information to detect and record the phases of spider behaviour that researchers regularly study.

System Flow Diagram



Approach

- Step 1**
A YOLOv5 object detection network and the Segment Anything Model [2] are used to identify the spider in the video.
- Step 2**
A registration of the spider from the SDF [3] framework is used to extract the locations of key points on the spider's body.
- Step 3**
Between frames, using point-to-point distance, the spider's position is tracked (typically 30 FPS).

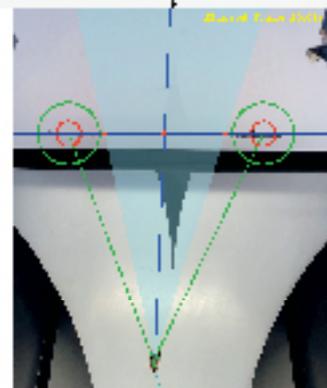
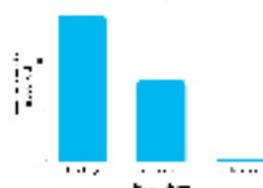
Results

The system is able to detect and track the spider in the video.

- The distance between the spider's body points is tracked.
- The spider's jump height is tracked.
- The spider's jump velocity is tracked.
- The spider's jump duration is tracked.
- The spider's jump frequency is tracked.

The system can be used to track the spider's position in the video. The system can be used to track the spider's position in the video.

Results of the spider's position in the video.



Student projects: Computer Science & Software Engineering

ARCHITECTURE & SAFETY FRAMEWORK FOR UAV FORMATIONS

Background

The capabilities and usage of drones is greatly increasing as the technology improves, which offers many opportunities for using them in a wide range of applications. However, the increased use of drones also brings a number of safety concerns, such as collisions, loss of control, and interference with other aircraft. **Ensuring safe and effective flight formations is a key challenge in the development of UAV systems.** This project aims to develop a safety framework for UAV formations that can be used to design and implement safe flight formations that meet the requirements for a given mission, scenario, and environment.

Needs

The solution must be able to generate safe flight formations that can be used to design and implement safe flight formations that meet the requirements for a given mission, scenario, and environment. The solution must be able to generate safe flight formations that can be used to design and implement safe flight formations that meet the requirements for a given mission, scenario, and environment. **The solution must be able to generate safe flight formations that can be used to design and implement safe flight formations that meet the requirements for a given mission, scenario, and environment.**

Challenges

One of the main challenges in the development of UAV formations is the need to ensure that the formations are safe and effective. This is a complex task that requires a deep understanding of the underlying physics and the capabilities of the UAVs. **Another challenge is the need to ensure that the formations are able to adapt to changing conditions in the environment.** This is a complex task that requires a deep understanding of the underlying physics and the capabilities of the UAVs.

Approach

The approach for this project is to develop a safety framework for UAV formations that can be used to design and implement safe flight formations that meet the requirements for a given mission, scenario, and environment. **The approach for this project is to develop a safety framework for UAV formations that can be used to design and implement safe flight formations that meet the requirements for a given mission, scenario, and environment.**

Collision Avoidance

Collision avoidance is a key safety requirement for UAV formations. This is a complex task that requires a deep understanding of the underlying physics and the capabilities of the UAVs. **Another challenge is the need to ensure that the formations are able to adapt to changing conditions in the environment.** This is a complex task that requires a deep understanding of the underlying physics and the capabilities of the UAVs.

Another key requirement for UAV formations is the need to ensure that the formations are able to adapt to changing conditions in the environment. This is a complex task that requires a deep understanding of the underlying physics and the capabilities of the UAVs. **Another challenge is the need to ensure that the formations are able to adapt to changing conditions in the environment.** This is a complex task that requires a deep understanding of the underlying physics and the capabilities of the UAVs.

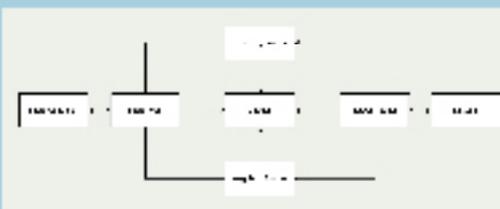
Objectives

- Develop a safety framework for UAV formations that can be used to design and implement safe flight formations that meet the requirements for a given mission, scenario, and environment.
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- Develop a safety framework for UAV formations that can be used to design and implement safe flight formations that meet the requirements for a given mission, scenario, and environment.

Architecture

The architecture for this project is to develop a safety framework for UAV formations that can be used to design and implement safe flight formations that meet the requirements for a given mission, scenario, and environment. **The architecture for this project is to develop a safety framework for UAV formations that can be used to design and implement safe flight formations that meet the requirements for a given mission, scenario, and environment.**

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CameraX

Next Generation of Field Capture

Background

- Trimble supplies instruments that are equipped with high-end camera, IMU sensor and GPS antenna for photogrammetry.
- The technologies provide great customer experience, but new simplified workflow could be explored.
- Trimble believes this technology can provide new customer value unexplored by the market until now.

Objectives

- Automate the image capturing process for photogrammetry.
- Automate the data gathering process for photogrammetry.
- Allow users to control the camera parameters to adjust the image quality.
- Make the image capturing process user-friendly.

Solution

As the solution, an android application has been developed. This application has a user friendly User Interface which allows the user to capture high quality images with device location and orientation tagging in the background.

Camera
Auto Capture. Focus. ISO. Shutter Speed. Metering.

Location
Longitude. Latitude. Altitude. Accuracy.

Orientation
Yaw. Pitch. Roll.

xmp™

Resulting Point Cloud

Result

Response from 4 Trimble employees who tested the app :

- App felt easy to use
- Easy to understand UI, not much setup needed.
- Straight forward to use, camera feed is smooth and clear.
- Cool app, super easy to use and functional.
- Simple UI, no lengthy set up process.
- Makes gathering images easy.
- Room for improvement to make the UI more intuitive.

UC
UNIVERSITY OF
CANTERBURY

Computer Science &
Software Engineering

Nitish Singh Supervised by Fabian Gilson

Industry Sponsor: Trimble

Product Owners: Stuart Ralston
Guillaume Clin

DRONE CATKIN HARVESTING

Eric Song supervised by Sam Schofield and Prof. Richard Green

How to harvest from 20m tall trees? Drones! (And some software)

P. Radiata pines form catkins harvested for pollen. But manual harvesting is slow, and can't reach most of the catkins on adult pines. Could we use unmanned drones to harvest catkins from any pine, no matter how tall?




P. Radiata Catkins DJI Matrice 300 RTK

OBJECTIVES

- Detect and track multiple catkins reliably in real-time (15fps)
- Guide pruning drone to catkins*
- Use only onboard Intel NUC computer + D435 depth camera

*Without crashing the drone, pruning off people's legs etc.

METHOD

1. DETECT

Efficient YOLOv5-nano neural network.

Trained with 210 training and 70 validation images: 3,867 catkins total.

Custom augmentation reduces false positives by superimposing objects:




2. TRACK

KLT tracker matches corner points (green) to track while moving.

Perspective transform calculated each frame with RANSAC to remove outliers (red).

YOLOv5 detections matched with tracker predictions.

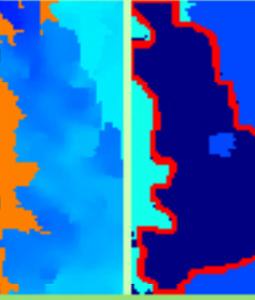


3. LOCALISE

Remove background from depth image for 'true' depth of catkin.

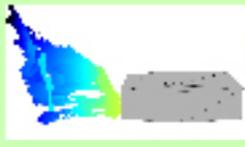
Meanshift algorithm clusters depth image. Novel optimization with prefix sum + binary search.

Remove small and concave regions from clustering.



4. GUIDE

Straight-line path to catkin, check pointcloud to avoid collisions



RESULTS

- 82% of catkins detected
mAP of 0.87 - misses small or dark catkins
- Accurate to 1.2mm
1.2mm RMSD within 1200mm distance. Significant camera error past 1200mm. All detections successfully tracked at 1m/s
- Single catkins pruned
Thick needles hinder sustained cutting reliability




FUTURE WORK

- Detect optimal cut point to avoid needles
- Improve performance in dark conditions
- More powerful hardware e.g. Nvidia Jetson with higher resolutions
- Tree detection or GPS to approach P. Radiata from long distances



Computer Science & Software Engineering

Networking Protocol for Autonomous UAV Formations

Niko Tainui, Caleb Sim, Nicholas Varley, Simon Wallace Blakely, Jiong-Kiao Guo

1. Context:

UAVs are highly mobile tools that are rapidly gaining popularity in situations where the environment is dangerous or difficult to gain access to. Drone formations provide an even greater functionality in these areas due to the greater area of control provided. There are many applications where this is useful such as search and rescue operations, wildlife surveillance and insect tracking.

A method of communication with the drone formation is required to control the drones autonomously.

2. Objectives:

The communication method needs to supply all drones with the target location set by the user. The method must also ensure the drones know each others position to avoid collisions. These objectives need to be met with a certain level of quality, especially the position updates.

Issues to overcome:

- **Information Loss:** The formation needs to be able to continue operation when information doesn't get received by a particular drone or ensure all drones get the information needed.
- **Latency:** The drone needs to be updated quickly to ensure safety information gets distributed within a reasonable timeframe.

3. Solution:

The drones are connected to a network hosted on a drones companion computer. The network protocol sends minimally sized packets to minimise packet loss due to collisions.

The solution is separated into a master and slave processes. The master process is designed to be operated by a human at this stage and transports locations to the formation. The slave processes are further separated into three parts; a receiver process, transmitter process and neighbour table.

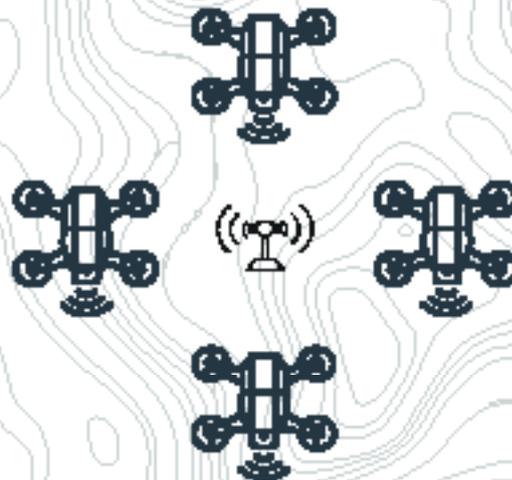
The transmitter process is tasked with sending packets to the rest of the formation. The packets are broadcast periodically to minimise the impact of missing one packet. The neighbour table is tasked with saving information received such as the neighbouring drones GPS position, this information is then used to prevent collisions. The receiver is tasked with receiving packets and separating the different packet types to send to their respective locations.

Command Packet:

Drone Id	Command
----------	---------

Periodic Update Packet:

Drone Id	Seq. No	Latitude	Longitude	Altitude
----------	---------	----------	-----------	----------



4. Outcome:

Three drones flying in formation using proposed networking method. The drones executed a square flight path supplied by the master process with no manual human control necessary.



Project supervised by Dr-Ing Andreas Willig and Graeme Woodward with help from Sam Pell.



Computer Science & Software Engineering



3D MODEL FOR A DIGITAL-TWIN OF A PLANT



Inga Tokarenko, Supervisor: Richard Green

INTRODUCTION

Only 3% of the world's water is fresh water and of that, 70% is used for agriculture. Currently 2.7 billion people struggle to find enough clean drinking water. Better water management in agriculture could help alleviate the fresh water shortfall.

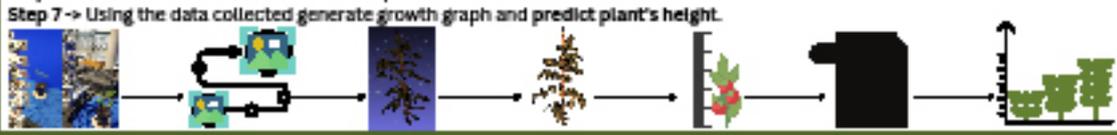
The goal of this project is to begin a solution that minimises the current impact of the agricultural industry. This project aims to create a digital-twin of a tomato plant in the form of a 3D model and measure and predict the plant's height. The solution's goal is to create a perfect growing environment for a plant to minimise water usage.

OBJECTIVES

- Generating a 3D Point Cloud**
Construct the first step of the 3D model of the tomato plant using a 3D point cloud. This step requires processing of the images in order to construct a 3D point cloud from those images.
- Generating a 3D Model**
Take the constructed 3D point cloud from Objective 1 and construct a 3D model of the tomato plant.
- Measure and Predict Plant's Growth**
Analyse the plant and determine its height based on the 3D model or image processing. Once the height is determined predict future potential growth.

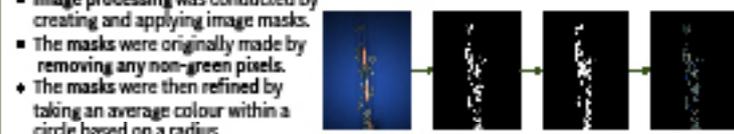
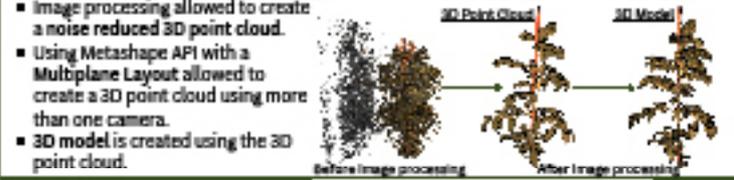
METHOD

Step 1 -> Collect the data using a robot with 6 cameras attached to it and a turn table with the plant on top of it.
 Step 2 -> Process the images by creating a mask and then apply the mask onto each image to remove the background.
 Step 3 -> Generate 3D point cloud using Metashape API.
 Step 4 -> Generate 3D model using NumPy and Open3D.
 Step 5 -> Measure the height of the plant using the 3D model.
 Step 6 -> Save all the data collected on the plant onto the CSV database.
 Step 7 -> Using the data collected generate growth graph and predict plant's height.

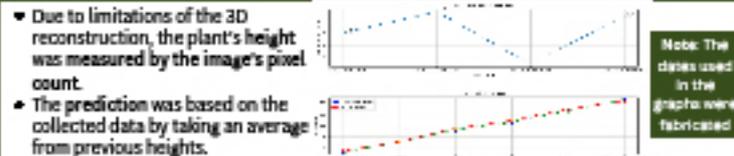


RESULTS

- Image processing was conducted by creating and applying image masks.
- The masks were originally made by removing any non-green pixels.
- The masks were then refined by taking an average colour within a circle based on a radius.
- Image processing allowed to create a noise reduced 3D point cloud.
- Using Metashape API with a Multiplane Layout allowed to create a 3D point cloud using more than one camera.
- 3D model is created using the 3D point cloud.

- Due to limitations of the 3D reconstruction, the plant's height was measured by the image's pixel count.
- The prediction was based on the collected data by taking an average from previous heights.



Note: The dates used in the graphs were fabricated.

LIMITATIONS

- Due to time restrictions the full life cycle of the plant was not able to be captured.
- The methodology did not preserve the scale of the plant in the 3D reconstruction, so absolute measurements were taken from the original images.
- Sensor resolution was not sufficient to capture the plants smallest features.

FUTURE RESEARCH

- Determine the health of the plant using attributes of the 3D model, pH, moisture, temperature sensors.
- Determine a pathway to measure the plant's height using the 3D mesh.
- Create a UI that will allow to view plant's health attributes and growth.



Post-quantum MQTT Protocol

Background

MQTT is a communication protocol used in the Internet of Things. It is often used in conjunction with private data such as cameras and sensors so cyber-security breaches could be significant.

Current methods for providing digital authentication (verifying who you are communicating with) rely on algorithms which can be broken by quantum computers. Thus when quantum computers become widely available, current security methods will no longer be secure.

Objectives

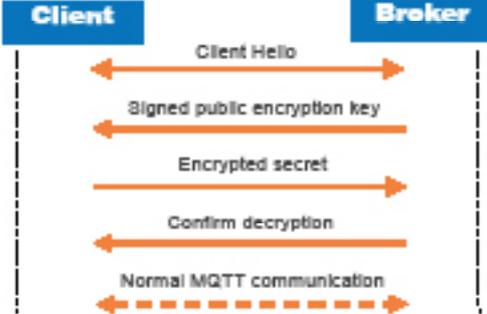
- Find methods and algorithms to add quantum-safe authentication to MQTT between the **client** and **broker**.
- Compare potential methods for adding quantum-safe authentication in terms of:
 - **Memory** used
 - **Bandwidth** required
 - **Computation** time

Solutions

1 Signature-based Scheme

The first authentication method is to implement a signature based scheme. Digital signatures work just similar to real life: someone signs a message, and anyone else can verify it was that person's signature.

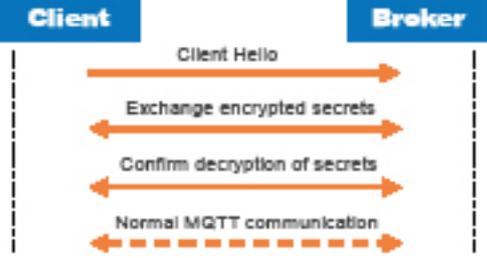
The **handshake** between the client and broker is as follows (simplified):



2 KEM-based Scheme

The second option is to use key encapsulation mechanisms (KEM) to authenticate. This involves encrypting a secret which only one person can decrypt, so you know it must be them if they can decrypt it.

The **handshake** between the client and broker is as follows (simplified):



Results

Algorithms

Based on *NIST research*¹ on quantum-safe algorithms:
CRYSTALS-Dilithium² is a suitable signature algorithm.
CRYSTALS-KYBER³ is a suitable KEM algorithm.

Memory

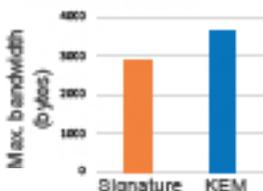
+

1184

Bytes

Both signature and KEM based schemes require an extra 1184 bytes for the client.

Bandwidth



Scheme	Max. bandwidth (bytes)
Signature	~2800
KEM	~3500

Time

The KEM based scheme is **7% faster** to complete authentication on average.

1. <https://doi.org/10.6028/NIST.R.9413-epd1> 2. <https://doi.org/10.13154/ches.2018.11.238-268> 3. <https://doi.org/10.1109/EuroSP.2018.00032>



Computer Science & Software Engineering

Student
Raven Townsend

Supervisor
Clementine Gritti

Vineyard Visualisation

1. Objectives

- Train a deep learning AI model to detect grape vine plants.
- Build a system to identify individual plants using images.
- Web interface to join the detection and identification systems to retrieve historical data about an individual plant.

Using deep learning AI and image comparison techniques to detect and identify individual grape vine plants.



4. Results

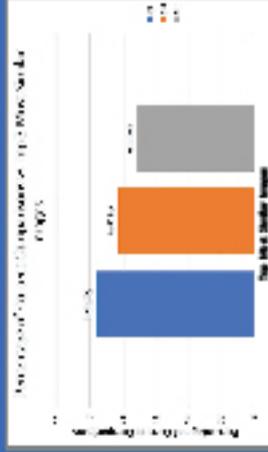
- Tests were completed using image scans collected by UC Vision. Detected grape vine plant images were masked and grouped per individual plant.
- All images were compared against all other images, the top three most similar images were recorded.
- The graph below shows the percentage of images where the plant was correctly identified. The percentage of the top three most similar images are shown.

2. Background

- UC Vision currently has no easy way to retrieve historical data about individual image scanned grape vine plants.
- The historical data can be used to see growth patterns, disease outbreaks, and plant health. The image scans made by UC Vision aid with analysis for vineyards.
- The current solution requires intimate knowledge of the code base, un intuitive design requiring exact knowledge of the row and plant, and can only be accessed by members of UC Vision.
- The solution currently in use is no longer suitable as it is not portable and does not allow vineyards to access and observe the project as it is developing.

3. Solution

- To detect grape vine plants a deep learning AI approach using Detectron2 was used. A custom model was trained using the image scans created by UC Vision images with different lighting, focal lengths, and angle were used to train the model to increase generalisation.
- Masks of each plant are created when detected and saved. The masked vine plant images are compared against each other using two computer vision algorithms, one to detect and compare features (ORB) and another to detect structural similarity (SSIM).
- The web interface gives remote access to the dataset on a red identification system, allowing images to be uploaded and compared out in the field or in the office. The historical data of the most similar plant is displayed for the user.
- GPS data is used with the historical data collected to increase accuracy and decrease the number of plants compared when out in the field.



Student: Niels van Antwerpen
Supervisor: Richard Green

Virtual Reality Interaction for Apple Thinning Training Tool

1. Motivation

In order to reduce the number of apples per tree, the apple tree is cut back to a certain level. This is done by cutting the branches of the tree. This is a very labor-intensive task and can be done by hand or by using a mechanical tool. The goal of this project is to develop a virtual reality training tool for apple thinning.



3.1. Interaction 1

Pressing on a button to start the game when they have finished the game.



When the user presses the button, the game starts and the user can start thinning the tree.

3.2. Interaction 2

Clicking the apple to cut it off and then the apple will fall to the ground.



When the user clicks the apple, the apple will fall to the ground and the user can see the result of the click.

3.3. Interaction 3

Dragging the apple to the ground and then the apple will fall to the ground.



When the user drags the apple, the apple will fall to the ground and the user can see the result of the drag.

4. Trial Game

When the user starts the game, the apple will fall to the ground and the user can see the result of the click.

Telling the user's performance: accuracy of the apple thinning, the number of apples that are left on the tree, the time it takes to finish the game.



When the user starts the game, the apple will fall to the ground and the user can see the result of the click.

5. Results

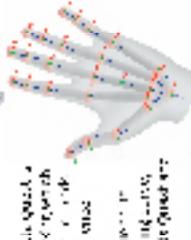
The results of the trial game show that the user can learn to thin the tree more accurately and faster when using the virtual reality training tool.

6. Future Work

In the future, we will develop a more advanced virtual reality training tool that includes more realistic apple thinning scenarios and a more detailed user interface.

2. Technologies

Developed by Mark Quade, students in the computer science department at the University of Illinois at Urbana-Champaign. The tool is available for use on a variety of platforms.



The virtual reality tool is available for use on a variety of platforms and can be used to train students in apple thinning.

The tool is available for use on a variety of platforms and can be used to train students in apple thinning.

Funded by Kullingon, Maarsluis, and Prof. Richard Green

Computer Science & Software Engineering, UG-VISION, Maarsluis

Tumour Region Segmentation in Whole Slide Images

Mitchell Vesle | Supervisor: Prof. Ramakrishnan Mukundan

Background

In 2020, breast cancer was the most commonly diagnosed type of cancer, making up 11.7% of global cancer diagnoses and 6.9% of global cancer diagnoses resulting in death. An important step in the identification of breast cancer is to extract and analyse a biopsy of the affected tissue. Manual analysis of biopsies can be time consuming and can lead to issues due to the subjective evaluation that can occur from pathologist to pathologist. By converting biopsies into digital whole slide images (WSIs) using high resolution digital microscopes it is possible utilise modern image processing methods to automate analysis tasks.

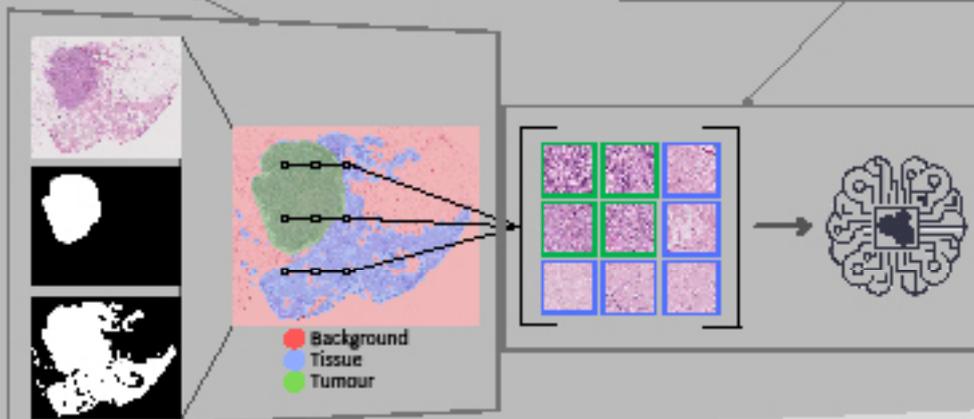
Objective

The objective of the project is to develop a machine learning algorithm to automatically identify tumour regions in whole slide images, and to validate the results against manual annotations by expert pathologists (provided by TIGER challenge [<https://tiger.grand-challenge.org/>]).

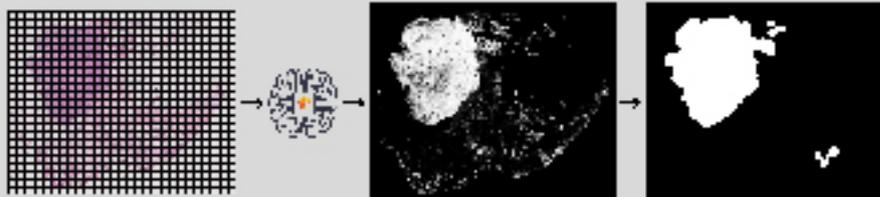
Training

An automatically generated image showing tissue regions (bottom) and a manually generated image showing tumour regions (middle) are used to classify a WSI (top)

Small image tiles (64x64) are extracted from the tissue and tumour regions of the classified WSI and fed into a Convolutional Neural Network (CNN) machine learning model with their corresponding label



Classification



When classifying a WSI the provided image is split up into tiles, where each tile is fed into the trained CNN and a tumour probability map of the image is constructed. The map is then cleaned up to only keep large contiguous regions of identified tumour tissue

Results

The trained CNN model managed an average accuracy of over 85% when evaluated against a balanced validation dataset and an average balanced accuracy of 77% against the 93 WSIs in the available dataset.

The average processing time for all images the dataset was 21 seconds with the median time being 13 seconds*

*The processing time is for 10000 tiles

Metrics

Validation Accuracy	86.2%
True Positive Rate	71.2%
False Positive Rate	16.9%
Precision	83.0%
Balanced Accuracy	77.2%
F1 Score	72.2%

Future Work

Future work would involve making improvements to the machine learning model to include detailed analysis of several features of tumour microenvironment (such as stain concentration, nuclei proliferation, and tissue texture characteristics) to improve classification accuracy as well as further improvement to the accuracy of training and validation dataset labelling.

Future work would also include the development of a graphical user interface that would allow users to select whole slide images and view analysis results



Computer Science & Software Engineering

Measuring Cortical Health Features with Minimal User Intervention

Background

Objectives

Solutions

- In the initial prototype, the cortical attenuation distribution over five energy bins was used to segment axial slices.
- Gaussian distribution of cortical attenuation is used to calculate confidence intervals for each energy bin.
- Final solution used neural networks to learn and segment the cortical region in each slice.
- U-Net, U-Net++ and Attention U-Net models were used.
- Training data was made through manual segmentation.

Results/Evaluation

Conclusions

- Grad-CAM highlights model's predicted cortical regions of image.
- Neural Network models compared after 11 epochs of training.
- Cortical thickness used to compare automated and manual methods.

Neural Network Model Comparison

Manual vs Automated Measurements

Model:	Dice Score (%):	Loss Function:	Run Time (s):
U-Net	87.0	0.00985	914
U-Net++	85.9	0.0106	2107
Attention U-Net	86.3	0.0101	1079

	Manual:	Automated:	Expected:
Cortical Thickness (mm)	1.06	1.07	1.02 ± 0.2

Computer Science & Software Engineering

Michael Woodard
Student

James Atlas
Academic Supervisor

Mahdieh Moghiseh
Sponsor - MARS Bioimaging Ltd.

DashIO

Who are DashIO?

DashIO is a company who created an application and backend platform for interfacing with Internet of Things (IoT) devices.



Bluetooth



NMEA2000



To test their libraries we utilized many different IoT protocols such as:

-  **Bluetooth Low Energy (BLE)**
Low power, short range wireless communication, compatible with all phones.
-  **Wi-Fi**
The common communication method was connected to an OBDII car sensor.
-  **CAN/NMEA2000**
Wired, similar to what your car uses to communicate between components, but used in large yachts
-  **LoRaWAN**
A Long Range Low Power that can be used where conventional radio cannot.
-  **Zigbee**
Wireless, commonly used for cheap home automation sensors

THE NETWORK BRIDGE

This Network bridge was developed by us to test all of the different peripherals in one place.

OVERVIEW

Four protocols were used to connect IoT devices to the DashIO app using our network bridge.



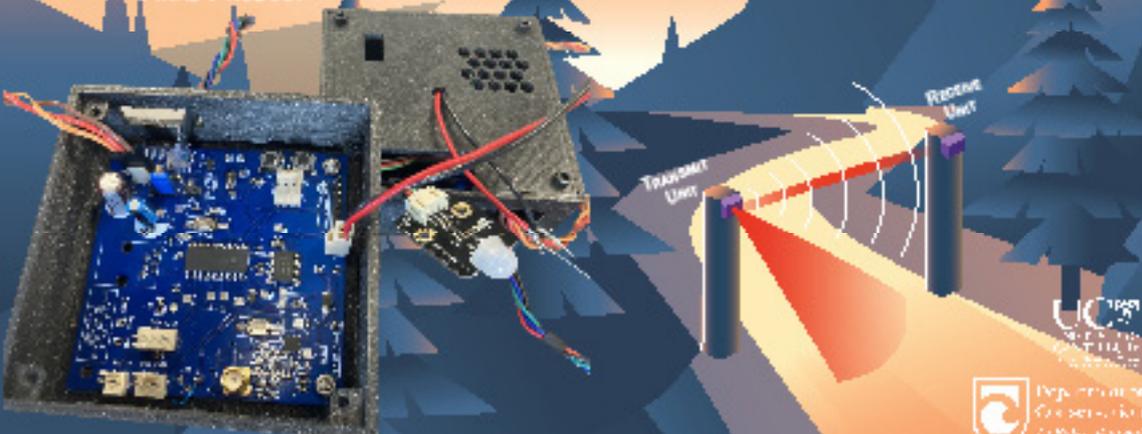
CREATED BY PARIS, JACKSON, RYAN, BRADEN

GITHUB  **DASHIO** 

Student projects: Electrical Engineering and Computer Engineering

TRAIL COUNTER

FINAL PRODUCT



BACKGROUND

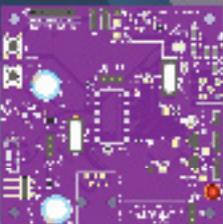
DOC NZ require research into alternate methods of sensing users on their trails. The existing pressure-plate system is vulnerable to digger damage during maintenance. These sensors should:

- Detect 80% of users
- Last 1 - 5 years
- Cost no more than \$500
- Have a range of 2 m
- Reduce accidental digger damage during maintenance

HARDWARE

Two dev boards were made, a 'TX' and an 'RX' board to interface with the sensors. These are based on PIC24F MCUs. The boards have:

- An XLP* low power mode.
- XLP interrupt pins
- High-efficiency 'pump' v-regs
- 12-bit ADC channels
- UART and Serial communications
- MPLAB and MCC debug tools




*Extreme Low Power

VERDICT

After trialing a variety of passive and active sensors the only feasible alternative was the passive infrared. All other sensors consumed too much power or were unable to meet the required 80% accuracy.

It is therefore recommended that a passive IR sensor is adopted or the existing piezo-system is redesigned to be strengthened to resist damage from diggers.

PASSIVE INFRA-RED (PIR)

People emit infra-red energy, which is detected by this sensor. This is intended to be a low power wake up trigger for the MCU

- Low power use (15 uA)
- Good range (8 m)
- Only minorly affected by sun IR
- Highly sensitive
- False positives possible
- Not able to count groups



Viability: Yes

INFRA-RED BEAM

An IR LED is paired with an IR photodiode to create a beam. A 5 mm 15° LED is monitored by an amplified photo diode.

- High power draw (20 mA)
- Low range (1 m)
- Will run if woken by passive sensor
- With two cross-beams, velocity can be found, to determine walker/biker
- Vulnerable to sunlight

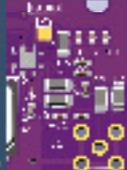


Viability: Unlikely

RADIO INTERFERENCE

By transmitting radio waves, a receiver can monitor interference and RSSI from a person passing through the transceiver zone.

- High power draw (13 - 18 mA)
- Excellent range (10 m +)
- Measures RSSI power drop at 500 MHz
- Immune to blockages, as not optical
- A person passing through reduced RSSI* slightly (-2dBm), a cyclist reduces by -9dBm.



Viability: Experimental *Powered Sign at Strath Tui

POWER CONSUMPTION

The device has to last for 1-5 years. Power is saved by:

- Using a passive sensor to wake up the MCU
- When the MCU is awake, high power sensors are turned on
- MCU architecture only uses 700 nA while asleep
- A daylight sensor shuts off the board at night time.

With 10 D-cell batteries at 5% time-on, the gauged lifespan is:

PIR Only	PIR + IR	PIR + Radio
4.1 yr	3.6 yr	1.7 yr

With Thanks To:
Phillip Hoi, Gareth Barwell, Scott Lloyd,
Daniel Hopkins, Randy Hampton

By: Ben Fletcher, Matthew Hornsby, Gordon Huang, Sarah Wynn-Williams
Sponsored by the Department of Conservation, POB: Stuart Cockburn
Supervised by Volker Rock

29/09/2023
Tel: +64 9 308 3700 ext. 2333

Buzzwire Wand

Background

- Gap Filer want to make a giant Buzzwire game.
- Buzzwire is a game where there is a hoop with a handle threaded through a wire maze.
- The goal is to get the other side of the maze without touching the wand to the maze.
- If the hoop touches the maze a buzzing sound is played.
- Gap Filer has made multiple giant buzzwire courses, several meters long and use 50mm stainless steel piping as the 'wire maze'.

Aim

Develop and prototype a wand which:

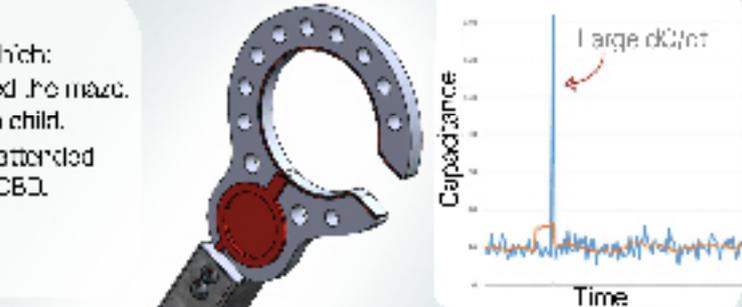
- Can detect when it's contacted the maze.
- Is light enough to be held by a child.
- Is robust enough to be left unattended outside 24/7 at Christchurch CBD.
- Is wireless.
- Is fun to use.

Features

- Multiple RGB LEDs for colour changing lights.
- Piezoelectric buzzer for sharp buzzing sound.
- Powerful vibration motor for notable vibrotactile feedback.

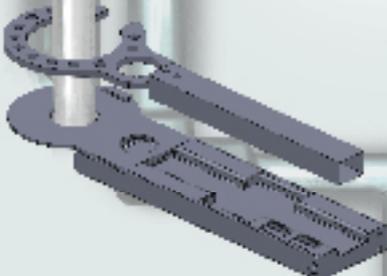
Detection

- The wand detects contact using a capacitive sensor.
- When the wand touches the maze there is a large change in capacitance [dC/dt].
- The large dC/dt triggers various lights, sounds, and vibrations for the 'buzz'.
- The wand automatically re-calibrates itself to work in different environments.
- Works reliably even when wet.



Power

- There is a charging station at each end of the maze.
- Pacing the wand on the charging stand gives the time taken and number of times the user got 'buzzed'.
- Induction coils wirelessly charge the lithium-ion battery.
- Temperature and charge sensors regulate the charge to the battery, making it safe to leave unattended.



Buzzwire team:

- Josh Tait
- Sami Heustice
- Kyle Wainwright
- Cory Phillips



High Voltage Testing Facility Upgrade

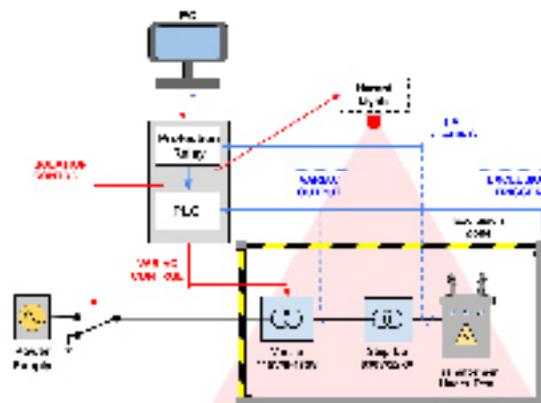
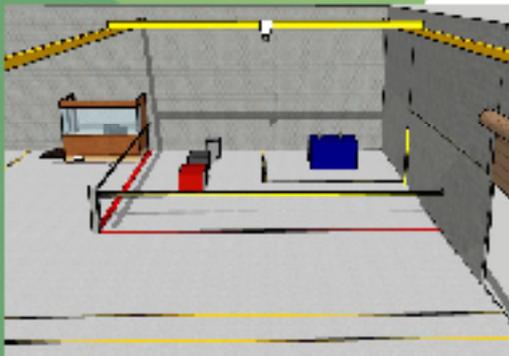
Background

A reliable supply of electricity is important for New Zealand's health and economy. Ventia test high voltage transformers to maintain the reliability of New Zealand's electricity network. Ventia's test facility in Palmerston North uses dated analogue control equipment to perform these vital tests. It is important to upgrade the facility so Ventia can continue to test transformers safely and accurately.



Project Goal

Upgrade the control, protection and safety systems of the high voltage transformer testing facility. Use digital electronics to maintain existing functionality and include automation of testing tasks. Combine upgraded systems with existing test equipment in an appropriate layout.



Protection Design

Keep circuit conditions within test equipment ratings using:

- SEL351 Protection relay
- Metal Oxide Varistor (MOV) surge protection devices.

Safety Design

Keep personnel in the facility safe during and in between tests using:

- Laser sensor and belt barrier exclusion zone.
- Hazard Lighting and sound
- Earthing contactor
- Earthing sticks

Control Design

Control test equipment to perform tests and monitor test measurements using:

- Allen Bradley Programmable Logic Controller (PLC).
- Computer for human interface

NEPALESE PICO-HYDRO

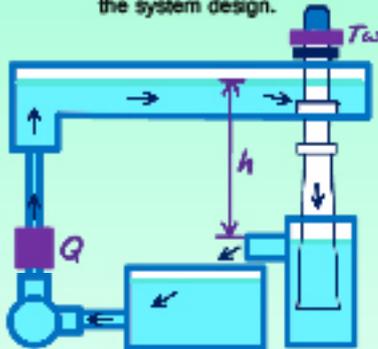
E08 – ENEL400 FYP

This is an ongoing project working to generate 1.5 kW of renewable hydropower for a Nepalese mountain village. This project is sponsored by Meridian Energy and aligns with its commitment to clean energy for a fairer, healthier world.

Power is generated using a reaction turbine that utilises power from both the velocity of the water and the pressure head of the system. This scheme uses a Kaplan turbine, which is suited to high flow rates and low heads, and is capable of very high efficiencies.

Mechanical Optimisation

A test rig has been developed over the last 3 years to simulate flow conditions. This is for gathering empirical data to evaluate and improve the system design.



Flow Conditioning

Flow conditioning was implemented along the flume for a more laminar flow for testing.



Real and Reactive Power Control

Suitable operating conditions must be maintained for the generator and the users will require steady voltage and frequency, despite the variable input power. This was implemented with a resistive dump load and single phase STATCOMs.

Load Simulation

For testing purposes, a Chroma regenerative grid simulator was used to provide the reactive power for the generator, and to simulate the village electrical load. This stabilises the system for mechanical efficiency evaluation.

Sensing and Efficiency

An ultrasonic flowmeter and a rotary torque transducer were used to gather the data needed to evaluate the mechanical efficiency of the turbine.

$$\eta_{\text{turbine}} = \frac{\text{shaft power}}{\text{power available in the water}} = \frac{T\omega}{\rho g Q h}$$

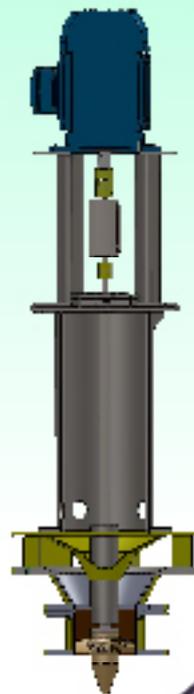
Turbomachinery and Support Structure

The support structure was designed to maintain very accurate concentricity. This is necessary to avoid cavitation effects around the blades from too much clearance, whilst also avoiding interference issues. A new design was manufactured, aligned, assembled and installed this year.

Preliminary Results

A range of Kaplan blade turbine angles have been tested, and the current efficiency is ~80% which is already an increase from the ~30-60% that was achieved last year.

The next project team will try to get this to 90%, then the implementation design can begin.



Team: Gussy Collet, Chloe Nicholson, Lydia Smith, Campbell Stevens, William Thomas
Supervisor: Andrew Laphom

Technicians: Ken Smart, Paul Agger, Edsel Villa, Nigel Pink, Tony Doyle
Meridian Sponsors: Rowan Sinton, Prakash Gautam





Multi-kill predator control system

Rats, possums, and other invasive predators cause huge damage to our taonga species. The Department of Conservation operates hundreds of thousands of traps and spend millions of dollars operating and maintaining them. By reducing the upkeep required for maintaining effective pest control, the goal of making New Zealand predator free is brought closer to reality.



Project Goals :

- Multi-kill, long life pest and predator control system.
- Similar weight, size, and cost to existing trap systems (e.g. DOC200 spring trap).
- Safe for user to carry and maintain.

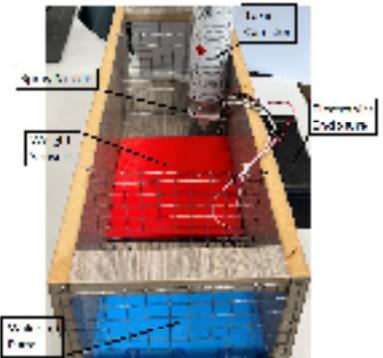
Design Process

The focus of development was ensuring the system was highly robust while minimising cost.

- Detects pests using simple pressure-sensitive resistors over a more expensive computer vision system.
- Controlled by low-power, low-cost 8-bit MCU.

Features :

- Weight activated aerosol toxin spray.
- Retrofit to existing trapping tunnels.
- Greater than 6 month life with no maintenance.
- Toxin dosage adjusted by animal weight.
- Ability to install chemical lure dispenser.
- Adjustable for different toxins and target animals.

Potential future developments:

- More sophisticated animal distinction.
- Communication system for remote monitoring and integration with other Kwicare traps / bait boxes.

Project EDZ: Supervisor: Alan Field, Project Lead: Jack Marshall
 Supervisor: Orlan Moore, Client: Peter Robinson, Technical Support: Phillip Ho
 A big thanks to all of our support staff and everyone who helped us!

Student projects: Electrical Engineering and Computer Engineering





The Curtain Robot

The initial concept was designed with a simple home integrated circuit for opening and closing curtains. The design evolved to include making a robot capable of opening heavy curtains and maintaining the ability to be controlled via a smartphone.





Team members:
 Ian Lister
 Dan Thompson
 Sam Hain-Dean
 Luke Tetlow

Allioliants:
 2022a, 2022b

Full Award: for entering the project with a win for passing the project

Introduction

Recent technology has allowed for the use of smart homes. The development of IoT devices has increased and different users have used the internet of things have more smart home technology systems available to acquire assistance.

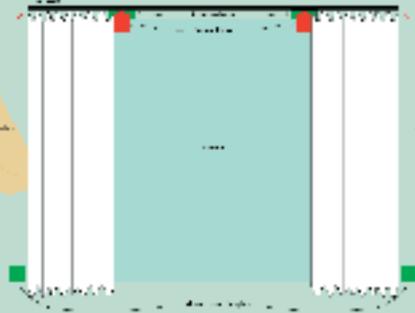
The solution will be compatible with existing IoT. The final product will be able to control curtains via a smartphone.

The 2 motorised curtains are opening and closing with a remote in two sets of 1.5m wide curtains. The remote opening and closing the curtains is a hard wired connection.

The remote is connected to a custom developed board that manages the curtains. The power is being sent to a light and management of the curtains is processed with a remote controlling the curtains via a smartphone.



Design Concept



Solution

The solution was created with a remote control that can be controlled via a smartphone. The remote control is used to control the curtains via a smartphone. The remote control is used to control the curtains via a smartphone. The remote control is used to control the curtains via a smartphone.

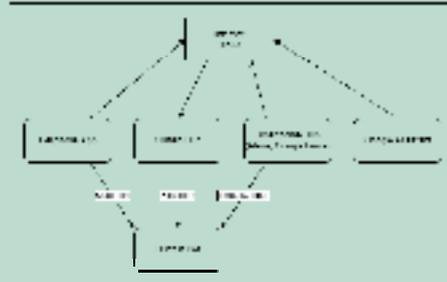
Control Panel Design



Smartphone App



Connectivity Diagram



RAT BAIT STATION MONITOR

CONTRIBUTING TO A PREDATOR-FREE NEW ZEALAND



Motivation

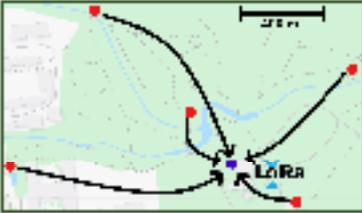
Peat bait stations are legally required to be checked regularly by owners. Kwiicare is interested in developing a remote monitoring device to improve the efficacy of the Kwiicare No Rats® bait station by reducing labour.

Project Goals

Develop a device that:

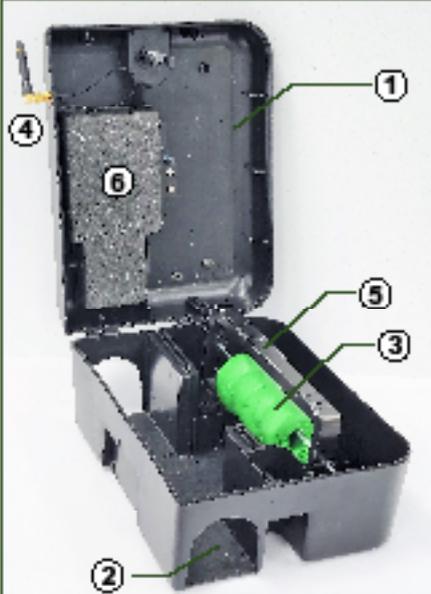
1. Is retrofittable
2. Measures bait levels
3. Communicates data to the owner wirelessly

Device Features



Prototype Device Overview

1. Existing bait station
2. Rat access tunnel
3. Rat bait
Prefeed or toxic.
4. External antenna
Tuned to assigned NZ LoRa bandwidth
5. Bait sensor
Proprietary optical bait sensor. 20-25% resolution.
6. Electronics casing
Designed for injection moulding with bittering agent and IP34 rating. Protects electronics from rats and moisture.



Prototype Testing Findings

- The sensor can measure the remaining bait in 25% increments.
- The device can communicate bait and device battery level data, timestamps, and any custom data.
- The device can communicate over 750m with line of sight outdoors, and 150m in a concrete and steel building.

LoRa Network

Peer-to-peer LoRa radio modulation transmits data from bait stations to a central device. Network is expandable to 240+ stations. Hardware is in place for LoRaWAN connectivity if desired.



Summary

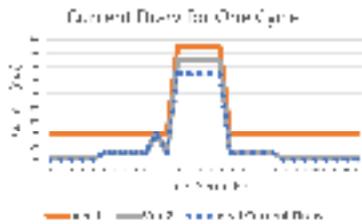
This prototype is a successful proof-of-concept for a product that can eliminate the need to check stations in person. Kwiicare will investigate commercialising this device in the future.

Waterproof electronics

Weatherproof casing with separate battery compartment.

Power-saving mode

A deep-sleep mode gives the device a battery life-time of over two months.





PROJECT MEMBERS

Christopher Dewhurst
Ashley McBride
Edward Tovey
Euan Robinson

SPECIAL THANKS

Prof. Philipp A. Martin (Supervisor)
Dr Peter Robinson (Kwiicare)
David Brittain (Kwiicare)
Thomas Smartt (DOC)
Brend Cockburn

Drone Localisation Without GPS

Drone light shows are the fireworks of the future. This project involved researching methods of drone localisation to increase the safety and reliability of urban drone light shows. Two solutions were investigated, ultrawideband (UWB) and fiducial markers.

Requirements



Any lighting conditions



Apply to many drones



200m range



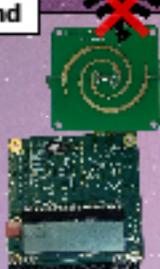
Communication blackout



1m accuracy

Ultrawideband

Ultrawideband systems use radio signals to measure distances between a tag and anchors at known locations, allowing the tags position to be found using trilateration.

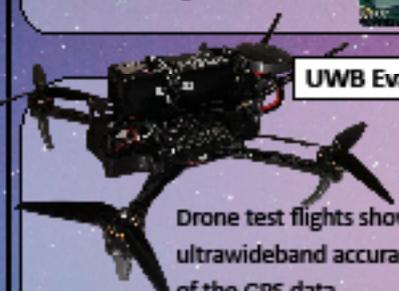


Fiducial Markers

Fiducial markers are designed to be recognised by a computer vision system. The system can calculate the position of the camera based on the pose of the marker.

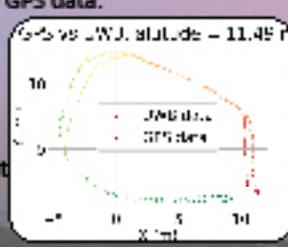


UWB Evaluation



Drone test flights showed ultrawideband accuracy within 1m of the GPS data.

Furtherest communication range of 205 m, but limited to 40 m 3D location range.

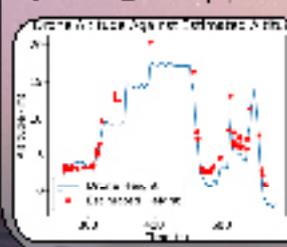


Fiducial Evaluation

Fiducial marker testing implementation.



Accuracy within 5 meters at maximum flight altitude. 200 m range possible with larger markers.



Recommendations

Neither solution can meet all requirements on its own, therefore SPS should investigate fusing the two location systems. To improve ultrawideband range, it is recommended to design custom printed circuit boards, to optimise emitted and received signal power. To improve the fiducial marker accuracy, it is recommended to add extra markers such that the position is calculated using more than one reference.



Angus Eason, Robert Rolleston - Ultrawideband
 Joshua Rogan, Daniel Mcnish - Fiducial Markers
 Client - SPS Automation
 Supervisor - Le Yang



FUTURE ARCHITECTURE OF THE NETWORK

Repurposing AC Components for DC Applications

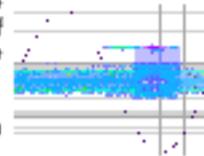
The Future Architecture of the Network is a research project focused on the future of New Zealand's electrical network. As part of this project, we have tested a representative selection of assets in the grid to compare component behaviour under AC and DC. Our project goal was to determine which assets are fit to repurpose in a hybrid AC/DC network.



Insulators

The leakage current and partial discharge were measured under AC and DC for a selection of porcelain insulators and a polymer surge arrester.

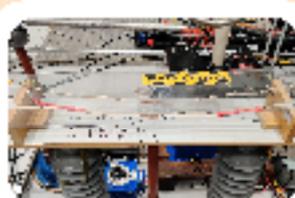
The partial discharge under DC was higher than under AC, but the leakage current was lower.



Medium-Voltage Cables

The leakage current and partial discharge were measured for a 33kV XLPE cable under AC and DC.

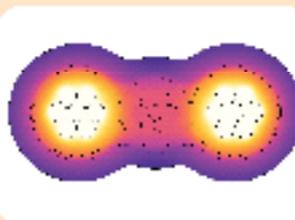
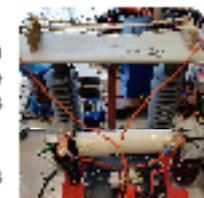
Like the insulators, the partial discharge under DC was significantly higher than under AC, but the leakage current was much lower.



Low-Voltage Cables

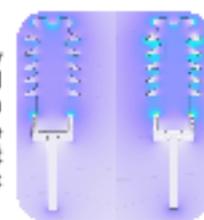
1mm² to 6mm² TPS cables were injected with various current densities to determine the temperature rise under AC and DC. The cables were tested in an unenclosed environment.

The steady-state temperatures of the cables under AC and DC were very similar.



Modelling

Finite element models were created to verify the experimental results. The modelled and experimental insulator leakage current were in agreement. The modelled cable temperature rise was similar to the experimental results, but there were discrepancies due to the dynamic experimental conditions.



Group Members:
Erin Shaller
Resulal John Estolaz
Waihe Qiu
Mengyan Huang

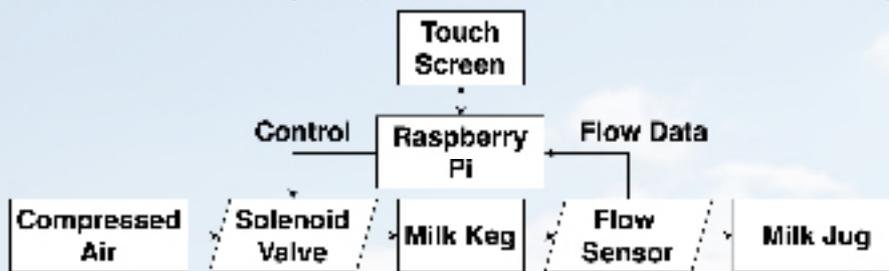
Special Thanks:
Sponsor: Andrew Lopham
Supervisor: Neville Watson
Lab Technician: Paul Agger



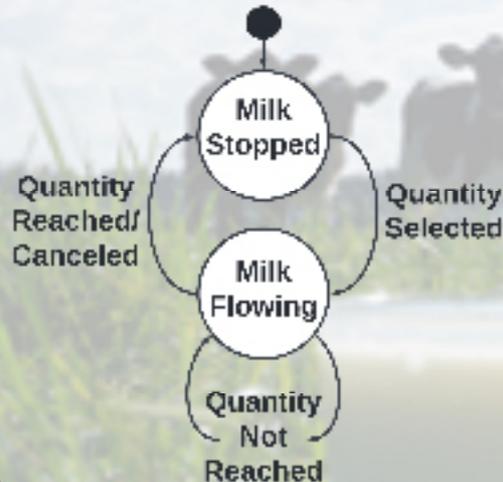
Future work includes increasing the sample size and variety of components and materials. Additionally, the studies should be extended to compare AC and DC performance in realistic environments. This means investigating the effects of water and pollution on the insulators and medium-voltage cables, and surrounding the low-voltage cables with thermal insulation.

E14: Milk Dispensing System

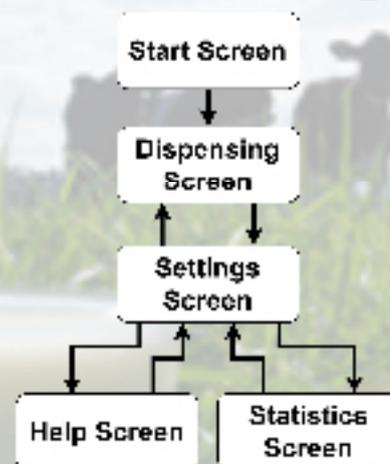
Problem: 500 Cafes x 30L of Milk = TOO MUCH PLASTIC!
Solution: Accurately dispense milk from reusable 10L kegs!



State-Machine



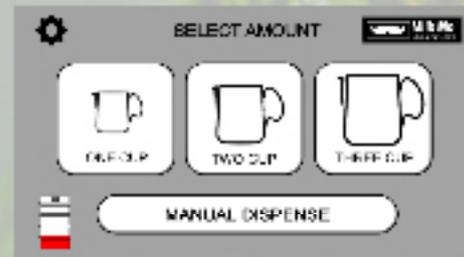
User Interface Flow Diagram



Casing Design



User Interface



The Smart Climbing Wall

Felix Backhouse, Connor McArdle, Tabitha Batcheler, Jun Noh

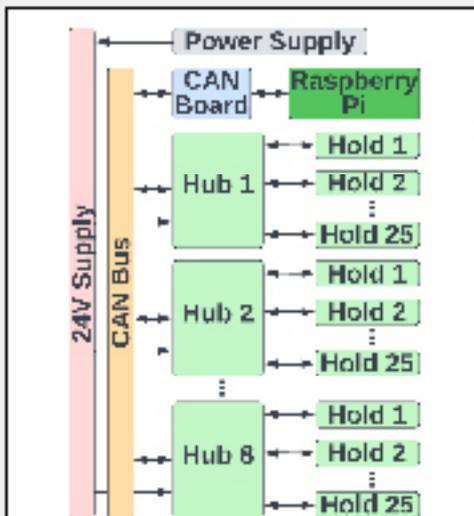
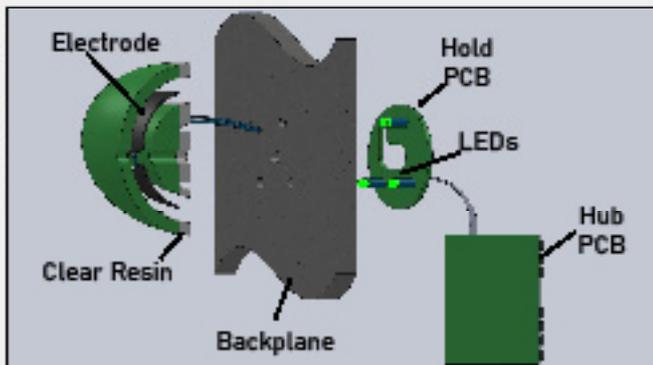


Overview

Uprising Industries is looking to add a "smart" climbing wall into its existing portfolio of climbing hardware. As such, this project's goal was to create a full-scale prototype while ensuring its economic viability.

The final prototype can light up individual holds, sense climber's movements, and combine these functions to show and track various routes.

This system improves user experience by allowing almost unlimited routes without the need to move holds.



System Architecture

The hub and spoke model allows scalability up to 200 holds while remaining cost-effective.

Working Principle

Each Hold PCB has a capacitive touch sensor, which connects to three electrodes in the hold to detect the climber's hand or foot.

The microcontroller in each Hub communicates with the capacitive sensors to detect climbers, and can also set the LEDs to a wide range of colours. The LEDs shine through a thin layer of optically clear resin to illuminate the outline of the hold.

Conclusions / Recommendations

Our design is scalable up to 200 holds and the hardware cost is less than \$10 per hold, fulfilling Uprising's key requirements.

Future developments could include gamified climbing and more refined user installation process.



Project E16

Sponsor: Sefton Priestley & Uprising Industries

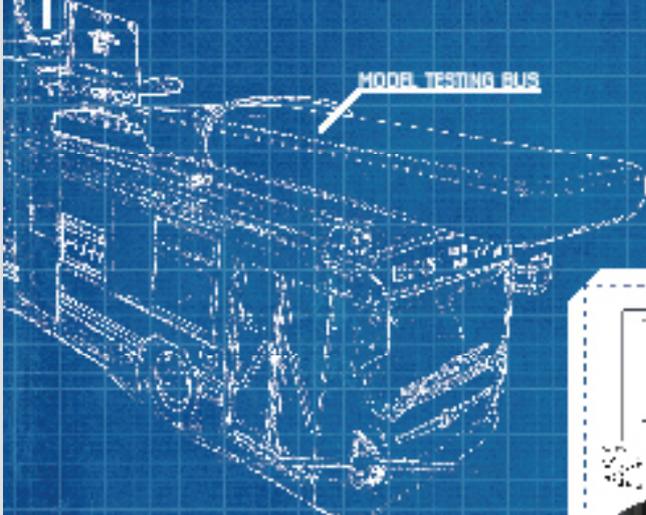
Supervisors: Allan McInnes & Nina Pernus

Technician: Phillip Hof, Edsel Villa

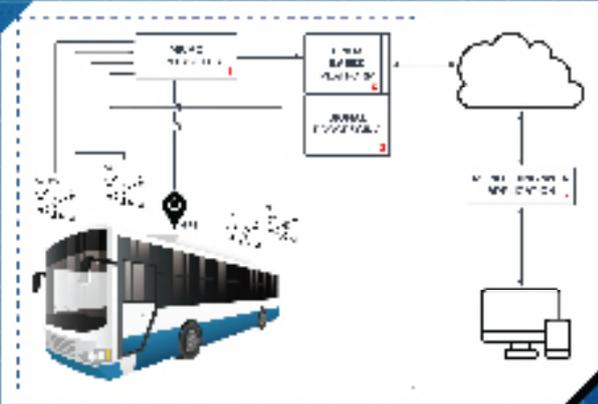


VEHICLE ACCELEROMETER DATA-COLLECTION AND VISUALISATION

E17



- **PROBLEM:** TRANSPORTATION AGENCIES WANT TO ENSURE THAT PASSENGERS HAVE THE SAFEST AND MOST RELIABLE RIDE POSSIBLE.
- **PURPOSE:** THIS PROJECT SEeks TO DETECT AND ANALYZE DATA FROM A BUS TO GAIN INSIGHT INTO PASSENGER RIDE QUALITY, CRASHES, AND ERRATIC TRAVEL.
- **HOW?** AN EMBEDDED SYSTEM COLLECTS SENSOR DATA [1], WHICH IS SENT TO AN ON-VEHICLE LINUX-BASED PLATFORM [2]. THE DATA IS THEN PROCESSED, ANALYZED, AND CATEGORIZED [3]. IT IS THEN SENT TO THE CLOUD AND DISPLAYED TO THE END USER VIA A MONITORING APPLICATION [4].

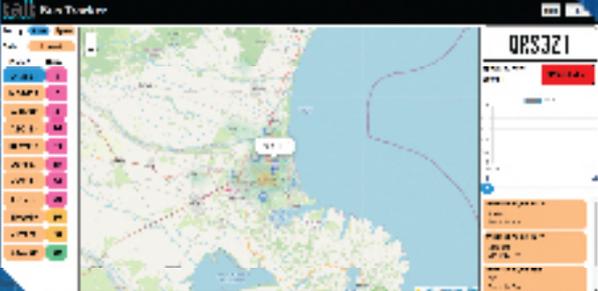


[1] EMBEDDED SYSTEM: THIS IS THE PROJECT'S FOUNDATION AS ALL SECTIONS RELY ON THE RELIABLE DATA PROVIDED AT REGULAR INTERVALS FROM THE EMBEDDED SYSTEM. A MICROCONTROLLER SAMPLES AND FORMATS DATA GATHERED FROM FOUR MULTIPLEXED Gyro/ACCELEROMETER SENSORS PLACED IN EACH CORNER OF A BUS. SIMULTANEOUSLY GPS INFORMATION IS COLLECTED TO DETERMINE EVENT LOCATIONS.

[2] LINUX BASED PLATFORM: THIS IS THE SYSTEM'S BRAIN AND IS BASED ON A RASPBERRY PI. IT COLLECTS AND STORES INCOMING ACCELEROMETER AND GPS DATA FROM THE BUS. THIS DATA IS THEN PROCESSED WITH PYTHON TO DETERMINE ANY ERRATIC VEHICLE BEHAVIOUR. IF ERRATIC VEHICLE BEHAVIOUR OCCURS AN EVENT IS CREATED WITH INFORMATION RELATIVE TO THE ERRATIC BEHAVIOUR, AND THIS IS SENT OVER THE NETWORK USING MQTT TO A WEB APPLICATION.

[3] SIGNAL PROCESSING: USEFUL DATA IS EXTRACTED FROM THE STREAM OF DATA COMING FROM THE ACCELEROMETERS. THIS IS ACHIEVED BY A SHORT AND A LONG MOVING AVERAGE OF THE DATA. THE LONGER AVERAGE HAS GREATER LAG, SO DURING AN ERRATIC EVENT THE DIFFERENCE BETWEEN THE MOVING AVERAGES INCREASES. ONCE THIS DIFFERENCE CROSSES A SET THRESHOLD AN EVENT CAN BE SENT TO THE WEB APP. TO BETTER VISUALISE DATA, A SCORE IS KEPT FOR EACH BUS, AND IS JERKED PROPORTIONALLY TO THE SEVERITY OF THE EVENT.

[4] MONITORING WEB-APPLICATION: THIS IS THE MOST IMPORTANT PART OF THE SYSTEM. IT DISPLAYS THE PROCESSED DATA. IT USES ALL THE BUSES IN THE FLEET, AND SHOWS THE LOCATION OF EACH BUS ON A MAP. IT DISPLAYS USEFUL INFORMATION ABOUT THE HISTORY OF THE CURRENTLY SELECTED BUS. THE APPLICATION IS BASED ON THE ANGULAR FRAMEWORK AND USES WEBSOCKETS AND MQTT TO COMMUNICATE WITH THE DATABASE AND THE BUSES IN REAL TIME.





Supervisor: PHILIPPA MANN
 Advisor: GRAHAM WOODWARD
 Industrial Sponsor: ALAN MANNING – Tait Communications
 Students: FORESTER KING, CAMERON McFIE,
 DANIELA McLEOD, SIMONEA RAYNES
 Further Information: <https://www.tait.academy/>



Student projects: Electrical Engineering and Computer Engineering



E22 - Smart Air Quality Sensor Network

Team: Alex Delyagin, Harry Shea, Jordan Norm, Oliver Kidd and Tristan Tiong
Supervisor: Shayne Crimp Client Supervisor: Anna Farquhar




Introduction

Human health is dependent on the quality of our air. Since we started living in urban centres with high population density the management of air pollution has become more difficult, and more important than ever.

To be able to understand the impact air quality has on human health, we need to be able to measure the quality of the air.

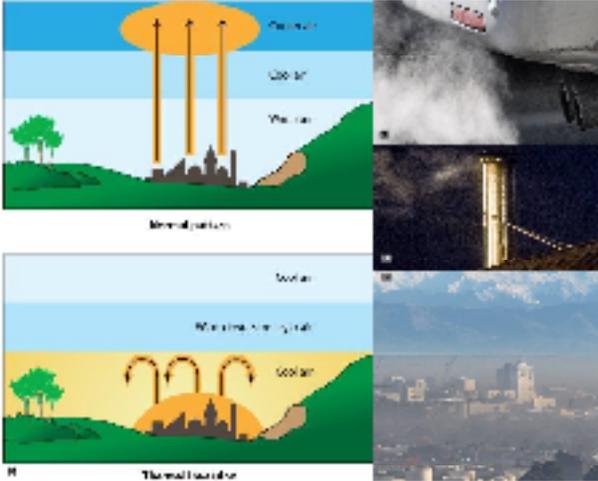
Christchurch has a history of poor air quality due to a thermal inversion layer caused by the port hills which traps pollutants at street level.

Presently, there are only three monitoring stations in Christchurch, these provided limited information.

Pollutants can be broken up into two categories, gases, and particulate matter.

Particulate matter (PM) is a broad term to cover suspended particles in the air, common examples are dust, smoke, and smog.

PM is characterised by size in microns, so an example PM₁₀ refers to all particles 10 microns and smaller.



The diagram illustrates a thermal inversion layer where cooler air traps warmer air containing pollutants near the ground. Photos show various air quality monitoring stations, including a tall pole-mounted sensor and a street-level sensor.

Solution

The design consists of sensors to measure PM₁₀, PM_{2.5}, nitrogen dioxide and ozone. It is fitted with a micro-controller which manages the reading of the sensors, communications, storage to a SD card, getting the current time and updating the status LEDs.

To lower the cost of the design and facilitate future development of the platform, the design has made use of common development boards where possible.

A custom main board PCB and driver circuitry for the gaseous sensors was developed.

The code was written using the Arduino framework.

SW-HI has been fitted and is ready to connect to the cloud. The hardware has a port set aside for use with an Icom modem to connect to Christchurch City Council's computer system.

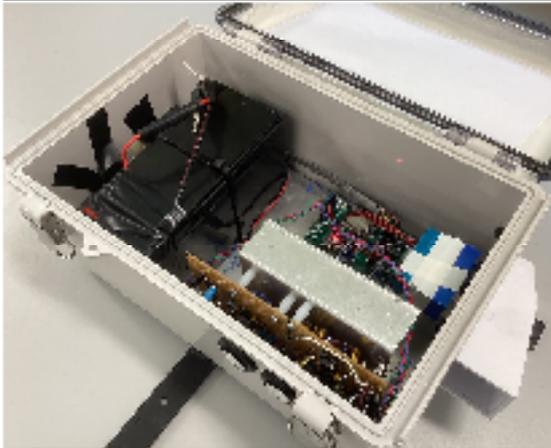
This has all been fitted within a weather-tight enclosure for outdoor use.

The approximate cost of the design is \$228.58 for one unit, but the sensors were supplied by Aeroqual so the actual price would be higher. This cost could be further reduced through refinement of the design and purchasing components in volume.

Goal

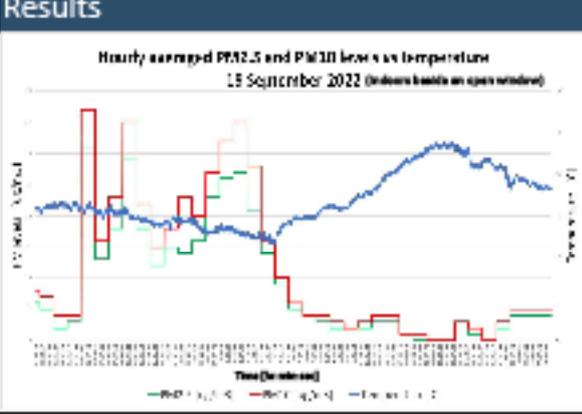
The CCC have tasked us with designing and building a low-cost pole-mounted device to measure air quality. To aid us in the development of this device, Aeroqual, we provided their air quality monitoring expertise.

We have identified PM₁₀, PM_{2.5}, NO₂, and O₃ as key pollutants to monitor. These four pollutants come from the burning of fossil fuels, with particulate matter also coming from burning of coal and wood for home heating. Christchurch can measure these four pollutants and relay the data back to the Christchurch city council via an Icom network. We would like to deploy a network of these devices around Christchurch to provide localized air quality information.



Results

Hourly averaged PM2.5 and PM10 levels vs temperature
18 September 2022 (Indoors inside an open window)



The graph shows that PM2.5 and PM10 levels are generally higher during the day and lower at night, which corresponds to the temperature fluctuations. The temperature peaks during the day and is lowest at night.

Next Steps

- 1) Deploy the prototype at a local air monitoring station for a week long test to calibrate the sensors.
- 2) Develop a PCB for the driver circuit of the gaseous sensors.
- 3) Develop a 2nd version of the main board to incorporate improvements.
- 4) Add Icom functionality.
- 5) Develop design to the point where it can be mass manufactured for city wide deployment.

68

Autonomous Formation of Drones

Problem Motivation

Search and Rescue

Environment/conservation research



x5



Problem Definition

To design, implement and test a software- and (wireless) networking general framework to safely operate a formation of autonomous drones in a rigid formation.

Simulation Environment







- Gazebo provided all the tools necessary to load drone models and visualise simulation flights in 3D.
- ROS is an open source robotics software that provides the framework that the algorithm is built from.

Developed Trajectory planning and Testing



Each drone maintains its position with respect to heading and position of the center of the formation.

By moving the centre point the formation will attempt to maintain its shape as each drone acts to hold position.

Test Flights/Results

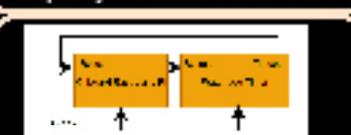
Our final flight successfully flew three drones around a 10 x 10m square while maintaining the formation. Successfully replicating our simulations!



The results from our final flight tests concluded that the control algorithm successfully controlled three drones with hardware faults preventing further tests with a full formation of five active drones.

Timeout Hardware Failsafe

To prevent drones from losing control a failsafe timer is used to reset the Raspberry Pi's onboard each drone.



Hardware reset circuit summary

This failsafe timer reset the Raspberry Pi in case of program halt or system failure.



PCB designed to reset Raspberry Pi in a system failure

To fit the circuitry on the drone without weighing it down a PCB was created that fit nicely on the exterior of the Raspberry Pi.



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Christchurch 8013, New Zealand

Team members:

- Nicholas Varley
- Simon Wallace-Blakely
- Caleb Sim
- Niko Tainui
- Jianqiao Guo

Academic Supervisor:

- Joe Chen

Project Supervisors:

- Dr Graeme Woodward
- Prof Andreas Willig

Clients:

- UC Wireless Research Centre
- UC Computer Science and Software Engineering Department

UCM35

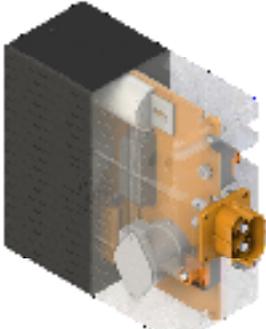
ELECTRIC LAND SPEED VEHICLE

E25

Alec Aoki, Ben Robinson, Peter Todd, Nils Smith

Project Goals:
 University of Canterbury Motorsport Club aspire to build world class vehicles. UCM35 fulfils this aspiration, endeavouring to design and build a vehicle capable of competing for the under 800kg electric world land speed record. The UCM35 Electrical Team is engineering a full suite of vehicle systems that are safe, reliable and capable of reaching record speeds.

Clients: Bruce Robertson
 Kevin Clunness
Supervisor: Paul Gagner



1 Precharge Unit
 Safe operation of the high voltage DC bus requires that voltage is ramped up to a controlled manner. This is controlled by a custom PCB using active voltage monitoring.



2 Discharge Unit
 Contains the systems to indicate the state of the high voltage DC bus and ensure safety following shutdown.



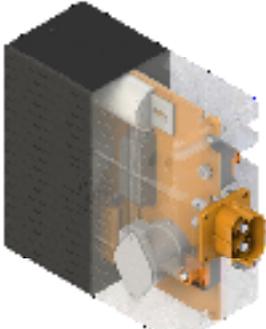
3 Fault Detection
 A safety system spans the car, checking for critical faults. Faults will shut down the vehicle.



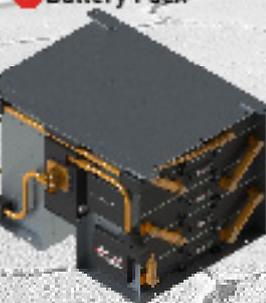
5 Motor
 The BRMAX 348 motor is a permanent magnet synchronous AC motor. With a "pancake" axial flux design, it offers higher efficiency than traditional radial flux designs. It has a peak power rating of 200kW.



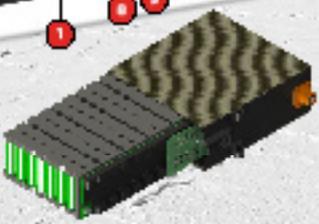
6 Dashboard
 The interface for the driver. Designed for simplicity, both displaying and sending essential information using the automotive standard CANBUS protocol.



4 Inverter
 The power electronics unit controlling the power flow from the accumulator to the motor. This is a commercial off the shelf unit manufactured by DriveTrain Innovations.



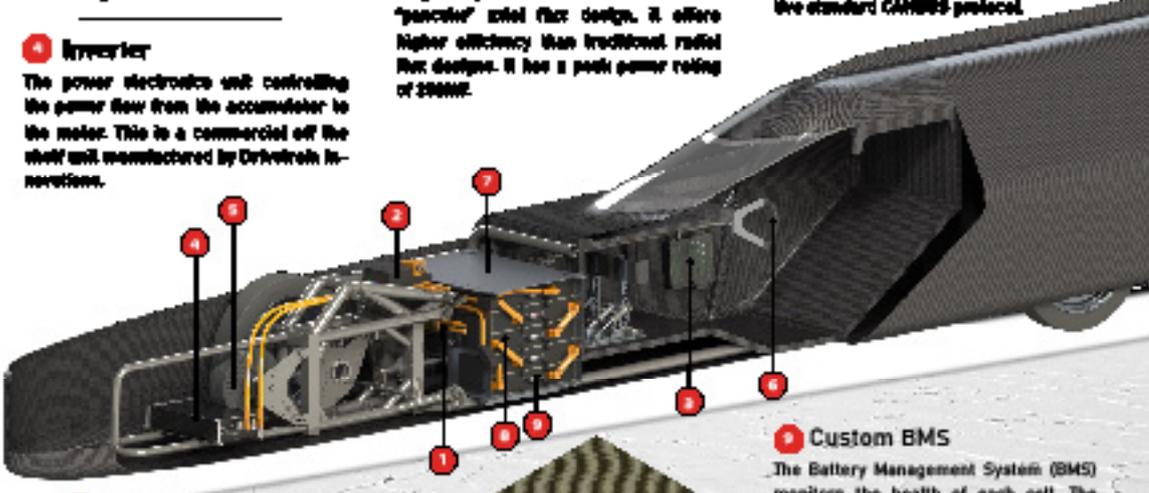
7 Battery Pack



8 Battery Modules
 The battery pack contains 10 modules. Each module contains 16x Enesapq Li-Ion "bricks". Modules are contained in a Kevlar composite shroud.



9 Custom BMS
 The Battery Management System (BMS) monitors the health of each cell. The system will trigger a vehicle fault if safe operating conditions are exceeded.





Vibration and Acoustic Analysis of The Wand Turntable

Project Statement and Aims:

The needle in a vinyl record player tracks oscillations in a record groove fractions of millimetres wide. These oscillations are converted to voltage signals in the tonearm. This voltage is then converted to the audio signals played by speakers. Any unintended disturbance to the needle affects the voltage signal, and in turn alters the music quality. Design Build Listen proposed that the team would investigate the noise that reaches the needle from both mechanical and acoustic sources.

Methods:

- **Theoretical modal analysis:** The plinth of the record player was modelled in a CAD software, analysing the resonant frequencies to show the vibration shape of each resonant mode.
- **Experimental modal analysis:** Accelerometers were set up in a grid across the turntable to experimentally determine the frequency response and internal damping of the plinth, quantifying how vibrations travel through the material.
- **Isolation design:** Accelerometers were used to measure the response of the turntable feet to external excitation. Several designs were tested - simple material slabs, rubber band (spring like) systems, and isolators inspired by earthquake dampers in buildings. This is to minimise the external vibrations entering the turntable.
- **Acoustic analysis:** Acoustic analysis was used to identify the main source of the audible noise heard without records playing. A frequency analysis was done on the makeup of this noise, and the sound pressure level (sound energy) was measured across the turntable surface to locate the source.

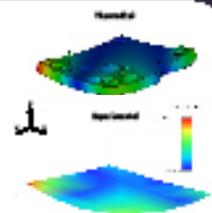


Results:

Theoretical & Experimental

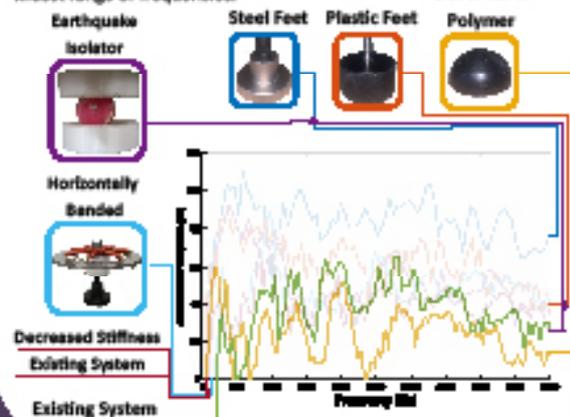
Modal Analysis

- Resonant Frequency at 200 [Hz]
- First Mode identified (See right)
- High internal damping >5%
- No amplification of vibrations within the range of human hearing



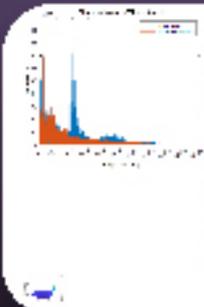
Isolation Design Summary

- The existing isolation feet (Green) work well, particularly at low frequencies (<500 [Hz])
- Steel feet (Dark Blue) performed the worst across all frequencies.
- The elastomeric polymer feet (Yellow) performed the best across the widest range of frequencies.



Acoustic Analysis

- Main acoustic noise present at 4 [kHz].
- Acoustic noise most prevalent directly above motor.
- Sound quickly falls into the noise floor.
- 35% reduction in audible noise by adding fibre-glass acoustic foam.



Conclusions and Recommendations:

- Minimal transmission of internal vibrations (see [Theoretical and Experimental Modal Analysis](#)).
- Utilize a combination of the elastomeric polymer and the existing isolation feet for further developments, including multiple tiers of isolation (See [Isolation Design Summary](#)).
- The main source of noise is the electric motor, and different insulation techniques have shown clear improvements in this. (See [Acoustic Analysis](#)).

Wireless Patient Monitoring

Purpose

Complete a feasibility analysis and a proof-of-concept prototype for a wireless patient monitoring device. This device will use low power sensing systems in hopes of improving respiratory care in neonates, helping increase parental interaction, and providing caregivers with fewer challenges.

Specifications

- To fit on an oval earlobe patch (30 x 16 mm)
- Should not extend further than 8 mm
- To operate in an incubator experiencing 90% humidity, temperatures up to 37 °C
- Transmission distance ≥ 100 m
- To sense temperature, SpO₂, PCO₂ and heart rate.
- Low power circuitry (< 10 mA)

Research



Several communication methods were researched for feasibility and it was concluded that Bluetooth Low Energy (BLE) was the most suitable for the project.

Significant research findings helped the team choose, design and test optimal sensors and electronic components.



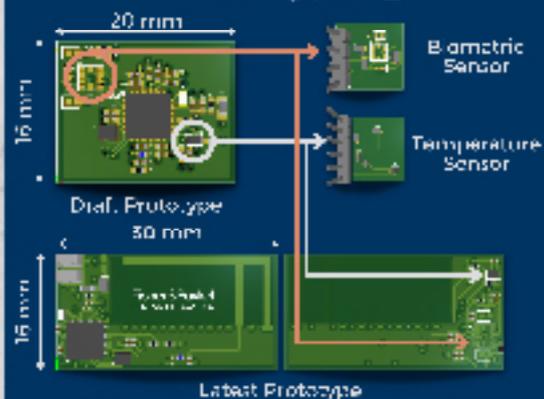
When power management became a concern, a 1 alternative wireless energy harvesting method was tested. However, it did not meet the sizing requirements.

Antenna research was conducted to ensure adequate wireless communication was achieved (1).



Current examples of epidermal patches used for neonate monitoring (2). This example uses NFC communication that requires a lot more material, more waste, and scans over a large area of the neonate.

Prototyping



This small form prototype meets the size specifications and can fit on a neonate's chest. The small form ensures less material waste and easier implementation.

Testing

Biometric Testing



Temperature Testing



References:

- (1) <https://www2.lbl.gov/~/media/emb/Disapplication-note/for-ICSS-designing-with-sub-antenna.pdf>
- (2) <https://www.sciencedirect.com/science/article/pii/S0278594116300010>



Team:
Tenyu Keene
Andro Mikhali
Ryan Walker
Kevin Zhang

Supervisor:
Dr. Yilei Zhang
Clients:
Gerard Chesterton
Philip Rowe



Student projects: Mechanical Engineering and Mechatronics Engineering



Simultaneous Ultrasonic Sensing of Flow Rate and Oxygen Concentration for Neonates



Students: Jessica Aitken, Katherine Ellis, Kimberly Lowe and Gian Padrucci Supervisor: Prof. Mark Jerry
 Client Mentors: Jed O'Brien and Frederick Wright Acknowledgements: Scott Lloyd, Phil Barnes, Bill Mohs and Philipp Hoff



REQUIREMENTS

- Accuracy to $\pm 2\%$
- 95% Precision
- Oxygen concentration sensing between 20-95%
- Flow rate sensing between 2-40 LPM
- Pressure drop < 2 cmH₂O
- Temperature sensing capability

COST

For 1-100 units, 3D printing is most economical. For more units, injection moulding should be considered.

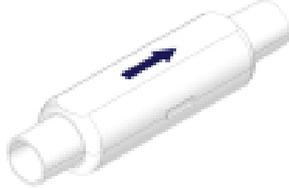
- \$308 for 1 unit
- \$151 for 100 units
- \$128 for 10000 units

Preterm birth is the principal cause of death for one million babies annually¹, requiring the ongoing need for effective respiratory therapies^{2,3}. The purpose of this project was to develop an ultrasonic sensing system to simultaneously display oxygen concentration and flow rate, to ensure the correct delivery of known therapies.



FLOW SIMULATIONS

Described a pressure drop of 0.54 cmH₂O at 40 L/m.

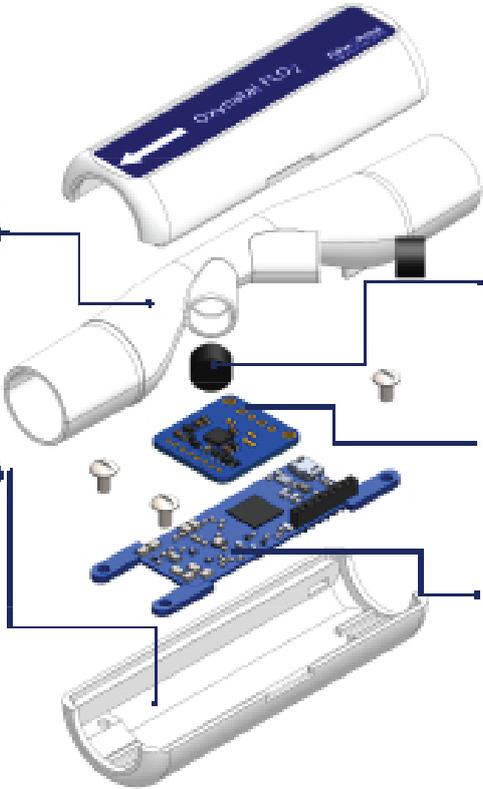


CALIBRATION

Flow rate was validated against TSI 4040 Air Flowmeter. O₂ conc. was validated against 0%, 21% and 99.5% O₂ conc. Correction factors are necessary to improve the accuracy and precision.

MODELLING SENSITIVITY

Modelling showed incorrect temperatures could cause high inaccuracies, so a temperature sensor was needed. Modelling also highlighted relative humidity sensing was unnecessary.



FLOW TUBE

22 mm male taper connectors, left to the central tube. 2 secondary tubes locate the transducers. Ultrasound is reflected across the flow.

OUTER HOUSING

Upper and lower parts fit within 35 mm diameter and 85 mm length.

- Opening clasp
- Minimal gaps
- Tight fit between parts
- Bosses for PCB fit
- Tabs for flow tube fit
- Outlet for power
- Flat top and bottom
- Directional flow arrows
- Finishing sticker

TRANSDUCERS

Two 300kHz transducers which each transmit and receive an ultrasonic signal.

TEMPERATURE BOARD

PT100 temperature sensor with Adafruit MAX31865 breakout board.

CUSTOM PCB

Based on Texas Instruments EVM430-FR6043.

- 5V Micro-USB connection
- 8-pin header instead of standard JTAG
- SPI connections for temp. breakout board

¹ Quinn JA, Hanson PH, Gonik B, Pruss L, Collard C, Haller-Hoore T, et al. Preterm birth: Case definition & guidelines for data collection, analysis, and presentation of immunisation safety data. *Vaccine*. 2018;36(49):6947-56.

² Babig R, Henry C, Gang S, Wagner H, Raeborn A, Valerian M, et al. The newborn delivery room of tomorrow: emerging and future technologies. *Pediatric Research*. 2021.

³ Gupta S, Donn SM. Continuous positive airway pressure: Physiology and comparison of devices. *Semin Fetal Neonatal Med*. 2018;23(3):264-71.



Plant Research (NZ) LTD.

Weeding Agricultural Robotic Solution

Background

Plant Research (NZ) Limited are plant breeders based in Templeton, Christchurch, specializing in peas, oats, wheat and triticale. Currently they employ seasonal workers to hoe the weeds between crop rows, at a large cost to the company. An engineering solution was desired to reduce this dependence.

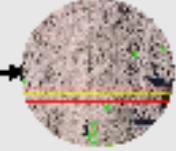
Project Brief

Design and implement a robotic solution capable of autonomously navigating through crop fields, identifying weeds and spraying them with a herbicide. Previous teams have already completed the chassis, drivetrain and power componentry.

Robust Weed Detection

- Simple and effective colour detection algorithm using Open CV functions in Python.
- Features variable size spraying, cluster detection and a linear tracking algorithm.
- 70% detection accuracy during testing.





Raw 480p Image
Colour Segmentation
Tracking

High Accuracy Navigation

- GNSS positioning using an Emlid Reach RS+ provides a global position accurate to 0.1 m.
- Implements a generalized path following algorithm, with a focus on minimizing row deviation.
- Capable of following a path with a deviation of less than 0.1 m.



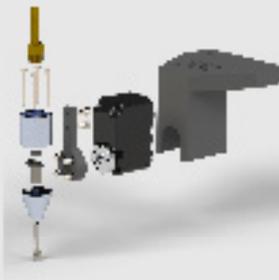
Obstacle Avoidance

- Detects obstacles using a single front facing Intel D435 stereo camera.
- Dynamically re-adjust paths to avoid obstacles in the row.
- Store obstacle image and location for the user to review.



Micro Jet Spraying

- Single degree of freedom servo operated positioning system.
- Micro dose solenoid actuated nozzle.
- Dynamically controllable dosage volume.
- Closed loop pump control regulates system pressure for greater accuracy.





2022 Team: Arton Muselov, Mark Gardyne, Sam Bain, Thomas Peterson
 2021 Team: Luke Burke, Daniel Bowles, Tristan Weastell, Matthew Bertschinger
 Client: Adrian Russell, Briar Kinney (Plant Research Ltd)
 Supervisor: Dr Yilei Zhang Technicians: Julian Murphy, Dave Fanner



ANIMATRONIC KIWI

BACKGROUND

Seventy percent of reported kiwi mortalities are attributed to dogs. Kiwi aversion training is an effective technique for reducing kiwi deaths. However, current props are static and some have a limited lifespan. The animatronic kiwi is an attempt to improve upon current kiwi avoidance training props by introducing motion to capture the dog's attention. It needs to operate quietly and stimulate the dog with visual cues.

BODY MODEL

A model of a kiwi body was produced using both 3D scans and interpolated 2D images provided by the National Kiwi Hatchery and the University of Canterbury. The body was covered with patterned fur to emulate kiwi feathers.



WIRELESS RELEASE

The prop is activated using a radio controlled relay that allows the trainer to release the prop from a distance of up to 30 m. A DC motor is used to actuate this mechanism. The mechanism is powered using rechargeable batteries for portability and sustainability.



Student Team: Matthew Bloomfield, Joost van Gorp, Samuel Schneider, and Josiah Duffield
Supervisor: Tim Giffney

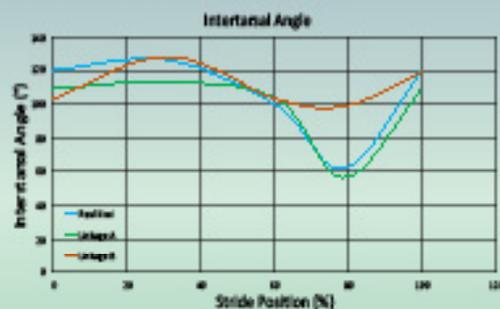
Client: Emma Bean

Project Mentors: Blake Cole, Karl Molving, Rob Whitten, and Marie-Joo Le Guen

Technicians: Julian Murphy, Julian Phillips, and Daniel Bishop

LOCOMOTION MIMICRY

Kiwi leg motion was replicated by comparing the joint angles of a real kiwi with the angles produced using two alternative mechanical linkages. The angles of the most realistic mechanism were then optimised using MATLAB software. Flexible silicone joints were used to allow the prop's legs to interact with the ground.



DRIVE SYSTEM

The kiwi is powered by a quill spring for its reliability, quiet operation, and repeatable slow release energy storage. The power from the quill spring is transmitted to the drive wheel and the leg linkage using toothed pulleys and belts. The drive wheel propels the kiwi along a rail.



Student projects: Mechanical Engineering and Mechatronics Engineering

DIE COOLER OPTIMISATION FOR THE CONTINUOUS CASTING OF BRONZE



FRASER
Engineering Services



UC
UNIVERSITY OF
CANTERBURY
Engineering Services

What is Continuous Casting?

AW Fraser manufactures round bronze bar via the continuous casting process. Molten metal flows through the graphite die, and heat is extracted by the water-cooled die cooler to solidify the bar.

Problem:

- AW Fraser's mild steel die coolers distort, reducing the heat transfer efficiency.
- Die Coolers also experience cracks which propagate over time into the coolant channel causing leakage.
- Failures result in over \$400,000 of production losses each year per machine.
- The team was challenged to determine the cause of the failures and recommend cost-effective design changes to the die cooler to reduce failure frequency.

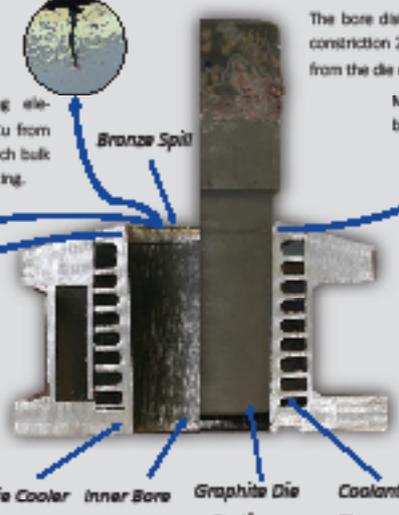
Cracking:

Diffusion of bronze product into the steel makes the rim susceptible to cracking above 723C.

Cracks allow embrittling elements such as Zn and Cu from liquid bronze spills to reach bulk material to progress cracking.

High temperatures change the microstructure and degrade material properties.

Die Cooler Failure Analysis:

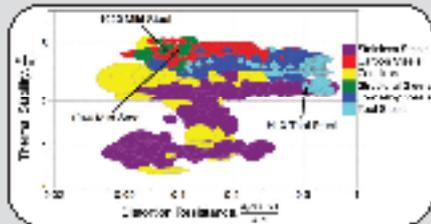


Distortion:

The bore distorts along its length, most significantly the constriction 20mm below the upper rim separates the die from the die cooler.

FEA predictions show that heat from bronze solidification causes high thermal gradients near the constriction bore depth, resulting in permanent distortion.

Material Selection:



- ANSYS Granta software used to explore material options.
- Optimization of thermal stability and distortion resistance.
- Also consider cost, weight and service temperature.
- Tool steel family shown to have improved performance over original mild steel.

Solution:

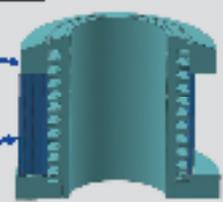
Hybrid design with Uddeholm Orvar 2M (H13) Tool Steel and 1020/1040 mild steel.

Choices were influenced by the national availability of materials and the manufacturability of tool steel.

Welding and heat treatment plans were developed.

AW Fraser will test the performance of the planned prototype in 2023.

Prototype:



Students:
Megan Bellon, Hayden Weaver

Sponsors:
AW Fraser, Fraser Services, Torvik Motive

Contributors:
Dr Catherine Bishop, Dr Oscar Torres, Dr Niko Eral, Dr Mathias Sailer

Dr Natalia Kozoluk, Sam Hummer

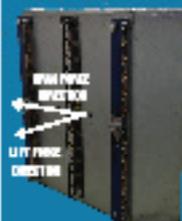
Stavros Mucolo, UC Workshop Staff

THE FARRA HIGH RISER

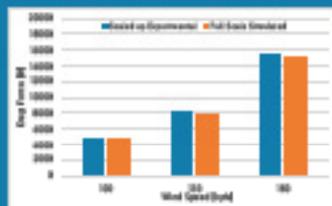
PROJECT GOALS

- Investigate historical wind speed data for a range of cities
- Review relevant wind and scaffolding codes
- Design and test aerodynamic cladding solutions for the original High Riser shape using Computational Fluid Dynamics (CFD) and a wind tunnel with the aim of allowing the High Riser to be used in extreme wind conditions
- Investigate a range of cladding materials and recommend the most appropriate solution
- Select appropriate horizontal restraints using testing results

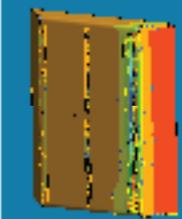
BASILINE CONCEPT: 45 DEGREE SHELL WITH TRUSSES



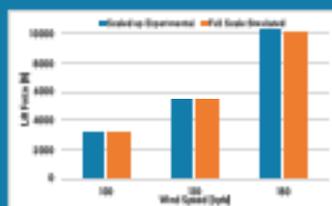
1:20 SCALE MODEL



DRAG FORCE ON THE FULL SCALE MODEL VS. WIND SPEED



CFD PRESSURE MAP



LIFT FORCE ON THE FULL SCALE MODEL VS. WIND SPEED

THE ORIGINAL HIGH RISER: Spencer on Byron Project (2019).
A modular building maintenance unit used for façade refurbishment

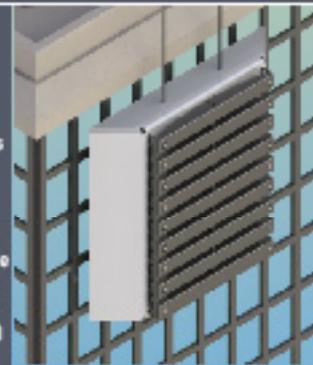


EXPERIMENTAL WIND TUNNEL TESTING: Our team manufactured 1:20 scale models of each aerodynamic cladding concept which we then tested in a wind tunnel at speeds of 60 – 180 km/h to determine drag and lift forces.

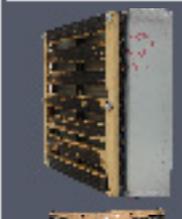
COMPUTATIONAL FLUID DYNAMICS (CFD): The aerodynamic performance of each concept was simulated using CFD to determine the drag and lift forces, alongside the drag coefficient. The models were validated by comparing the simulated results with the experimental results before scaling up the model to the High Risers full size.

THE FINAL CONCEPT

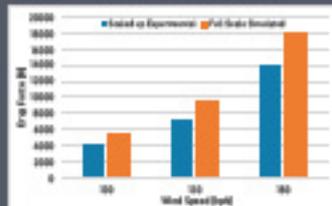
The final cladding concept uses a combination of inverted airfoils and a 45 degree shell. Compared to the original High Riser design the additional airfoils reduce the lift force pulling the cradle away from the building, and the 45 degree shell streamlines airflow over the cradle. Polyethylene was chosen as the cladding material as it was the most economical, low weight, and high strength option.



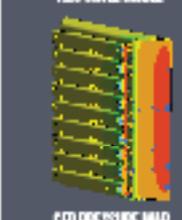
ADVANCED CONCEPT: INVERTED AEROFOILS



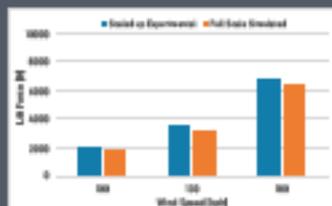
1:20 SCALE MODEL



DRAG FORCE ON THE FULL SCALE MODEL VS. WIND SPEED



CFD PRESSURE MAP



LIFT FORCE ON THE FULL SCALE MODEL VS. WIND SPEED

PROJECT OUTCOMES

- Our team provided concepts for the cradle shape, horizontal restraint system, and cladding material that will reduce the restraint loads and make the High Riser safer and more efficient than other scaffolding products on the market.
- Using advanced analysis such as wind tunnel testing and CFD, our team provided wind loading data for a range of complex cladding geometries that Wind Code Standards alone cannot provide.
- We also verified that using simple procedures such as following the New Zealand and International Wind Code Standards are valid methods for evaluating wind loading on a non-complex cradle shape.

GROUP MEMBERS: Katie Rata Gottlieb, Maurice Polz, Morgan Gibbons, and Jarrod Harrison

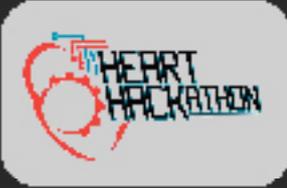
PROJECT SUPERVISOR: Professor Geoff Rodgers

CORPORATE SPONSOR: Thomas Schweitzer, Design and Innovation Manager of FARRA Engineering

SPECIAL THANKS TO: Bill Mohs, David Reid, Tony Doyle, Anthony Doyle, and David Fanner



Total Artificial Heart



Problem statement

There is a high incidence of heart disease and severe lack of available transplants. An artificial heart aims to prolong a person's life until a transplant is available, or possibly indefinitely.

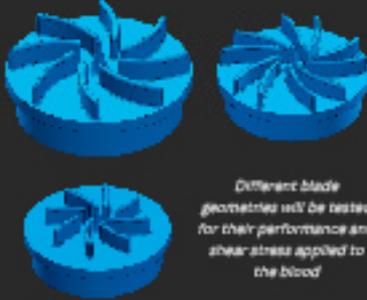
Our goal is to design a compact, implantable system that mimics the pumping action of the heart's left and right ventricles.

Requirements

- 5-7L/min of flow
- Pressure equivalent to 120/80 (mmHg)
- Avoid damaging the blood cells

Pump design

The first prototype is a centrifugal pump with turbine blades designed to pump blood without damaging it. The pump housing is manufactured using 3D printed tough resin for precision and water-tightness. A modular design allows for quick switching of blades, for rapid testing.



Different blade geometries will be tested for their performance and shear stress applied to the blood.

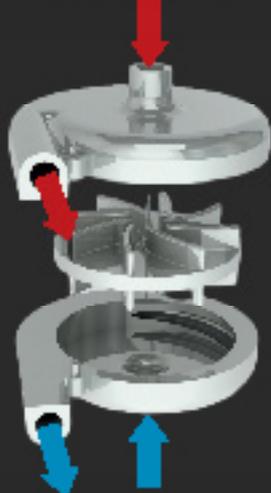
Future plans

Future Heart Design

- Magnetically levitated
- Dual Chamber
- Electromagnetic motor

Future Control Design

- Measurement of body's impulses
- Adaptive flow output



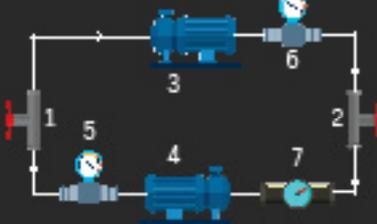
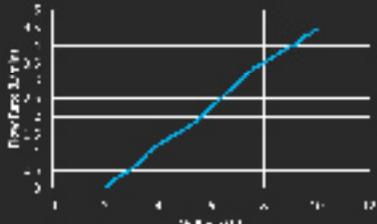
Future designs will use a dual-sided magnetically levitated turbine to emulate the left and right ventricles, transporting both oxygenated and deoxygenated blood.

The Heart Hackathon

The Heart Hackathon is the world's first tertiary total artificial heart design competition. Student teams from around the world will compete to design and prototype a total artificial heart.

Testing station

The testing station allows for verification of the heart's output by simulating the systemic (1) and pulmonary (2) loads of the body. The left and right ventricles are represented by pumps (3, 4). The pressure (sensors 5 and 6) and flow (sensor 7) are measured frequently, allowing for a control system to adjust the pump's output according to the body's needs.

The testing station is capable of measuring a pump's pressure and flow output to verify the heart's performance.



TEAM M10
 Luke Forrester
 Sarah Maden
 Harvey Morton
 Anahita Piri
 Christopher Hoyle de Lange
 Dr Debbie Masro




Student projects: Mechanical Engineering and Mechatronics Engineering



Stainless Steel Corrosion Investigation



PROBLEM

Pitting corrosion in Fonterra's processing pipes made of stainless steel due to presence of chlorides. Pitting is the formation of small holes on component surface, can also be affected by temperature, flow and pH.



Not estimated
Cos. of Corrosion: Loss of product

\$16 billion

High costs

Designing for corrosion resistance

Plant's upstream Local corrosion Lead standard hydrochloric



Flow

METHOD

- A material's resistance to pitting can be quantified by its critical pitting potential (CPP), which is sensitive to the temperature and chloride concentration of the fluid.
- This can be found using a technique known as cyclic potentiodynamic polarization.
- We designed a testing rig that allowed us to find the CPP of 304L and 316L stainless steel grades at temperatures between 30°C and 70°C under stagnant and flow conditions.



Flow used to simulate and corrode

Stainless steel

Graphite anode electrode

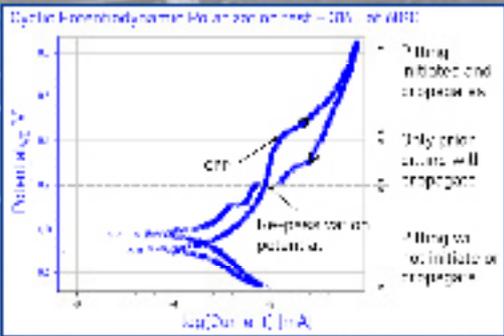
RESULTS

304L STAINLESS STEEL

- Breakdown potential little variation with temperature

316L STAINLESS STEEL

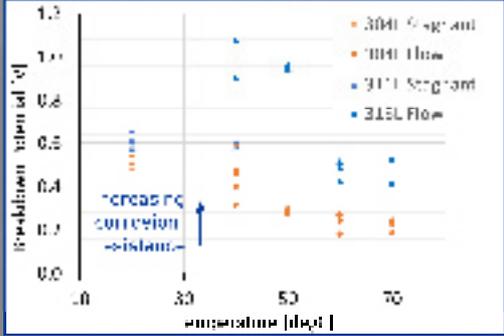
- 40-50 °C was not a harsh enough environment to cause pitting, and instead another phenomenon known as transpassive dissolution occurred
- Pitting was observed for 60-70 °C, as indicated by the lower breakdown potential



Stagnant cyclic potentiodynamic polarization

FLOW VS STAGNANT

- Stagnant solutions experienced lower breakdown than flowing



Breakdown Potential (V)

temperature (deg C)

From Birchall, Lew, Richerson, Loch Scott, and Wu Smith

Sponsor: Jack Roberts – Fonterra

Supervisor: Paul Callaway Bishop

Thanks to Oscar Thomas and the workshop technicians.

79

Measurement of Heavy Vehicle Towing Forces



Purpose

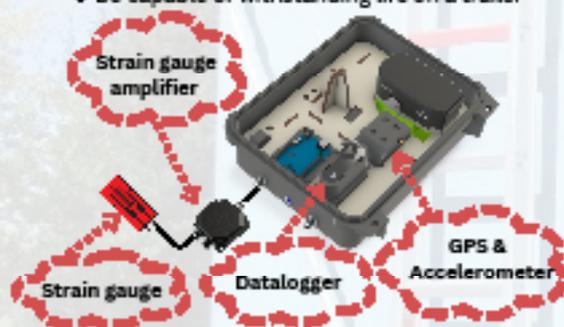
The purpose of this project was to design a system which could attach to a truck trailer and measure the axial towing forces, trailer acceleration and location.

Specifications

- Battery powered - minimum life 24 hours
- Be able to measure in excess of the expected forces from NZS5446:2007
- Be equipped with GPS and an accelerometer
- Force measurement accuracy of +/-3%
- Be capable of withstanding life on a trailer



A trailer drawbar with the system installed



Solution

- Strain gauges are glued onto the drawbar to measure strain. These can be calibrated to output the force transmitted through the draw bar.
- A datalogger stores the strain measurements, location and acceleration from several modules.
- A power tool battery is used to power the system.
- MATLAB is used to process the data.

Calibration

- A calibration rig was designed to calibrate the strain gauges upon installation. This does not remain on the trailer.
- The rig is placed between the truck and trailer. The truck pulls forward and exerts a force through a calibrated load cell. This known force is used to calibrate the strain gauges applied to the draw bar.



Testing & Results

- The system was tested on a truck and trailer.
- A sample of the non-calibrated force measurements is shown below.



Strain gauges being applied to a drawbar

Team: Caleb Emmers, Ethan Stewart, Jack Fairmaid, Matthew Emmett
 Sponsor: TransTech Dynamics Ltd
 Client mentor: Dr Tom Brooks
 Supervisor: Dr Angus McGregor
 Technicians: Oscar Torres, Julian Phillips, Julian Murphy, Zac Perston, Tony Doyle, Antony Doyle, Garry Cotton, David Fanner
 Special thanks: Special thanks to Frews Transport in Darfield for allowing us to test the system on one of their trailers.
 CAD Models: CANedge2, CANmed.gpc: <https://casellectronics.com/> Battery: Grabcad - user: DS
 Measurement node: <https://villagsystems.com/> Ringfeder: TransTech Dynamics
 Strain gauge: <https://www.tml.jp/>



FYP Project M33
 This project was made possible by the University of Canterbury

CYBER POTATO



MOTIVATION

Wyma Solutions are world leaders in innovative post harvest processing of fruit and vegetables. They are seeking a solution to reduce the damage occurring to their potatoes.



PROJECT AIM

To create a data acquisition device to identify impacts on a potato as it travels down a packhouse line. The data collected will help Wyma to accurately quantify and locate impacts occurring to a potato. This means their packhouse line can be modified to reduce bruising and wastage.

SOLUTION

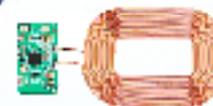


ORIENTATION

Uses 9DOF IMU with sensor fusion to determine the impact orientation at a sample rate of 25Hz.

IMPACT ACCELERATION

Records impacts up to 500g at a sample rate of 3.2kHz.



WIRELESS CHARGING

Allows for waterproof charging of the device with a 4 hour battery life.

SHELL DESIGN

Urethane coated, 3D printed shell has a density of 1.08g/cm³. This provides mechanical properties that mimic that of a real potato.



SOFTWARE

Wi-Fi user interface enables control of data acquisition and access to test results from any wireless device.



PROJECT TEAM
Azmarah Manjapathy
Amos Plumptre
Yazmin Shipley
Pravin Tangavelu

SUPERVISOR
Dr Chris Pretty

TECHNICIAN
Julian Murphy

CLIENT
Wyma Solutions
Cory Smitheram



THE BEST FROM EVERY HARVEST
wyma.co.uk

Vegetable Polisher Clean In Place System

Problem

The Wyma Vegetable Polisher cleans produce post harvest. Over time dirt and vegetable debris build up on the interior walls and brushes which can hinder performance and potentially support bacteria growth. Currently, Wyma's vegetable polishers are manually cleaned which is highly time intensive and produces variable results.

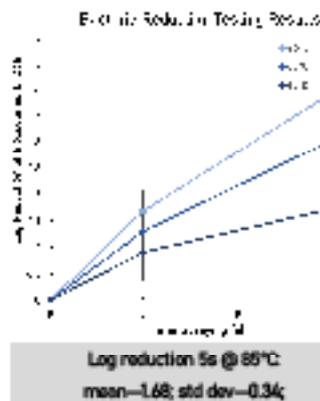


Aims

- Remove vegetable debris from the interior walls and brushes
- Determine requirements for bacteria reduction
- Integrate into a built-in clean in place system

Bacteria Testing

- Log reductions of E. Coli on brushes were measured after simulated cleaning at 65-85°C.
- Implementing 5s spray @ 85°C for 1.5 log reduction based on reduction requirements and minimising water usage.



Brushes and Interior Walls Testing

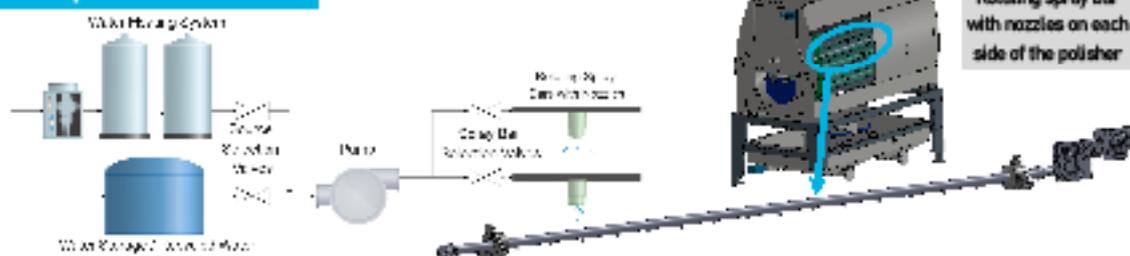
1m long spray bar @ 5 bar pressure with interchangeable nozzles

Bar in stationary position at set distance away for the test

Apply water for set period of time (30-60s)



Proposed Solution



Daily Cleaning Cycle

Step 1: Clean Interior Walls:

- High pressure water flows through 65° fan nozzles at 5 bar, 7.7 L/s
- Two spray bars rotate sequentially to reach all interior walls surfaces
- Reaches distances from 90 mm to 1000 mm
- Total water usage: 2,500 L per cycle

Step 2: Clean Brushes

- High pressure water flows through 65° fan nozzles at 5 bar, 7.7 L/s
- One spray bar operates by remaining stationary as polisher drum rotates, 150 mm away from brushes
- Total water usage: 14,000L per cycle for a 14 brush shaft polisher

Weekly Cleaning Cycle

Bacteria Reduction Phase:

- Water heating system delivers 85°C water at 2.5 L/s
- Low pressure heated water flows through 65° nozzles on spray bar
- One spray bar is able to spray all brushes
- Total water usage: 1500L per cycle



Project Team Members:

Max Bowron
Nathan Pain
Stephanie Lee
Kate Wells

Supervisor:

Dr Angus McGregor

Client: Wyma Solutions

Dr Kent Stewart

Acknowledgements:

Rayleen Fredericks
Garry Cotton
A. S. Wilcox & Sons
Crozier Farms



VOLLĒ GOLF: GOLF SWING MACHINE

Cole Baker-Smith, Lewis Griffin, Sam Middelberg and Ben Remacha

Client Background

Vollē Golf was founded in 2018, launching New Zealand's first premium direct-to-consumer golf ball. It was a commercial success, and Vollē began looking ahead to new and continued product development.

Having been conducting their product testing with an independent company in the United States, they found the process to be expensive and cumbersome. So, the idea was born to design and build a test bed capable of replicating a golf swing through impact so Vollē can locally test new ball designs.

Design Criteria

To be a success, the design needed to meet these six criteria:

Consistent
Must produce repeatable results

Interchangeable
Can hit all major types of golf clubs

Adjustable
Can change swing speed and impact angle (AoA)

Presentable
Will become a marketing tool

Transportable
Needs to be used for offsite testing and demo days

Simple UI
Easy to modify swing parameters

Proposed Solution

Motor Platform

The motor platform provides a stable mounting point for a 3-Phase AC servo-motor. The motor can deliver swing speeds up to 110 Mph, and produces consistent swings every time. The shaft angle can be adjusted to suit the type of club being hit.



Ball Tracking

An off-the-shelf launch monitor can be set up and used to get real time data of every shot.



Rotating Arm

An aluminium arm reinforced with steel brackets provides a lightweight and rigid solution. The club is mounted in quick change clamps at the bottom of the arm.

Acrylic Shrouds

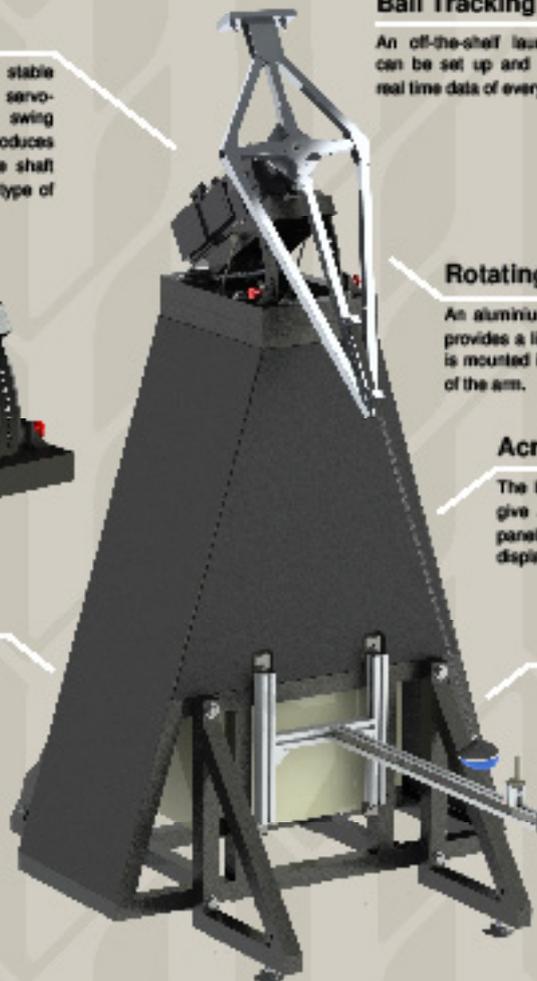
The body of the machine is shrouded to give a clean finish to the design. These panels can also be screen-printed to display the clients branding.

Transportable Design

The motor platform, tee box and legs can all be removed for transport. When disassembled, the machine can be transported using a standard sized trailer. Wheels are also mounted to the rear legs to make transport easier when fully assembled.

Tee Positioning

To be able to hit with different clubs, the tee is mounted to a cantilevered arm that can be moved and locked in place anywhere in the tee zone. This is also how the impact angle (AoA) is changed.



Special thanks to: Tim Gilbey (project supervisor), Tony Doyle and the UC Mechanical Workshop, Rodney Elliot, and all other parties who have helped us to achieve our project goals.



Environmentally Friendly Hot Water Heat Pump

Project Brief

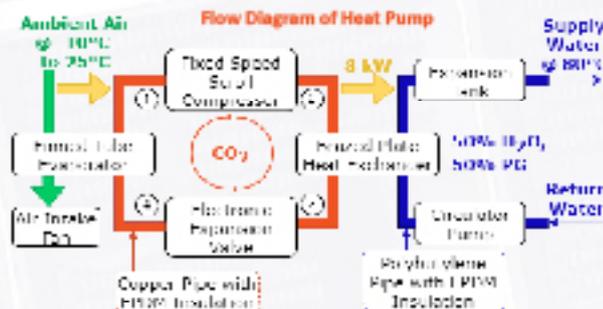
Our project tasked us to create a CO₂ heat pump to deliver hot water to an indoor fireplace. A gas fireplace can produce over 8 kW of heat output while an electric fireplace can produce 3 kW of heat output. The aim was to deliver a heat pump that could produce the heat output of a gas fire with the efficiencies and environmental safety of a heat pump. CO₂ was selected as it is an environmentally friendly refrigerant as it has a Global Warming Potential (GWP) of 1, compared to commonly used R290 (propane) refrigerant (GWP of 4) and R32 (GWP of 677).

Specifications

- 80°C hot water supplying 8kW of heat energy
- COP higher than 3.5 at 15°C
- COP higher than 2.0 at -10°C
- Sound Pressure Level (SPL) of 40 dB at 1 m from unit.

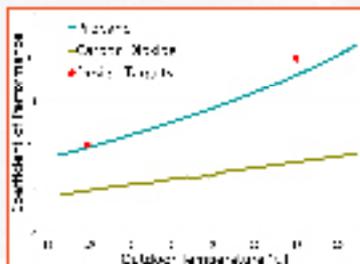
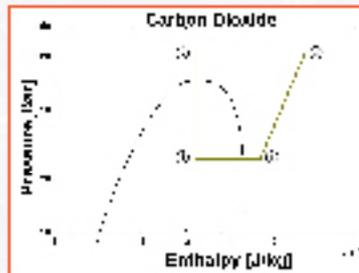
Deliverables

- Component selection and justification
- Component configuration and design layout
- Acoustic and thermodynamic analyses supporting our component selections.



Thermodynamics

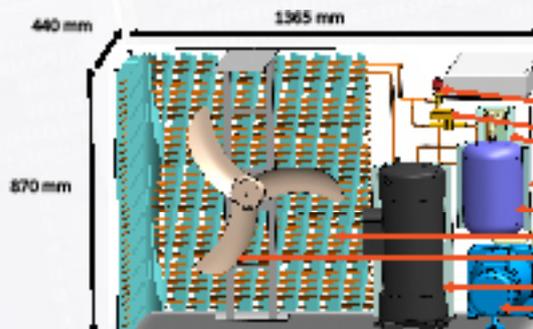
- Engineering Equation Solver (EES) was used to model the thermodynamics
- EES model informed component sizing
- Scope changes lead to comparison with propane.



CO ₂	Propane
Transcritical	Subcritical
80 bar min. operating pressure	30 bar max. operating pressure
High temp. output	97° max. temp.
Lower COP	Higher COP

Acoustics

- Suppliers chosen based off provided sound data
- Fan speed lowered at cost of increasing heat exchanger
- Fan simulated in Comsol to verify sound at 1 m
- Effect of aesthetic housing features compared



Component	Component Sizing
Electronics Box	420x275x85 mm
Electronic Expansion Valve	140 bar max. pressure
Solenoid Valve	Used in defrost cycle
Brazed Plate Heat Exchanger	Surface area of 0.195 m ²
EPDM Insulation	1 inch - 2 inch thick
Water Buffer/Expansion Tank	Volume of 8 L
Fin and Tube Heat Exchanger	Surface area of 25 m ²
Axial Fan	630 mm in diameter
Scroll Compressor	15 cm ³ per revolution
Circulator Pump	10 m Pressure Head



Team Members:
David Evans Josh Stewart
Tim Smith Jack Yates

Supervisor:
Bill Mohs

Clients:
James Fisher Troy Jolly
Luke Davis



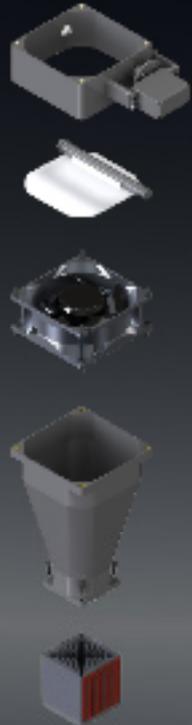


Thermal Modelling & Experimentation for Unmanned Stratospheric Vehicles

Project Brief

Develop and build an instrument payload for a high altitude balloon to demonstrate active heating and cooling in stratospheric conditions, and record and control measurements throughout the flight.

The payload will be subjected to high altitude conditions expected to reach up to 100,000 ft in the stratosphere. Both airframe, instrument and payload are subjected to high pressure and temperature variations throughout the mission, where the payload must reach TST of 100°C during heating and TST of 0°C during cooling. The payload may experience all of this and the payload must be designed to ensure the maximum life of payload and data for an 8 day flight temperature range.



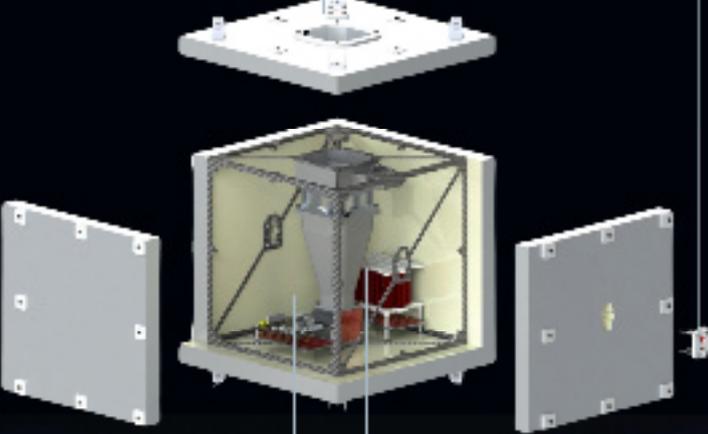
Payload Final Design

Multilayer Radiant Shielding

Shielding is used to protect the payload from the harsh environment of the stratosphere. The shielding is made of multiple layers of different materials to provide thermal insulation and protection from radiation.

External Sensor Modules

External sensor modules are used to monitor the environment and provide data to the payload. These modules are designed to be robust and reliable in the harsh environment of the stratosphere.



Electronics

The electronics are used to control the payload and provide data to the ground station. They are designed to be compact and reliable in the harsh environment of the stratosphere.

Heating System

The heating system is used to maintain the payload at a constant temperature during the flight. It consists of a heater and a temperature sensor to monitor the payload temperature.

Cooling System

The cooling system is used to maintain the payload at a constant temperature during the flight. It consists of a cooler and a temperature sensor to monitor the payload temperature.





Team Members

Chris Williams
Liam Williams
Liam Williams
Liam Williams
Liam Williams

Supervisor

Chris Williams

Client Mentors

Chris Williams
Liam Williams



Kea Aerospace

Student projects: Mechanical Engineering and Mechatronics Engineering

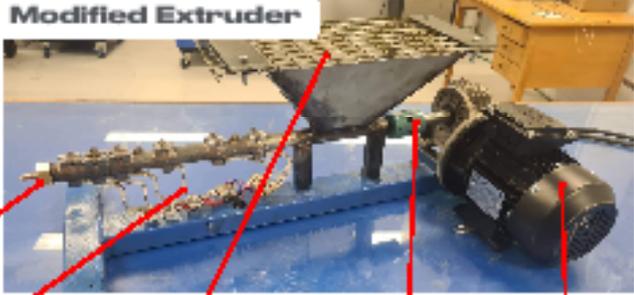
ECO-FRIENDLY REINFORCEMENT FOR CONCRETE



OBJECTIVES

1. Develop a co-axial pultrusion machine capable of producing glass fibre reinforced plastic (GFRP) rods
2. Combine pultruded rods into a single 8 mm rebar
3. Determine the mechanical properties and examine microstructure of the GFRP rebar

Modified Extruder

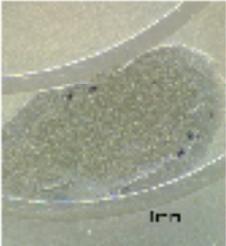
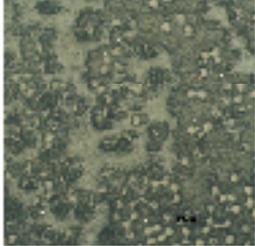


Extrusion Dia Hopper Safety Cover Screw Coupling Motor and Variable Speed Drive

Heating Element Wiring

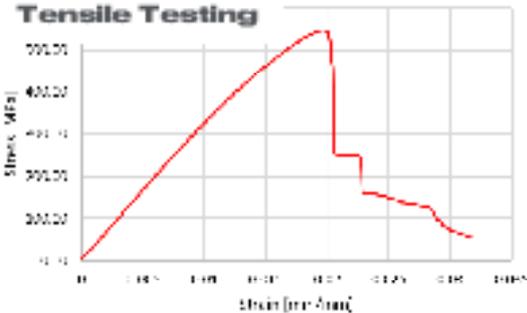
RESULTS

Microscopy

Optical microscopy was used to determine how the degree of impregnation changed with processing parameters

Tensile Testing

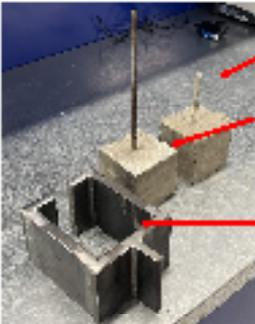


Tensile testing revealed that the GFRP rods have an ultimate tensile strength of 545 MPa

The highest quality GFRP rods were produced at a barrel temperature of 230°C with a screw speed of 20 RPM

The GFRP rebar with no surface treatment has a pull-out strength of 2.25 kN in concrete

Pull-out testing



GFRP rebar in concrete

Steel reference rebar in concrete

Specimen holder for pull-out testing



Team:
Daniel Yu
Isambard McMinin
Logan Bigwood
Rousseau Ross-Baker

Supervisor: Prof. Dirk Pons
Client: Anton Good
Special Thanks:
Julian Murphy
Tony Doyle
David Road



UNIVERSITY OF
CANTERBURY
Te Ararohe o Te Taumata Rau

UCM35

Adam Donaldson, Ryan Morton, Sam Coldicott and Sam Walls.

ELECTRIC LAND SPEED VEHICLE AERODYNAMICS

Project Brief:
Design and manufacture a streamlined and stable aerodynamic package for an **electric land speed vehicle**. The vehicle will compete in the Dry Lake Racers Association (DLRA) Speed Week and Bonneville Speed Week competitions with the goal to break the current E1 class world land speed record.

Aerodynamics

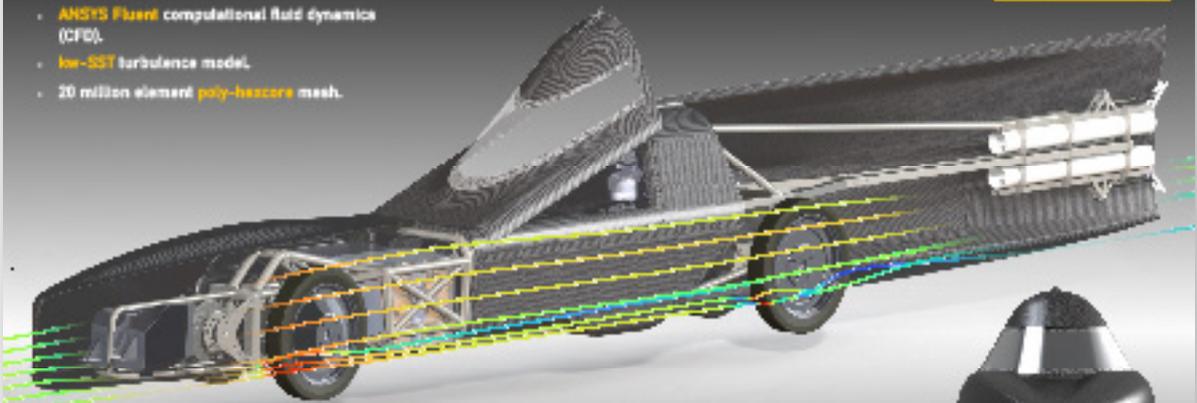
- Low Drag Coefficient: $C_d = 0.331$.
- Large tail produces **restorative** moment at all yaw angles.
- Balanced downforce creates **stable pitch** moment at all ride heights.
- Sharp fit** along tail separates flow in yaw to reduce unwanted lift.
- Wedge nose** design diverts flow around vehicle to reduce lift.
- ANSYS Fluent** computational fluid dynamics (CFD).
- low-SST** turbulence model.
- 20 million element **poly-hexcore** mesh.

Canopy

- 4 bar** linkage hinge mechanism with gas strut actuation.
- 3mm** Polycarbonate windshield.
- Actuated from inside and outside for safety in case of rollover.

Parachute and Safety

- 1m** diameter UCM made ripstop nylon **crossform** parachute.
- 0.5G** peak deceleration.
- 2.4m** commercial drag racing reserve chute.
- Pneumatic** actuated release.
- Mechanical and pneumatic **relief backups** in event of failure.



Thermal Management

- Closed loop **ice cooling** system for motor and inverter.
- 30L** Tank with internal baffle plate.



Composite Manufacture

Composite body panels created from a combination of **carbon fibre**, **Kevlar** and **Carbonel** to reduce weight, increase stiffness and produce a smooth surface finish to lower drag.

- CNC Mould Prepped
- Carbon fibre layup
- Carbon fibre resin infusion
- Finished part released.







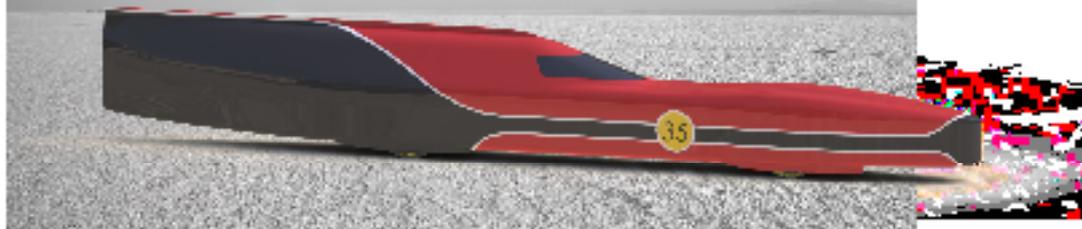
Clients:
Dr. Kevin Clemens
Bruce Robertson

Supervisor:
Dr. Natalia Kabailuk

Special thanks:
Mechanical Workshop Staff
Professor Mark Jermy
Dr. Bill Melis
Dr. Eva Häkansson
Dr. Lewis Clark



M22 | UCM 35 E1 Land Speed Record Vehicle



Project Goal :

University of Canterbury Motorsport aims to design, manufacture and compete for the **under 300 kg electric world land speed record**. The team also to build a world class vehicle using engineering concepts necessary in land speed racing.

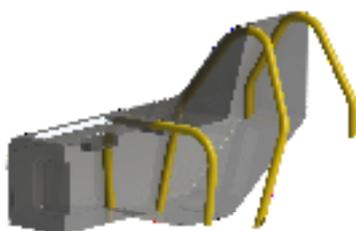
Chassis Goals :

- ▶ Safety
- ▶ Lightweight
- ▶ Transportability

Chassis Team :

Essam Fergouse
Byron Shields
Dermic Powell

The UCM35 vehicle uses a hybrid of a carbon fiber mid section (monocoque) and steel tube front and rear (spaceframe) sections. The front and rear spaceframes provide structure from the monocoque where components are mounted to. The use of spaceframes was developed by the complexity of component-mounting and length of the vehicle. Without the need for the mold making process required for a composite structure, the spaceframes provided a cost and time-efficient solution.



Driver Safety

The vehicle incorporates a CO2 and AFFF Foam suppressive system mounted to the rear of the monocoque. Both systems are activated via pull cables within the monocoque.

The system also is to suppress a potential fire until the driver is able to egress from the vehicle successfully.

Monocoque

The monocoque serves as a protective capsule to rest the driver. The Monocoque is constructed from a carbon fibre honeycomb-structure, providing a stiffness and strength to weight ratio superior to steel.

Steel roll hoops are embedded within the carbon fibre side to provide additional protection to the driver in the form of energy absorption.



Spaceframe

The vehicle is designed with two spaceframes either side of the monocoque that integrate the beamsteer and powertrain components.

Both were designed for suspension, power delivery and powertrain loads. Removable spaceframe sections allow for accessibility and storage of the vehicle in a 20 foot container.



Future of UCM35

UCM35 will compete in the Dry Lake Basin Australia (DLBA) speed week competition in March 2023, with the goal to break the current world record held by Brigham Young University. UCM will race Under Bert Mularo's coach number 89 through the blessing of the Mularo family.

Supervisor: Bruce Robertson | Clients: Math Cassara, Bruce Robertson

Acknowledgements: Antony Doyle, Tony Doyle, Rodin Carr, Ryan Martin, Max Zhang, James Ward



UCM35

Oisicelle Bright, Andrew Fudge, Samuel Rowland, William Selinger

ELECTRIC LAND SPEED VEHICLE

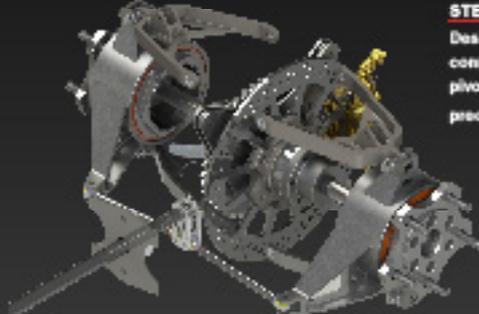
M23

POWERTRAIN

PURPOSE STATEMENT

To design, manufacture and integrate the powertrain for the World's Fastest Electric Land Speed Vehicle in the E1 class (Electric < 500 kg), competing at Lake Gairdner, Australia in March 2023, and Bonneville USA in August 2023.



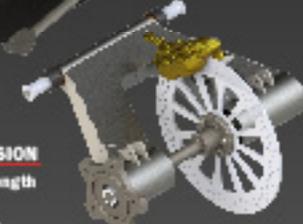


FRONT ASSEMBLY

The front assembly was designed to minimize cross-sectional area while providing stability and control. Front wheel drive allows the rear assembly to be drastically simplified as well as moving the centre of gravity further forward. A parallel-mounted double wishbone system was used for suspension to enable independent wheel movement with zero hump steer.

STEERING

Designed for safety with a quick release wheel connected to a chain and link system with a pivot arm. A 10:1 steering ratio allows for precise wheel adjustment.



REAR SUSPENSION

Designed for strength and simplicity. The rear assembly utilizes a centrally mounted brake rotor and a dependent suspension system through a motorbike style swingarm.

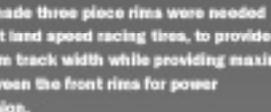
DRIVER PEDALS

Both pedals are adjustable, with dual push type master cylinders, a brake overtravel switch and a rotary position sensor on the accelerator.



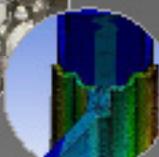
MOTOR ASSEMBLY

The 200 kW motor provides a single speed direct drive to the wheels through a sprocket chain assembly. The sprockets can be changed to define maximum speeds and the chain can be tensioned by adjusting the motor angle using the adjustable standoffs.



DESIGN & MANUFACTURING









RIMS

Custom made three piece rims were needed to support land speed racing tires, to provide a minimum track width while providing maximum area between the front rims for power transmission.

SPECIAL THANKS

Tony Doyle, Antony Doyle, Richard Jahan, David Fanner, David Road, Dominic Powell, Max Zhang.

Client & Supervisor
Bruce Robertson

Client
Nevele Clemens



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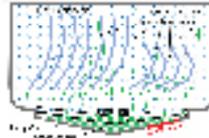
Student projects: Mechanical Engineering and Mechatronics Engineering

DishDrawer Steam Drying

Background

Motivation

Currently, dishes are dried with hot water. This wastes energy as heated water goes down the drain. Steam heating transfers heat through condensation so wastes much less water and energy.



Objectives

- Retrofit the DishDrawer to efficiently produce steam
- Ensure steam drying meets drying quality standards by heating dishes to 60°C
- Produce and demonstrate an efficient steam drying cycle
- Explore further heating efficiency improvements

Producing Steam



Instrumented Test Rig

1. DishDrawer (provided by Fisher & Paykel)
2. Sterilized dishes (provided)
3. Thermocouples
4. Humidity sensors
5. Power meter
6. Variable power unit
7. Water plate override switch
8. Steam production enclosure
9. Perforated plates (industry standard)

Steam Production

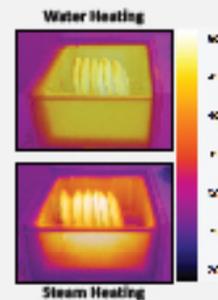
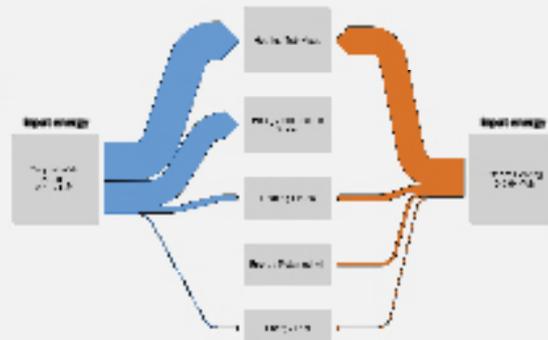
Using this equipment, steam was able to be produced and its heating capability measured.



Where Does the Energy Go?

Heating dishes only accounted for 20% of the total input energy, as an analysis was completed for the water and steam cycles to determine where the energy was going:

- Heating the DishDrawer itself accounted for 30% of the total input energy in the steam cycle
- Using steam reduces the energy transferred to the tub by 20% (as shown in thermal images)
- With steam there is no hot water poured down the drain
- Equal amounts of energy are still used to heat plates to 60°C



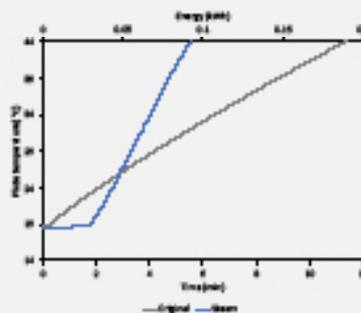
An Efficient Steam Drying Cycle

Key Outcomes

- Heat transfer medium switched from water to steam
- Water volume experimentally calibrated
- Power input optimized
- 50% of the original energy is saved
- 50% faster than the original cycle

Further Improvement

Theoretical analysis suggests that the faster the rate of steam production, the more efficient the process is. This is due to the difference in the mass diffusivity of the plates and tub, leading to further energy savings at even higher power levels.



53%
More energy efficient

53%
Faster

FISHER & PAYKEL

Project Team
Bradie Southerton
Henry Mearns
Martin Hurling
Nick Yarker

Clients
Wayne Mason
Ian McGill

Supervisor
Daniel Bishop

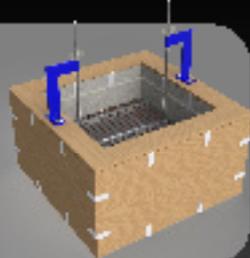
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Insulation Testing Rig

Project Background and Objectives

- The ovens designed and produced by Fisher and Paykel Appliances use a 25 mm layer of fibreglass wool wrapped with aluminium foil for thermal insulation of the oven cavity. Fisher and Paykel aim to optimise this insulation to decrease oven energy consumption while protecting the oven electronics.
- This project aimed to build a testing rig which collects measurements of temperature and heat flux across various insulation samples. The results of the tests were used to inform the client about potential insulation alternatives for their ovens.



Final Design

Cold Plate

- The cold plate is required to remove up to 1200 W of heat from the system.
- A centrifugal pump pumps cooled water at 320 L/hr through copper tubes embedded in the cold plate.
- The cold plate has nine thermocouples and four heat flux transducers to measure temperatures and heat flux on the cold side of the insulation sample.

Hot Plate

- Heat is supplied by four mica plates which heat the underside of two 5 mm aluminium plates.
- The mica heaters are powered by a controller which uses two 600 W power supplies.
- Nine thermocouples are embedded between the aluminium plates to measure temperatures on the hot side of the sample.

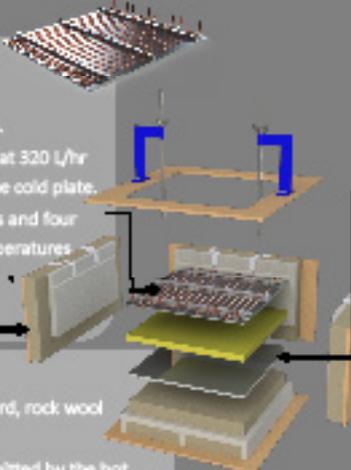


Housing

- Made from layers of ceramic fibreboard, rock wool and plywood
- Required to withstand the 1200 W emitted by the hot plate so that the external rig temperature does not exceed 50°C—the “safe to touch” temperature
- Height adjustment mechanism, attached to housing lid, controls the compression of the insulation sample.

Data Acquisition

- Type K thermocouples
- Four differential-temperature thermopile sensors measuring heat flux and temperature (Type T thermocouple)
- Calibrated to 5% accuracy
- LabVIEW software to record data and Excel software to process data



Thermal Simulation in COMSOL

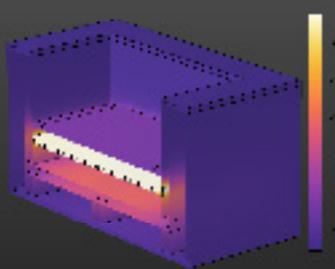
- Time-dependent COMSOL studies were used to study:
 - Distribution of heat throughout the rig
 - Main heat transfer paths and housing heat losses
 - Time required to reach steady state operation

Results

The thermal conductivity was calculated from the data using Fourier's law, where q is the heat flux passing through the sample, T_H is the temperature of the hot plate, T_C is the temperature of the cold plate and L is the thickness of the sample.

$$k = \frac{qL}{T_H - T_C}$$

The k value of this particular sample was determined to be 0.0358 W/m*K



Challenges

Controlling the power output proved to be a challenge when attempting to stabilise the temperature at a desired value. A written procedure will be developed to reduce this difficulty for future tests carried out by Fisher and Paykel Appliances.



Team: Charmi Patel, Diana Kommedal, Nick Corkery and Sem Bonthron
 Supervisors: Mathieu Sallier and Daniel Bishop
 Special thanks to Julian Phillips, Gary Cotton, Bill Motha and the Workshop Team

Client: Gabriel Castilho, Fleurine Barre-Debilly and Nick Chang

FISHER & PAYKEL

DESIGNING A SUSTAINABLE ALTERNATIVE TO POLYSTYRENE PACKAGING

PROBLEM

Expanded polystyrene (EPS) is commonly used in appliance packaging but is not consistently recycled. The Australian National Plastics Plan now requires companies to phase out EPS by July 2022.

OBJECTIVE

Design and validation of reusable spring dampers for use as appliance packaging. To perform protective duties, alongside being economically and physically viable.

REQUIREMENTS

- Protect 45 kg oven from drop
- Stackable & modular
- Stampable & foldable
- Protected from yield for reuse
- Withstand cyclic loading
- Curb-side recyclable

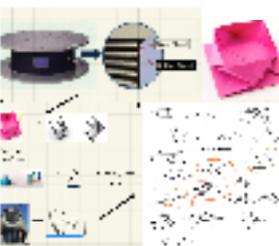
CURRENT PACKAGING

- EPS is not commonly recycled - filling landfills
- Toxic trash exposed to humans and wildlife
- However, EPS is beneficial: lightweight, cheap, mouldable, optimum mechanical properties



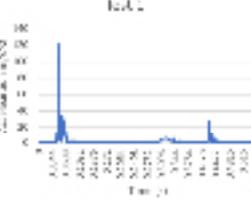
CONCEPT DESIGN

- Researched designs from existing earthquake dampers and complex origami for sheet metal folding
- Brainstormed potential concept designs & selected optimal design



DROP TESTING

- Accelerometer was used to measure the impact of a 300 mm drop height (flat, edge, and corner drops)
- Impact magnitude, force, and impact time recorded for baseline comparison



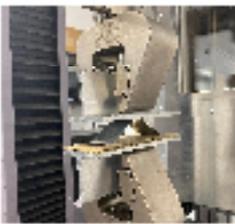
PROTOTYPING

- Sheet metal bent and formed through press method
- Alterations of bend radii, thickness, width, length, and taper made to optimise design
- Yield preventer added



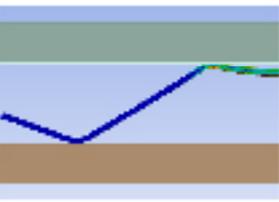
COMPRESSION TESTING

- Single and cyclic compression loading
- Max load, initial stiffness, energy absorbed, and yield extension extrapolated from data
- Designs rated to identify best performing concept



FINITE ELEMENT ANALYSIS

- Non-linear, dynamic, and frictional effects
- Allowed design optimisation by performing parameter studies



FINAL DESIGN

- Taper included for efficient material usage
- Folded ends used as yield preventer
- Optimised parameters chosen to maximise energy absorbed and yield strength



VALIDATION

- Tested in compression with single and cyclic loads
- Yield point identification - tune the yield preventer
- Substitute prototypes into oven packaging and drop test to validate protective performance



FISHER & PAYKEL

CLIENT:
ANDRE STEYN,
STEPHEN KIM

TEAM:
CLAIRE JOHNSTON,
CAELUM BETTERIDGE,
JOBEN CHAHAIL

SUPERVISOR:
MARK STAIGER
TECHNICIANS:
BILL MOHS,
OSCAR TORRES



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PA-Kayak

Electric Power-Assist



Background

Power-assist electric bikes allow exploration of New Zealand for riders of all fitness levels. Our vision is to harness this success into our new product, the power-assist kayak.

Deliverables

We have been tasked with the design and construction of an electric power-assist kayak prototype. This prototype is to be tested with two drive systems, and we will discuss the advantages of each.

Mirage Drive

- + Can beach easily
- + Shallow water travel
- 1 : 1 gear ratio
- Difficult to implement power-assist



Inspiration

The recent boom of electric power-assist bikes has allowed a far greater percentage of New Zealanders to explore all it's land regions. Can this success be applied to a kayak?



Propeller

- + Reliable
- + High gear ratio
- + Easy to implement power-assist
- Difficult to beach



BAFANG E-Bike Motor

We have chosen a 750W BAFANG e-bike conversion kit to power our drive systems during testing.





Construction

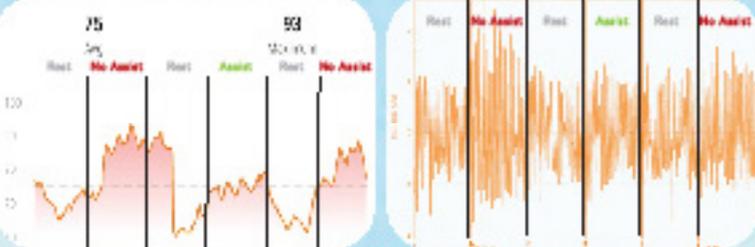
Major modifications were made to a fibreglass kayak. This involved making room for the drive systems while ensuring water-tightness. The Prototype was then tested at Lake Roto Kahatu, measuring the performance of the power-assist for each drive system.



Test Rig

A test rig was constructed to analyse the users heart rate (left) and breathing flow rate (right) with and without power assist. This testing confirmed that the rider exerted less energy when pedalling with power assist. The test rig also helped develop and validate the two drive systems.





FYP GROUP M29
Members: Ethan Roylance, Matt Boyle, Sam Dwidge, Sam Garton

SPECIAL THANKS
Supervisor: Dr. Don Clucas
Tony Doyle and the workshop, Julian Phillips, Shayne Crimp



93

M30 ENZTEC

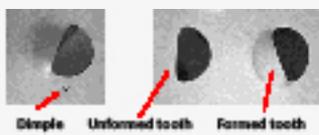
Automated Inspection of Acetabular Reamers

BACKGROUND

ENZTEC produces **Acetabular Reamers** for **total hip arthroplasty**. Their product is changing to be single use thus the production will increase. Checks for defects are completed manually but this will no longer be suitable due to the increased volumes.

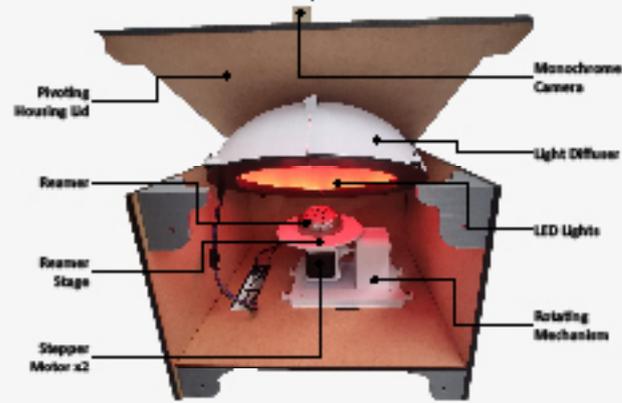
Currently the most common defects are:

- Unformed teeth
- Dimples and black spots




PURPOSE

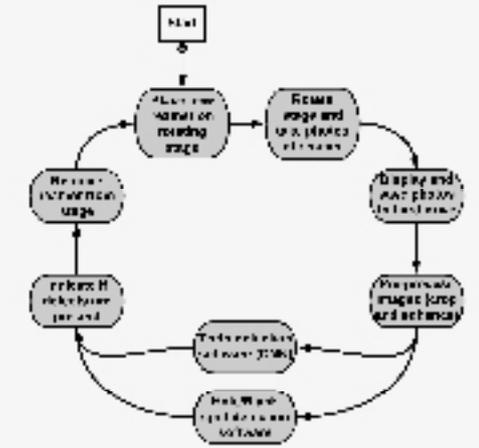
The Acetabular Reamer Inspection team aimed to design and build a device prototype. This prototype will detect the two main types of defects on the top surface of the Acetabular Reamer. The desired outcome was to provide ENZTEC with an automated prototype, validating evidence portfolio, and calculations to confirm the success of the prototypes design.



SCOPE

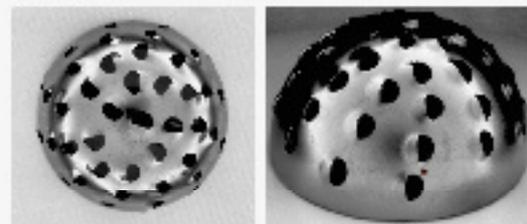
A proof-of-concept Computer Vision Device with focus on optimising the device for cost and image quality:

- 1 reamer checked less than 2 minutes 📌 >2 min
- Missing teeth, dimples & black spots 📌 98%, 92%
- Dimples & Black spots of 1 mm minimum 📌 0.4 mm
- Reamer sizes: 50 to 65 mm 📌 45 to 66 mm



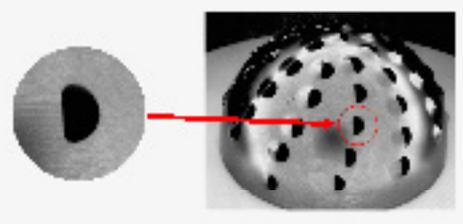
BLACK SPOT DETECTION

The black spot and dimple detection uses the **OpenCV blob detection** function. The parameters of the function were optimised for this application. They detection method outputs the number of dimples per image and outlines the location of the defect in red. **The current accuracy is 98%**, with plans to improve this in the future.



UNFORMED TOOTH DETECTION

The Unformed tooth detection method uses a **ResNet Convolutional Neural Network** with 4 layers to identify missing teeth from. The CNN was built using a dataset of 3493 photos of individual. The CNN was trained off 2768 images, validated using 522 images and tested on 183 images. **The current accuracy is 98%**.





Client: Dr Iain McMillan
Supervisor: Dr Chris Pretty
Special thanks to Rodney Elliot and Julian Murphy for their help with the project

Team members:
 Daniel Foote
 Riki Drebsch
 Amelia Rolfe
 Margot Cranishaw



STAND ASSIST FOR THE ELDERLY

Problem

Staying active is one of the best ways to combat the degenerative effects of aging. However, the fear of falling often stops elderly people from getting active. Stand assist devices will improve health and quality of life for the elderly by increasing mobility.

- After a fall, those admitted to hospital stay in bed for 10 days on average
- By 2035, the number of people over 65 years in NZ is expected to double to 1.2 million



- Semi permanent device that sits underneath a couch/chair.
- Adjustable width and handle height for compatibility.
- Increases stability and confidence of the user.
- Promotes a "base over feet" position.

Solutions

- Stand assist outside the home -
- Simple modification to a standard walker -
- Walker with an excess of fixed handles -
- Low handles give support during standing -



Development

Initial concepts were prototyped and trialed. The second round of prototypes built upon the first by incorporating feedback from industry experts and the results of user testing.

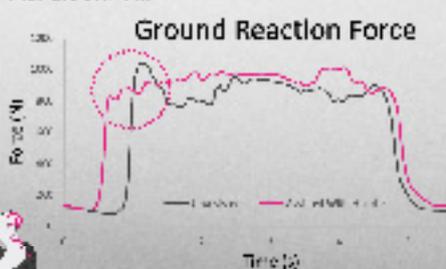
Testing

Testing was carried out using a force plate. Data and motion capture systems recorded force and muscle activation were measured in an elderly volunteer, both using the prototype device and unassisted.

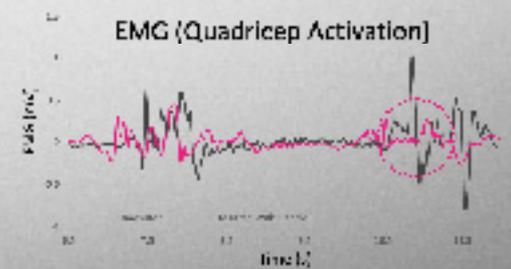
Results

As shown in the graphs, the prototype handle device is effective at assisting an elderly user in performing a sit-to-stand transition. Use of the handle reduces peak ground reaction force when standing by 20%, and significantly reduces quadricep activation during the sitting down phase. These metrics together quantify a significant reduction in effort when using the device. This matches qualitative results from user testing, where feedback was overwhelmingly positive and indicated that the handle made the sit-to-stand transition far easier. Future work on the project includes optimisation and refinement of the prototype device into products ready to be manufactured.

Ground Reaction Force



EMG (Quadricep Activation)





NZS Team:
Euan Mitchell, Joshua Woodard, Luke Kelly, James McKeown

Academic Supervision:
Prof. Anthony

Client:
Liz McKinnon

Special Thanks:
Derek Gillies, Bruce Pappas, Gary Pugh, Mike Jones, Anne, Malcolm & Beth Ryan, Leanne & John Booth, Jill & Murray, and Jeffery

ENZTEC

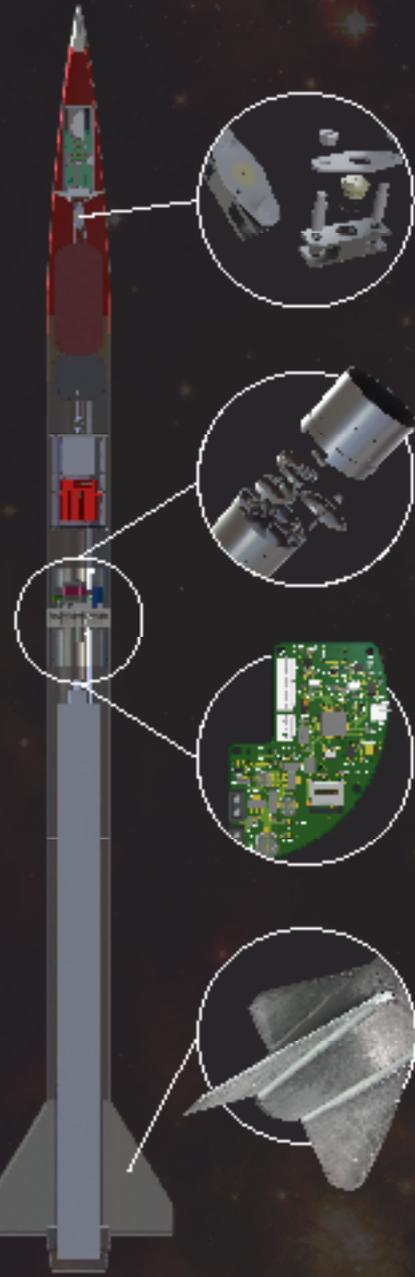
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Spaceport America

Apogee Controlled Rocket





Development

The rocket was built and tested in multiple phases. During one of these tests, there was a catastrophic failure with the rocket, which meant the entire system had to be rebuilt two weeks before the competition.

To ensure accurate apogees, we developed simulations and HITL tests to validate the control system without requiring a full scale launch.




HITL & Control

The control system combined four accelerometers and two barometers with a Kalman filter to predict the rocket's current velocity and altitude.

This position was then compared against a simulated optimal trajectory created with the robotics simulation package OpenRocket.

A PID controller was implemented to calculate the airbrake extension required to return to the optimal trajectory.

The control system was tuned by running hundreds of simulated launches inside OpenRocket using a Hardware In The Loop (HITL) testing system.

Competition Results

In June, the team traveled to New Mexico, USA to be the first New Zealand team to ever participate in Spaceport America!



We reached an apogee of 22,910ft (10km) and achieved a max velocity of Mach 1.99 (2222km/h).

We placed 9th in 20K COTS and 21st out of 149 teams!

Recovery System

A dual-parachute recovery system was designed, and employed line-splitting devices to eject a drogue and a main parachute.

Airbrake Design

The airbrakes used three petals, which deployed to linearly change the drag coefficient of the rocket between 0.25 and 0.5.

These petals were actuated using a servo motor, and the shape was designed to produce the linear response.

Custom Electronics

A custom PCB was designed to control the airbrakes. The PCB had two sets of identical accelerometers for high and low G phases of flight as well as two barometric pressure sensors.

Composite design

The rocket's airframe is made of carbon as it provides a rigid and light-weight airframe.

The nosecone is made from fiberglass for better signal-to-noise ratio for the tracking components.

Model built by: Peter Leigh, Jacob Skunderli, Mitchell Skunderli, Luke Thomas, Tyler Mitchell-Gault

Model built by: Josh Smith, Julian Baker, SE Maki, Olaya Mares, David Morris, Jack O'Neil, Ryan Wilson, Lily Wilson, Mitchell O'Neil, Peter Lee, Sarah Kellison, The Red Family, UC Mechanical Engineering, and the following students: Ben Skunderli, Ben the Legend in the Workshop (Tony Doyle, David Todd, David Fleming, Tristan John, Ken Smith)







Student projects: Mechanical Engineering and Mechatronics Engineering

Tadpole Mobility Scooter

The goal of this project was to design and build an electric mobility scooter with superior geometry and functionality. The client wanted a tadpole design, with one rear driving and two front steering wheels. This gives benefits of a backwards tip causing the user to land on their shoulder rather than head and having clear visibility of the widest point of the scooter with the two wheels placed in front of the driver.

The Client's Current Trike

The "Supa Scoota" has several target areas for improvement:

- Current scooter lacks stability
- Poor controls
- Poor display
- Limited manoeuvrability



Adjustable Prototype

An initial prototype was manufactured using steel for adjustability to test and optimise the scooter geometry. During this design, the team designed with these key deliverables in mind:

- Use of mountain bike components to improve the serviceability
- Better Ergonomics with single hand control and biomechanically designed seating.
- Increased performance of steering, stability, and scooter range

The Key Improvements in the Prototype are Shown Below

Rear Suspension

A single pivot mountain bike design was chosen to offer superior comfort and serviceability.



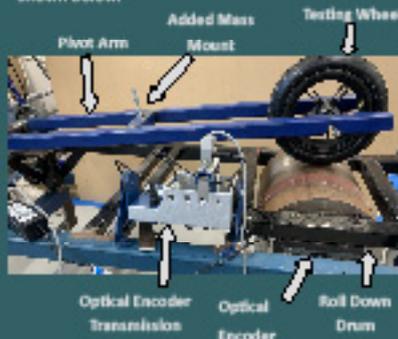
Wheels

To improve the battery life of the scooter, a study into rolling resistance is being conducted to reduce the tractive effort required as below

$$F_{\text{tractive}} = F_{\text{ax}} + F_{\text{D}} + F_{\text{me}} + F_{\text{D}}$$

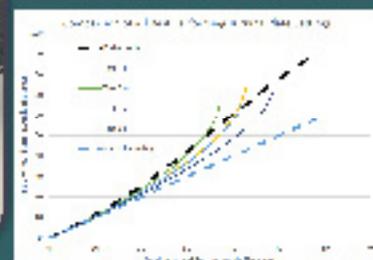
$$\& F_{\text{ax}} = \mu N$$

To study which tyres have a low rolling resistance, a purpose built roll down dynamometer test rig was constructed, as shown below.



Ackermann Steering

Due to having two front turning wheels, a simple Ackermann system was a requirement for accurate steering. This was done by including an adjustable turning plate which turns the inside wheel a greater amount than the outside wheel. Optimum settings were found as shown below. These settings were tested on the first prototype, producing turning without slip across the full range.



Electronics Design and Implementation

Display

- Shows scooter speed,
- Inclination, battery charge and time
- Enclosed in a weather-proof case



Control Box

- Teensy 4.1 Microcontroller
- MPU6050 IMU (speed and inclination)
- 4-36V Voltage Regulator
- XC4382 BE Bluetooth Module



Motor

- 48V Motor Controller
- 36V 350W Hub Motor
- Powered using a 36V battery



Student Team

Max Goodwin Jacob Clough
Harry Zarifeh Omar El-Zahar

Supervisors

Shayne Gooch
George Stillwell

Client

Roland Matthews

Special Thanks To

Tony and the mechanical workshop staff, Edsel Villa, Phillip Hoffman, and Julian Murphy for all their help with the project.

M34 FOOTPLATE RE-DESIGN

Conor Fuller, Hayden Bull, Tom Abbott, and Benjamin Mitchell

THE PROBLEM

Flow Kayaks current footplate design has poor adjustability and a shorter than expected lifetime. Customers have found cracks developing near the connections and hockey sticks which we aim to solve.

WHAT THIS SOLUTION WOULD ACHIEVE

Our solution targets increased performance from athletes, enhanced strength and durability, improved manufacturing technique and is adaptable to a wider range of multisport kayaks.

THE NEW DESIGN

We have designed 3D printed taper blocks that will allow our product to fit into both Flow Kayaks and competitors boats.

The carbon fibre layup has been computationally optimised.

Use of existing parts such as the toe pedals allows our new product to be rapidly implemented into production

Flat hockey sticks allow for faster manufacturing and a simplified load path, increasing strength

MECHANICAL TESTING

The team measured the loads exerted on the footplate by various athletes. We also conducted material testing to better understand the mechanical properties of the carbon fibre weaves used by Flow Kayaks.

FEA

Finite element analysis was utilised to optimise the carbon fibre layup weave, orientation, and geometry. It also serves as a quantitative gauge to determine the improvement on the original design.

MANUFACTURING

Using an industrial 3D printer the male plug for the footplate was produced, the surface was then prepared to facilitate Flow Kayaks in manufacturing a production mould.

Special thanks to:
Keith Jessop, Chris Stagg, Oscar Torres and Mark Staiger

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2019/2020

FLOW
KAYAKS

Student projects: Mechanical Engineering and Mechatronics Engineering

Supersonic Wind Tunnel Design

Background

A lack of supersonic testing facilities exists in New Zealand, which means there is an opportunity to greatly expand on learning and research capabilities in this field. The UC wind tunnel laboratory is looking to capitalise on this opportunity through the design and construction of a new supersonic wind tunnel.

Specifications

- Design must cost less than \$200,000 NZD
- The tunnel must be capable of producing a range of Mach numbers, up to Mach 2.5
- The tunnel must have a test section of 0.3×0.3 m, to allow space for models and measuring devices.
- The tunnel must produce a run time of approximately 30 seconds.

Method (Method of Characteristics)

To determine the nozzle profile coordinates, characteristic lines were generated and flow properties were utilised to find the shape of the profile.

Parameter	Value
Stagnation	100
Pressure	1.0 - 20
Temperature	1000 - 2000
Inlet/Exit Gas	Air/Water
Exit Flow Direction	Radial

3D model of the adjustable nozzle

Screws clamp the adjusting rods in place. Moving the flow screen using the handle adds tension to the elastic rubber profile. This makes a solid profile.

3D velocity streamlines

Diffusing Nozzle

Butterfly valve

Vacuum Tank

Vacuum Pump

Software

- CAD models of the entire wind tunnel and its components
- CFD analysis, results and validation
- Supporting documentation eg. Design review, technical report and cost sheet
- Materials and purchase list

Project Team

Samuel Collins
Henry Newman
Jorge Erik

Supervisor Prof. Dan Zhao
Dr. Ray Lin Co
Dr. Bill McIn

References

1. Faye and Goto. "High-Speed Wind Tunnel Testing", 2005
2. Heller et al. "Design and Construction of a Supersonic Wind Tunnel", 2002

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Protein Crystallography in Space



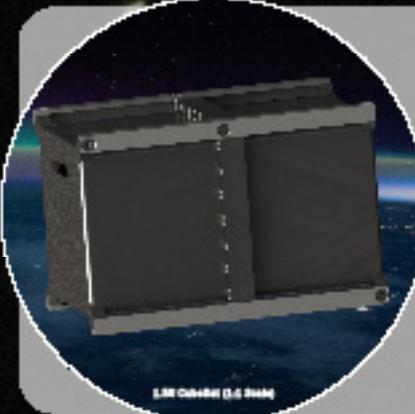
MSc Final Year Project, Science Methods, Logan Smith
 Bachelor De Paul DeBruin
 Chemie Dr. Sarah Grosse (PI), David Wright (partner)
 Thanks to Julian Phillips, Tony Doble, Roberto Cornejo

Project Background

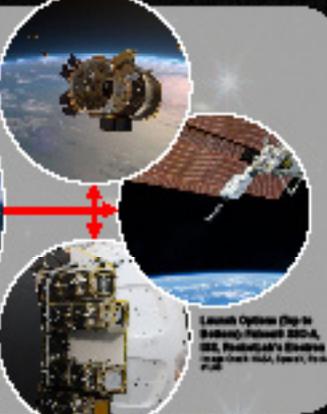
This project will reduce the cost of seeding protein crystal experiments to space. Protein crystals are used for prototyping medicines like the COVID-19 vaccine, but require large pure protein crystals, which do not form easily under the effects of gravity due to convection. Experimentation has been done on ISS, but this has a long expensive lead time. Utilizing a CubeSat will lower the cost and time required to undertake future experiments.

Left to Right: Synthetic Protein Crystals, Tiny Diffraction, COVID-19 Vaccine





L3Harris (U.S. Space)



Launch Option (Big to Small): Falcon 9, SES, ProtonM, Soyuz, Vega, Ariane 5

Camera, Lens and Lighting Assembly:

1. Diffuse LED backlight for brightfield imaging
2. Nanowell Array
3. Calibrated UV light for objective IR imaging
4. Front magnification lens
5. UV stress tested lens
6. Rear magnification lens
7. Protective UV filter
8. Tested and calibrated Avium camera with 2.4µm pixel size



Sample Exchanger Mechanism:

- Mechanism to move samples, increasing the scientific payload
- Vibration test prototype produced

REDACTED

REDACTED

REDACTED

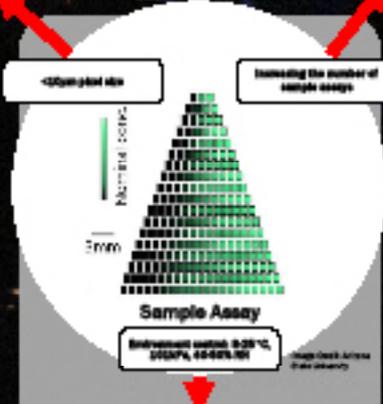
REDACTED

Seal Option Testing:

- <5% pressure loss for all options
- Experience gained applying seals correctly
- Cross-validation with MATLAB model



Sample Assay

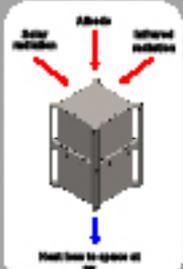


Increasing the number of sample assays

Enhancement needed: 0.25°C, 50µM, 40-60% RH

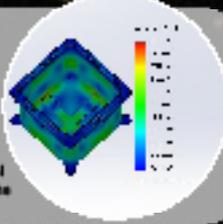
Thermal Management:

- Total incident heat flux is dependent on orbit beta angle and orientation of satellite
- MATLAB used to model the heat flux over time & internal heat generation from the electronics

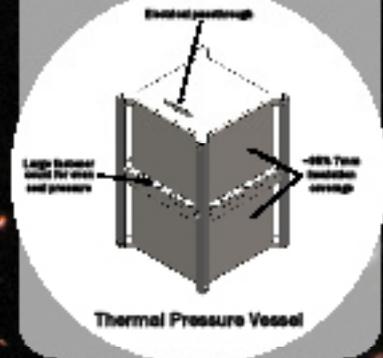



Ti-6Al-4V Shells:

- >20 FOS on yield
- High corrosion resistance
- 906 gram pressure vessel
- Easy to machine



Thermal Pressure Vessel

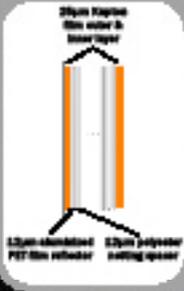


Large thermal mass for wind seal pressure

• 80% Time reduction coverage

Multi-layer Insulation (MLI):

- Multi-layer Insulation (MLI) was the chosen solution
- Between 15-25 layers will be used
- COMSOL used to simulate orbit conditions for different configurations of MLI



25µm Kapton film outer & inner layer

15µm aluminum PET film reflector 15µm polyester netting spacer

DRONE MOUNTED CATKIN HARVESTER

Overview:

Consisting of two workstreams, this MBIE funded project is the first step of a 5 year plan to improve multi-robot system capabilities with the goal of performing high precision and autonomous tasks.

Workstream 1: Design a retrofitable autonomous catkin harvester.

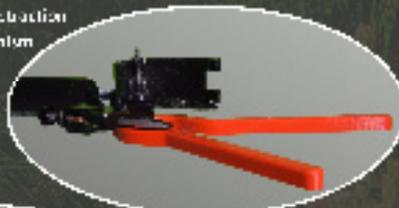
Internal Mechanism

- + Gears and bearings to maximise cutting strength
- + DC motor for high and powerful cutting actuator
- + Limit switches to detect leaf sensor level



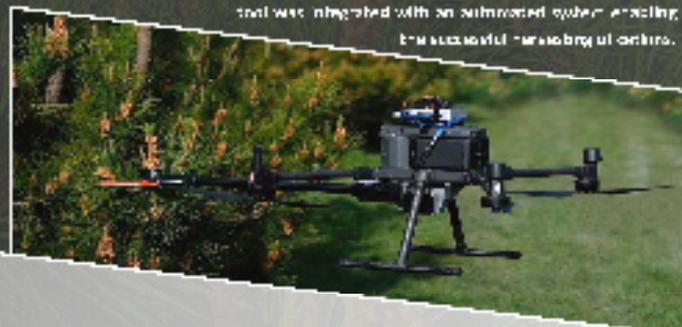
Clipper Head

- + Lightweight cutting shears
- + Compliant catkin gripper
- + Guide for improved cutting
- + Spring retraction mechanism



Development Through Testing

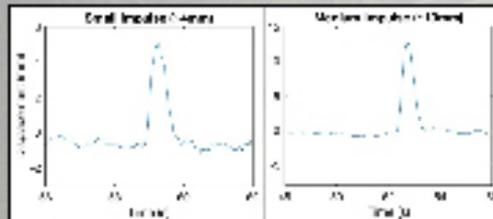
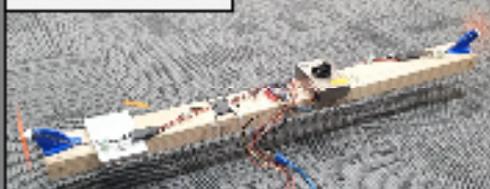
- + To determine the payload limitations of the cross, point-to-point, counter-balanced and unbalanced test flights were completed. Combined with the majority of the mass, the motor and drone was the least damaging to longitudinal stability. The balanced rotational inertia was the biggest contributor to stability.
- + Field testing highlighted the importance of minimizing vibrations and avoiding resonant frequencies. The extension material was changed to carbon fibre and the length was altered to 700mm
- + From these requirements a 1.7 kg retrofitable tool, with a clipper head of 900g was designed and built. The tool was integrated with an automated system enabling the successful harvesting of catkins.



AUXILIARY STABILISATION SYSTEM

Workstream 2: Improve the positional hover accuracy for 1% of the size of drone to 1.1mm.

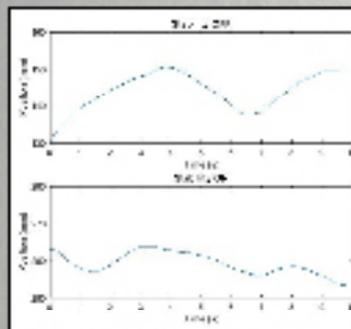
1: INITIAL 1 DOF CONCEPT



1-DOF RESULTS

The system was able to stabilise the motion of the 1 DOF concept to within ± 3 mm. This proved the feasibility of a single-actuator system.

2: FINAL 1 DOF DRONE IN BMA 10N



FINAL RESULTS

Flight testing revealed a marked improvement in hover stability of the drone. Hover stability improved from an average variation of 1.12mm with the system unaided.

Future steps:

1. Addressing the build up of dusty drone arms over longer hover periods
2. Drone position control using system

Sponsors:

As a Deloitte, ERM, Accenture, AECOM, and BDO sponsor

Client:

Richard Green

Supervisor:

Paul J. Grogan

Said of thanks to:

Samuel, Todd, and Kristina, etc.



MINISTRY OF BUSINESS,
INNOVATION & EMPLOYMENT
HIRINA WHARATUTUKI



Student projects: Mechanical Engineering and Mechatronics Engineering



UC
UNIVERSITY OF
CANTERBURY
100 Hereford Street
Christchurch, New Zealand

Semi Automated Twin Head CNC Router



MOTIVES

The motivation for this project is to make the process of cutting Structural Insulated Panels (SIPs) semi automated, thus reducing labour requirements. This will ultimately increase efficiency and reduce costs. In doing so, this will promote SIPs mainstream popularity, bringing Formance SIPs into the affordable NZ housing market.

SCOPE

The project scope was to design and build a semi-autonomous CNC router prototype, to achieve Formance's technical requirements. Due to size constraints, a small scale prototype is being built to perform nested cuts on 1.2 x 1.8m panels of varying thicknesses from 115 - 305mm.

FUTURE STEPS

With the success of this project, Formance will be able to manufacture the rotator, modify electrical wiring and extend the I-beam length to accommodate their standard 7.2 x 1.2m roof panels. If the extended router meets expectations, it opens up opportunities for low-cost expansion throughout New Zealand.



Twin Router Heads

The twin router heads are the main feature of the project. Traditional methods use a large 50mm diameter cutter bit, or saw blade, which cuts through the Orientated Strand Board (OSB) and polystyrene. This creates excessive unrecyclable waste. The twin head design means only the Orientated Strand Board on both sides is routed, leaving the polystyrene intact. This allows for easy transportation to the polystyrene hot wire station, where the cutting process is completed.



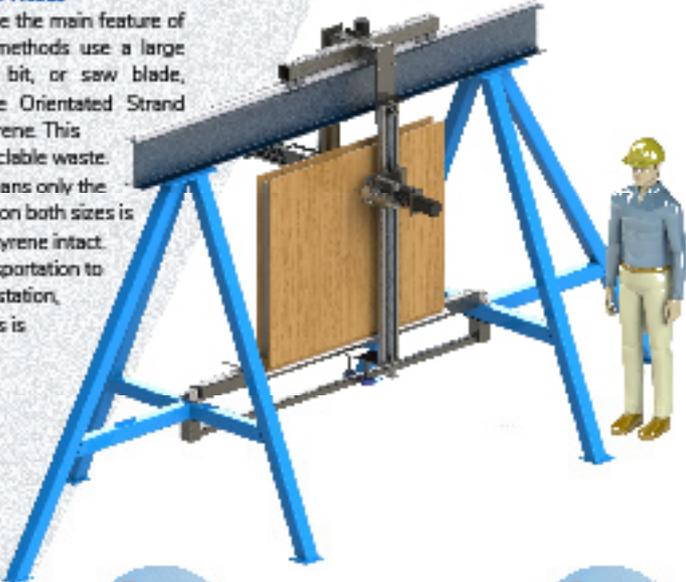
Carriage

The carriage houses the x, y and z axis motion control. Motion of the x axis is achieved via a rack and pinion, while the y and z axis use linear ball and screw sliders. The y-axis sliders are chain linked as so their vertical motion is synchronised to increase accuracy.



Electrical

The router is driven by a series of four closed loop stepper motors. These feature encoders which increase cutting precision. The router is controlled using Mach 3, a CNC controller software.



Rotating Mechanism

With the largest size SIPs weighing 150kg, a loading mechanism is implemented to minimise manual handling.

1 SIP is wheeled up to the router on a trolley, which is level with the rotator.

2 It is then slid over the rotating support block.

3 Using a pneumatic system, it is rotated 90° to the vertical position and locked in place.

4 The SIP is then ready for routing operations.

Team Members
Dylan Budge, Harry Dodd
Josef McBride-Wilson, Bob Letui

Supervisor
Associate Professor
Don Clucas

Special thanks to
Tony Doyle
Anthony Doyle

Client
Nick Hubbard



FORMANCE

Formance.co.nz



Wheelchair Retrofit for Use in the Australian Outback

Background

Standard wheelchairs are not fit for the Australian Outback terrain and extreme conditions. The aim of this project was to develop a kit-set such that diabetic amputees can retrofit their own wheelchairs for use in the Australian Outback. This project was run as a collaborative design competition with UNSW.

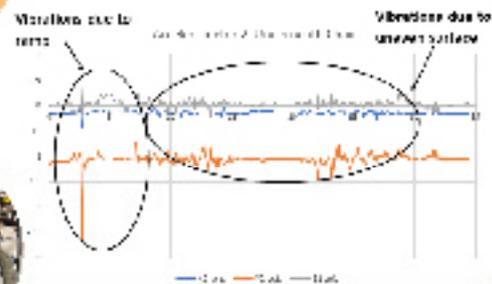
Stability Testing

A standard set of testing methods and criteria were required for both teams. A static stability testing device to measure critical tipping angles and a test dummy based on ISO7176 were used to determine these angles. The unmodified wheelchair indicated the least stable configuration with rearwards stability at 11.69 degrees.



Vibrational Analysis

Wheelchair vibrations are known to be harmful to the wheelchair user and cause damage to the wheelchair over time. The analysis utilised two accelerometers and Arduino hardware/software to capture the vibrational data experienced by the wheelchair. Testing was conducted on an obstacle course that simulated the Outback terrain.



Cushion

Quadruple density foam and gel cushion were used to increase comfort by reducing vibrations felt by the user. This mitigated the risk of pressure sores and kept the body cool by regulating body temperature in the humid environment.



Stability Plate

A rear wheel stability plate is mounted to the frame with a bolt through pre-existing holes on the side. This plate shifts the axle position backwards providing increased rearwards stability and lowered centre of mass. Static stability testing showed a 61.7% increase in rearwards critical tipping angle to 18.91 degrees.



Caster Suspension

The aim for this design was to incorporate suspension into the caster wheels. By manipulating the geometrical shape of the round-bar, it provides suspension to the wheelchair when subjected to vibrations caused by external loading.



Anti-tip

The anti-tip mechanism reduces the likelihood of tipping backwards, hence improving user safety. The design is simplistic, low profile and easy to manufacture. It has adjustable lengths with the use of a spring button and hole configuration.



Client: University of Canterbury & University of New South Wales
 Supervisor: Dr Deborah Munro
 Sponsor: University of Canterbury
 Acknowledgements: Tony Doyle, A/Prof Lauren Kark & UNSW team
 Project team: Adam Chung, Luke August, Oliver Hawker, Hannah Chatfield

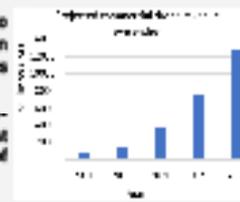


UNSW
 SYDNEY

Optimizing Separation Distance to Enhance Multi-rotor UAV Aerodynamics

1. Introduction and Objectives

- The aim of this project was to find the optimum separation distance between propellers of a quadcopter UAV.
- The optimum propeller separation will maximise thrust and minimise power output of a quadcopter UAV.



2. Methodology

2.1 Experiment:

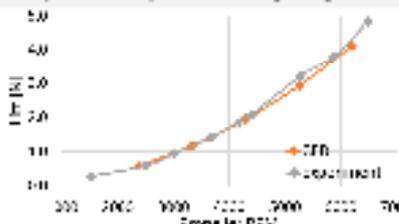
- Lift force data was measured with/without free stream velocity in the wind tunnel.
- Multiple flow profiles were conducted at different propeller conditions.

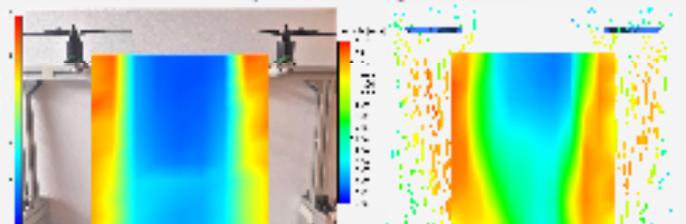
2.2 CFD:

- Conducted mesh sensitivity analysis to achieve reliability of model.
- Forces and flow properties are examined for a better understanding.
- Figure of merit (FM) and power coefficient was plotted to determine the optimum performance.

3. Validating CFD

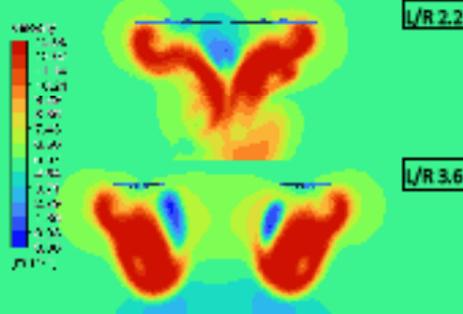
Lift plot and flow profiles show a good agreement between CFD and the wind tunnel experiment, validating the CFD model.

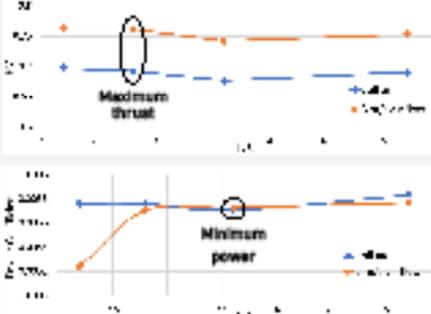




4. Results

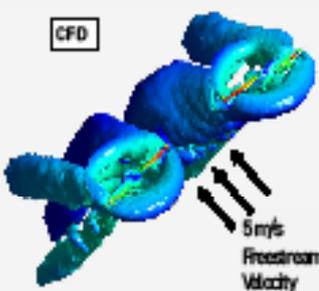
The separation of adjacent quadcopter propellers was measured with the variable L/R, which was given by hub separation over propeller radius. As the separation of adjacent propellers increased, the amount of wake interaction decreased. The relationship between propeller separation and wake interaction is visualised below in the velocity contour, where a separation of L/R 2.2 has a visible wake interaction, and L/R 3.6 has none. The amount of propeller wake interaction effected performance metrics such as power coefficient and the figure of merit (FM).

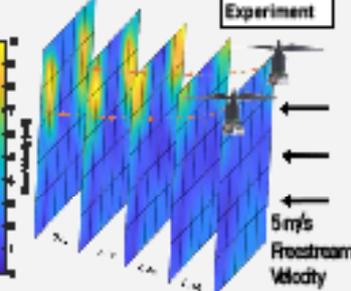




The two performance metrics were plotted against L/R separation, which shows that L/R 2.8 maximises thrust capacity and L/R 2.2 minimises power output.

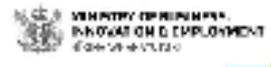
The vortex core region (CFD) shows propeller wake interaction by visualising the high vorticity region of the wake. The 2D velocity contours from wind tunnel testing were stacked next to each other to show the agreement in the 3D flow profile of the propellers. From both experiment and CFD results, it is obvious that the freestream velocity (5 m/s) pushes the wake generated from the propellers downstream.





5. Conclusions

- After the consideration of structural weight, it was found that an L/R of 2.8 was the optimum propeller separation to maximise thrust capacity and minimise power output of a quadcopter UAV.
- Further research should investigate how changes in propeller speed and the addition of turbulence would effect the optimum separation of the propeller.



MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT

Team members:

Caleb Gray **Sam Dougherty**

Tracy Newell **Zane Ogden**

Supervisor:

Prof. Dan Zhao

Dr. Ray Lin Co



UNIVERSITY OF CENTRAL FLORIDA

104

KIWICARE Alternative Trap Box

Project Aim

Rats and Mustelids (stoats, weasels and ferrets) pose a risk to many native species in Aotearoa. DOC200/PCR200 traps are used to control these species. These are set in wooden housings which have many transport and handling issues.

The aim of this project is to develop a lighter trap housing that is easy to transport, user-friendly and sustainable.

Current BT200 Trap Box

- Heavy (5.5kg+ per housing)
- Bulky (difficult to carry more than 2 housings)
- Prone to water damage
- Time consuming setup and use



Proposed Trap Box Design

- 10 boxes carried per person (+ 8 Boxes)
- 1.2kg net weight per box (4kg Lighter)
- 3 Piece - Injection moulded
- Recycled polypropylene
- UV resistant material
- Easy to assemble



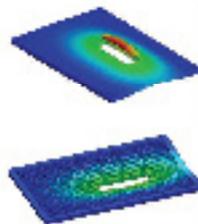
Easy 5 Step Trap Setting Method

1. Peg down baseplate
2. Slide trap on cleat
3. Set trap
4. Put lid on
5. Put strap on



Finite Element Analysis

A FEA analysis was done to ensure the baseplate would have the strength to withstand the force of loading the trap. The honeycomb structure performed the best as it had the greatest strength to weight ratio.



Fatigue Testing

Fatigue testing was done to the baseplate to replicate 5 years of solid use. This was done by manually loading and triggering the trap 130 times. No plastic deformation or damage was observed to the baseplate.



Next Steps

- DOC certification
- Finalise material filler
- Accommodate monitoring device and automated spray in design
- Integrate the feedback received from end users



Material and Sustainability

The trap housings will be made from recycled post-consumer waste polypropylene with a CaCO₃ filler and UV stabilisers. This material can easily be injection moulded and has a lower environmental footprint than virgin plastic.

A sustainability analysis found that they have 80g less CO₂e than the wooden traps when used in the backcountry.



Team
Kaden Gibbons
Alex Darling
Max Truell
Thomas Kain

Client
Dr. Peter Robinson
Supervisor
A/Prof. Sid Becker

KIWICARE

RODIN
CARS

FORMULA FORD M47

Project Brief: Rodin Cars have a 4-speed H-pattern Formula Ford. It is currently unsuited to their existing driver training program and they require a driver development vehicle which is cohesive with their existing platforms.

The Solution: A modified Formula Ford platform with a B-speed paddle shifted sequential with improved driver ergonomics.

ELECTRICAL

- Designed mounts to keep new hardware within existing bodywork.
- Repaired existing harness.
- Designed custom wiring loom for pneumatic paddle shift kit.
- These engineering solutions are adaptable and reversible.

POWERTRAIN

- Transmissions have been investigated and the FTB-200 was found to be the best fit for ease, practicality and logistics.
- A new input shaft has been designed to fit this transmission.
- An adapter plate and new suspension mounts have also been designed.

ERGONOMICS

- A modified steering column with a new steering wheel has been fitted to the car.
- A paddle shifting unit has been designed and mounted to the wheel.
- A new ergonomic base frame in which the custom moulded seat insert is placed into.
- Modified and improved pedal box to allow for large adjustment of position.

Client: Rodin Cars
Supervisor: Zac Perston
Team: Jordan S. Richard, Jessica Lee, Callum Boddall and Jack Noble-Adams

UNIVERSITY OF
CANTERBURY
Private Bag 4800, Christchurch 8142
New Zealand

Blair's Trike Carrier

Scope: Design and manufacture a custom trike carrier that Blair can operate

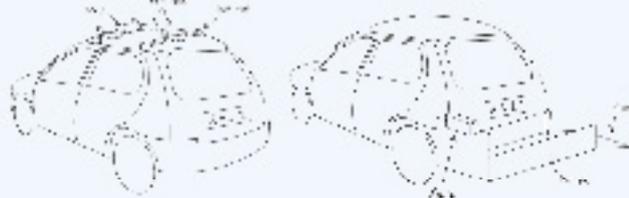
Background: Blair's cerebral palsy severely limits the motion in his legs and right arm. He frequently cycles in his custom electrically assisted trike, but this needs to be transported by someone else unless he wants to cycle from his house.



Specifications: Make a custom carrier that Blair can use by himself, so he has the independence to take his trike where he wants, when he wants, by himself. The carrier must meet NZTA legal requirements.

Concepts

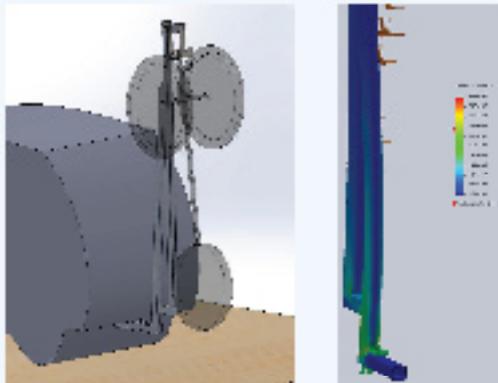
Early concepts were roof mounted, rear mounted, or other. Most use some type of winch for assistance, as testing proved Blair can operate a winch. We filtered out the most improbable down to 6 designs, including the two shown below:



Design selection: We chose the final two designs by evaluating against constraints, considering risks, and considering manufacturing difficulty. Constraints include securing the trike, Blair being comfortable operating the carrier alone, meeting legal requirements, low risks posed to users, the ability to swap between car, and an unobtrusive design.

Criteria	1	2	3	4	5	6	7	8
Requirements (Out of 10)	100	90	110	110	90	90	100	100
Cost	100	100	100	100	100	100	100	100
Manufacturing difficulty	100	100	100	100	100	100	100	100

Design 1: Vertical Carrier

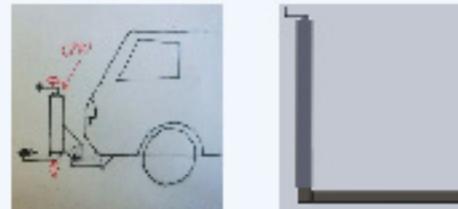


Design overview: Blair drives his trike up to the carrier, attaches the hooks onto the front of his trike and manually winches the trike up.

Design features: Attaches onto a hitch receiver on the back of Blair's car.

Design analysis: The structural integrity of this design was validated with a MATLAB script, hand calculations, and a Solidworks simulation. These used a maximum loading of 3x the trike weight to account for bumps, acceleration/deceleration, and wind. The calculations gave a Factor of Safety of > 3.

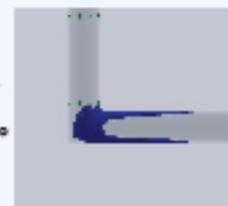
Design 2: Horizontal Carrier



Design overview: The horizontal design allows Blair to extend and retract the foot over the carrier. The connection point attaches to the centre of mass of the trike and is lifted into place by the stand.

Design features: Design includes a tension line leading from the outer edge of the foot and extends to the top of Blair's car for extra safety.

Design analysis: The design was validated with hand calculations and in SOLIDWORKS analysis. Two separate designs were pursued; a larger square cross section design, and a smaller circular cross-section design. The square section exceeds the weight constraint, but allows Blair to ride directly over the connection point. The circular section has a greater FOS, but is more difficult to attach.



Clients: Blair Nevin, Sue and Carl Nevin

Client Liaison: Shayne Crimp

Supervisor: George Stillwell

Team members: Adam Finlayson,
Jacob Heyblom, Nick Tuckey

Special Thanks:

Christine Products

Digby Symons



HYDROGEN PRESSURISATION



PROJECT BRIEF:
 To evaluate traditional and novel methods of hydrogen pressurisation for mass sensitive aviation applications. The main focus is to model and experimentally test the concept of a reciprocating feed system.

MOTIVATIONS:
 Growing environmental concerns have championed hydrogen as the fuel for the future. To have a competitive energy density hydrogen must be stored as a cryogenic liquid. Mass-sensitive applications require a low storage pressure to minimise fuel tank weight. Therefore hydrogen pressurisation systems are necessary when hydrogen is used as a fuel.



Storage Vessel
Pressure: 1bar
Temperature: 293K



PRESSURISATION SYSTEM



Fuel Cell
Pressure: 10bar
Temperature: 293K



Typical aircraft for this application.
10kg/hr H₂ demand

CANDIDATE SYSTEM EVALUATION
 Four systems were evaluated using models to predict system mass, power consumption, and efficiency.

STORAGE AT PRESSURE

VAPORISER COMPRESSOR

PUMP VAPORISER

RFS

Mass Model:
 System weight dominated by tank weight. Tank mass calculated using ISO-21029-1:2018. Storage at pressure increases mass 3x relative to other solutions.

Power Consumption Model:
 Compressor consumes 100x more power than pump-vaporiser. Model based on 1st law of thermodynamics.

Pump Availability:
 No low flow rate LH₂ pumps are commercially available.

Selected System:
 RFS is favourable on mass and power yet no real-world system past prototype stage. A prototype was built for validation and discovery.

RECIPROCATING FEED SYSTEM (RFS)
 A reciprocating feed system utilising the high volume expansion ratio of LH₂ presented the opportunity to design and build a lightweight and compact rapid pressurisation system.

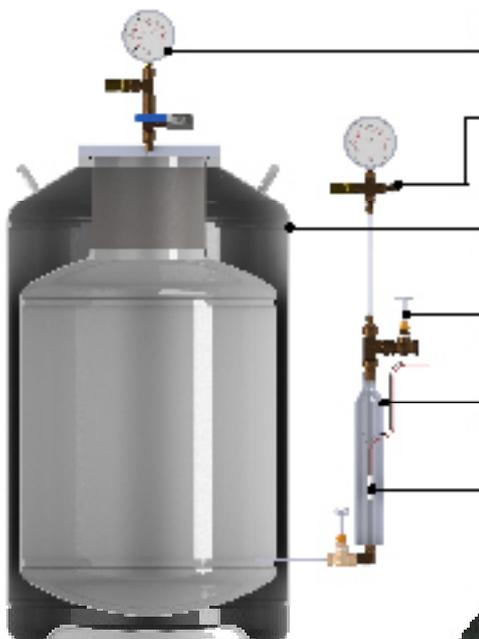
1.
VALVES OPEN AND RFS TANK FILLS WITH LIQUID HYDROGEN

2.
VALVES CLOSE AND HEATING ELEMENTS BUILD PRESSURE

3.
PRESSURISED HYDROGEN FLOWS OUT OF RFS TANK TO HEAT EXCHANGER

4.
VALVES OPEN AND CYCLE IS REPEATED

THREE TANKS 120° OUT OF PHASE PROVIDE CONTINUOUS PRESSURISED FLOW



Instrumentation
 The Dewar and RFS tank each have pressure gauges and pressure relief valves.

Liquid Nitrogen
 Liquid nitrogen is the best fluid in place of liquid hydrogen for its safety.

Dewar
 120L vacuum insulated double skin pressure vessel.

Cryogenic Valves
 2x globe valves provide control over the inflow of nitrogen and outflow of gas from the RFS tank.

RFS Tank
 The RFS tank is a 600mL pressure vessel in which the fill/heat/pressurise/vent cycle occurs.

Heating Elements
 400W heater at the bottom of the RFS tank delivers the heat for pressurisation.

Student Team: Mitch Davis, Mitch Radcliffe, Henry Knight, Sam Armitage

Supervisor: Mark Jerry

Mentor: Jonas Weier





LUNG MECHANICS



12 DEATHS/DAY
from lung dysfunction in NZ

Respiratory illness responsible for
2-3% OF NZ GDP

Personal healthcare expenses
creating large
SOCIOECONOMIC GAP

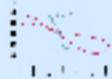
SCOPE

Combine mechatronics and computational mechanics to optimise clinical outcomes including:

DIAGNOSIS



MODELLING



CARE



MANAGEMENT



Devices to simulate obstructive lung disease in healthy people

Endotracheal tube (ETT) cuffs for neonates

Simulating COPD

Chronic obstructive pulmonary disease (COPD) affects more than 200,000 New Zealanders. We are developing a device to induce symptoms of COPD in healthy test subjects, to enable safe, rapid evolution of new treatment devices and protocols.

Development **DESIGN** → **TEST** → **IMPROVE** → **REPEAT**



Final Design

The final design uses resistance filters and a volume-limited elastic expansion chamber (VLEX-c) to increase exhalation resistance. Measurements from pressure sensors are used to calculate breathing volume, flow, and pressure.



CPAP Filters



Venturi



Pressure Sensors

Connects to CPAP mask One Way Air Valves

ETT Cuffs for Neonates

Adult endotracheal tube (ETT) cuffs are inadequate for use in neonatal patients.

Goals

- Minimise/eliminate cuff contact on throat.
- Create turbulence in air flow past cuff to block flow.

Cuff Designs

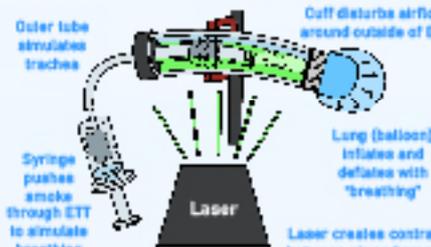
SLA printed with flexible resin.



Fins reduce cuff surface area pressing tracheal wall, ↑ turbulence in flow, ↑ resistance to escaping air.

Testing

Smoke and green laser used to visualise airflow in simulated "trachea".



Outer tube stimulates trachea Cuff disturbs airflow around outside of ETT

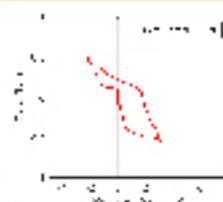
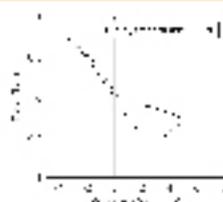
Syringe pushes smoke through ETT to simulate breathing Laser creates contrast between air and smoke

Lung (balloon) inflates and deflates with "breathing"

Results

Simulated VS real COPD PQ loop →

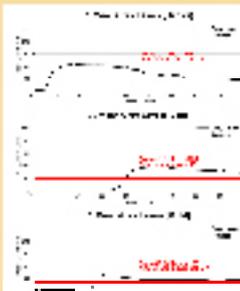
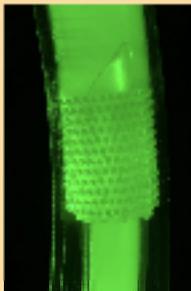
Note the wide loop on inspiration is due to anti-Covid filters.

The device successfully simulates the effects of COPD in healthy test subjects. Results were validated by comparing pressure - flow (PQ) loops of healthy test subjects to COPD data.

Results

Data analysed using colour processing functions in MATLAB (left), to compare smoke concentrations in trachea between test videos. The cuff was very successful blocking escaping flow during inspiration (right).



TEAM

Jaimey Clifton
Alexandra Edmonds
Elliott Wilkins
Chris Smith

SUPERVISORS

Dist. Prof. Geoff Chase
Ted Larios
Ella Guy
Trudy Caijé-van Der Klei

Measuring Sleep, Stress & Anxiety with Wearable Technologies

PROJECT SCOPE & BACKGROUND

- 3.6% of the world population affected by anxiety & chronic pain
- Current assessments are subjective
- Helius therapeutics wants an objective, readily available, long-term measurement for clinical trials of CBD products
- Our goal is to validate stress & HR metrics measured by wearable devices as an indicator of anxiety and pain.



DEVICE & ALGORITHM SELECTION

Considerations:

- Type/quality of sensors
- Biomarkers measured
- Metrics provided
- Data resolution
- Accessibility
- Cost/prevalence

Garmin Venu SQ was selected for validation testing



COLOUR-WORD-CONFLICT (CWT) & COLD PRESSOR TESTS

- Stroop effect is a delay in reaction time between controlled and automatic processing of information
- CWT induces anxiety by exposing subjects to conflicting stimuli.
- Cold pressor induces moderate pain by plunging hand/wrist in ice-water
- These tests are used to validate ability of a device's built-in stress metrics to measure wearers stimulus-response



GREEN



BLUE

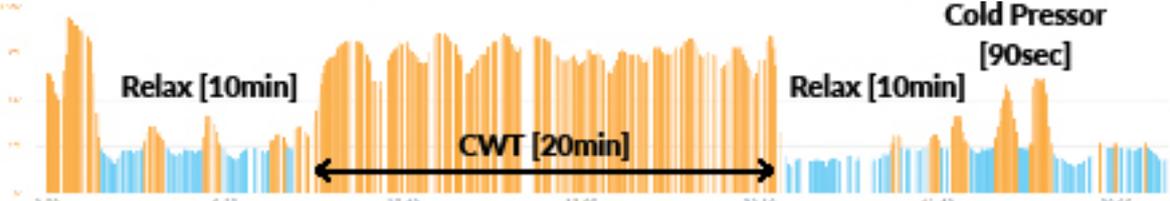
TEST PROCEDURE

- 30 participants (15 male, 15 female)
- 10min relaxation to set a baseline
- 20min colour-word-conflict test
- 10min relaxation to reset a baseline
- 90sec cold pressor test
- 10min relaxation to reset baseline

RESULTS & CONCLUSIONS

- Garmin algorithm shows good resolution (measurements taken every 3sec)
- Response to stimulus is clearly measured by the Garmin Venu SQ
- Prelim. conclusions show this device/algorithm would provide good data for CBD clinical trials

"The stress is like trying to quit vaping during exams"



Cold Pressor [90sec]





UNIVERSITY OF CANTERBURY
100 New Zealand Avenue
Christchurch 8140 New Zealand



Team: Wade Bennett, Isaac Flett, Harris Oon, Louis van Zyl
Supervisors: Dist. Prof. Geoff Chase, Dr. Tony Zhou, PhD Candidate Jasie Dixon
Special Thanks: PhD Candidate Hamish Ferguson, Dr. Steven Su

Student projects: Mechanical Engineering and Mechatronics Engineering

M53 REMOTE RELEASE CLAMP

Purpose

- To design and produce a prototype remote release clamp for Cawthron's Shellfish Tower. The Shellfish Tower is a new form of cultivation technology that is submerged 10m deep for exposed bivalve (e.g. oysters and mussels) farming. The remote release clamp is to be attached to the top of the shellfish tower to remove unnecessary diving risks and improve harvest efficiency. Success for this project will be achieved with a working prototype.

Inner Cones

- 80° angle on inner cone creates a self-locking mechanism uses the tower's buoyancy to clamp onto the mooring line
- Moving inner cone piece up will release clamp allowing the tower to float to the ocean surface

Hydraulics

- Twin, double acting cylinders provide 2.8kN of force at 210 bar
- System includes directional control valve and an accumulator

Housing

- Two symmetrical sections for easy assembly
- Hydraulic cylinders sit at 80° parallel with the angle of the inner cones
- Cones release mooring line as cylinders extend

Jaws

- Three methods to grip the rope were developed during the concept phase
- Testing resulted in the final design containing large serrations, an offset of one rope diameter, and an angle of 90° in each jaw

Communication

- Wireless communication is needed to facilitate release of clamp remotely (remove need for divers)
- Traditional methods (Wi-Fi, Radio) unsuitable for underwater use.
- Innovative system using Ultrasonic transducers created
- System successfully tested in fresh and salt water (results shown below)

FEA Stresses on Housing Section

Sectioned Clamp View

Transducer Receiving Signal

Shellfish Tower

Housing

Inner Cones

Polypropylene Mooring Line

Offset

UC
UNIVERSITY OF
CANTERBURY
2014

Ngā Punga o te Moana | **CAWTHRON**

Supervisor: Wayne Woods
Students: Liam Maragh, Rowan Power, Isaac Miles, Gerald Moran
Officer: Kerin Newman, David Robinson, Rebecca Scott

Hemp for Healthy Homes

Manufacturing Process



Hemp plant

Fiber

Hurd
Hemp hurd is 70% of the plant, and is often a waste product.

Skalk

Motivation and Scope

Panelise NZ of Taranaki manufactures prefabricated wall systems from wood-based panels using Rigid Air Barrier technology. Products of the hemp industry may be able to produce a construction panel with advantages over the currently used wood-based panels. This project aimed to determine the feasibility of a hemp-based panel for use in Panelise NZ's construction system, including:

- Develop a manufacturing process for a hemp-based construction panel.
- Compare the mechanical properties of hemp panels and traditional panels.
- Evaluate sustainability benefits of hemp panels.
- Estimate costs and economic impacts of hemp panels.

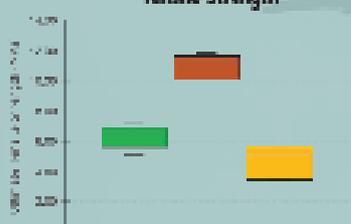


Heat press:
Hurd is pressed at 190 °C to a density of 880 kg/m³.

Board is cut to size, ready for use in a wall system.

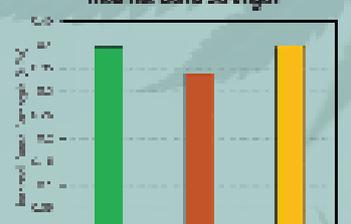
Mechanical Comparison with Wood-based Composites

Tensile Strength



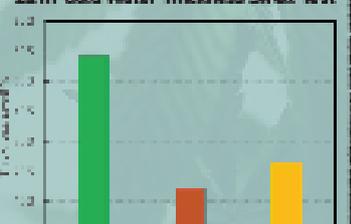
Number of tests: Hemp: 12, Strand: 8, Particle: 3

Internal Bond Strength



Number of tests: Hemp: 5, Strand: 4, Particle: 3

24 hr Cold Water Thickness Swell Test



Number of tests: Hemp: 2, Strand: 2, Particle: 3

Lifecycle Emissions

Hemp panel:
Hurd: -101.6 kg CO₂e
Adhesive: +73.6 kg CO₂e
Total: -28.0 kg CO₂e / m²

A hemp panel has the potential to sequester 862 kg of CO₂ equivalents, compared to 197 kg emitted by a wood-based alternative.

Economic Impact

Opportunity for 300+ jobs in Taranaki alone

MPI predicts a \$13 M industry for hemp finished goods by 2030.





UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
University of Canterbury

Team: Tone Kandazao, Phoenix Zhao, Kaspar Seltano
Supervisor: Sid Becker
Clients: Michelle Bauer, Neil Bridgeman
Thanks to A.I.C.A. NZ, Cartelids, Oscar Torres, and the Mechanical workshop team.



Panelise NZ
www.panelise.co.nz

Student projects: Product Design - Industrial Product Design

Waste Sorted

Sorting the Waste Issue with Sustainable, Organic Solutions.

Imagine

a World Without Waste

Discover
Researching various and possible solutions for this project. Researching the current problem, then considering the existing solution.

Define
Identify specific user requirements for the product. Researching how they can be achieved. Consider the user and the problem from a user perspective.

Develop
The student considers the user requirements and the design of the product. Researching the user requirements and the design of the product. Researching the user requirements and the design of the product.

Deliver
Presenting the final solution to the user. Researching the user requirements and the design of the product. Researching the user requirements and the design of the product.

User Testing

Time to research on previous in the field

John
Alex
Ben
Lisa

"Design that gives the user what they need is the best design. It's not about the product, it's about the user."





Stackability



Flips open to allow for sorting

It's Sorted!

UCI PRODUCT DESIGN

St. John's College

Abel van Boven
 Supervisor: Professor
 Supervisor: Professor
 Supervisor: Professor
 Supervisor: Professor

Student projects: Product Design - Industrial Product Design

Inform Me

Active Journeys




Materials

1. Distribute signs on to the reading of the name of the bus on it for easy to fit.
2. Filter the index allows to be used as a bus.
3. Use finger, in an area below to get an idea of the size of the bus for the fit.
4. When at the size of the board and to check if the index allows to be used as a bus.
5. In the case of the bus on the board it is measured on the board to confirm the size.
6. Put the board on the board to check the size of the board.
7. To see the size of the board to see if the board is the size of the board.
8. To see the size of the board to see if the board is the size of the board.

Aims

This information board has been designed to help those that are visually impaired able to use public bus transport. The aim of this project was "To help to the public transport system through user information and to help through using those with visual impairment on a bus journey". This has been achieved by including the key features such as information to help guide the user on the information, complete bus journey planning and a clear sign that informs the user how far away the bus is and when they need to get up.

Use the pins to follow the path to plan the journey that one wishes to take from start to end. There is also a way to make the information for users and it is integrated correctly. The aim is to help to the public transport system through using those with visual impairment on a bus journey. This has been achieved by including the key features such as information to help guide the user on the information, complete bus journey planning and a clear sign that informs the user how far away the bus is and when they need to get up.

It is important to make sure that this system has been designed to be used in a way that is useful and inclusive to all.

Key Features

1. To allow the user to follow the path to plan the journey that one wishes to take from start to end.
2. To allow the user to follow the path to plan the journey that one wishes to take from start to end.
3. To allow the user to follow the path to plan the journey that one wishes to take from start to end.
4. To allow the user to follow the path to plan the journey that one wishes to take from start to end.
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- To allow the user to follow the path to plan the journey that one wishes to take from start to end.
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- To allow the user to follow the path to plan the journey that one wishes to take from start to end.
- To allow the user to follow the path to plan the journey that one wishes to take from start to end.

The Process

The process of the design was to create a design that was user friendly and to help those with visual impairment on a bus journey. The process of the design was to create a design that was user friendly and to help those with visual impairment on a bus journey.





RSA Active Journeys - Inform Me

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Industrial Product Designer
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THOMAS WOOD



Student projects: Product Design - Industrial Product Design

THE SPIN STOVE.

Project Aim.
To create a safe and highly efficient flatpack stainless steel woodfire stove for less than \$16.40 NZD that can be assembled with basic tools with no fasteners.

Project Introduction.

This campaign project seeks to improve the displacement of people in parts of the world such as India and Afghanistan. Due to economic circumstances, the people in the low-income areas have to live in huts that are not suitable for the weather conditions in the region.

The flat pack stove project is the result of a competition for the government and the company 'The Flat Pack' project by the company 'Flat Pack' to design a stove for the people in the low-income areas. The stove is made of stainless steel and is designed to be assembled with basic tools with no fasteners. The stove is designed to be assembled with basic tools with no fasteners. The stove is designed to be assembled with basic tools with no fasteners.

Order an assembly manual for the stove. The stove is designed to be assembled with basic tools with no fasteners. The stove is designed to be assembled with basic tools with no fasteners. The stove is designed to be assembled with basic tools with no fasteners. The stove is designed to be assembled with basic tools with no fasteners.

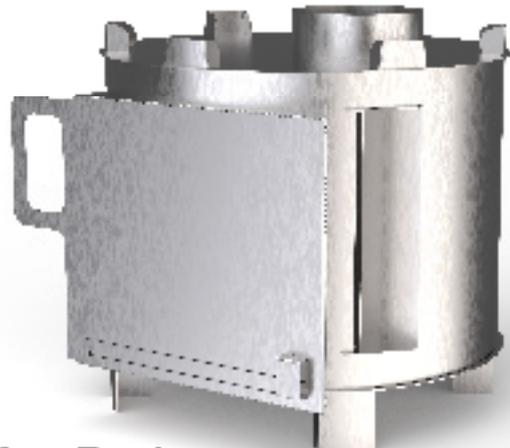


Cold -5 Degree Winter Camps up to 10,000 people Tight LM by Conditions Basic furnished stove Assembled by Local

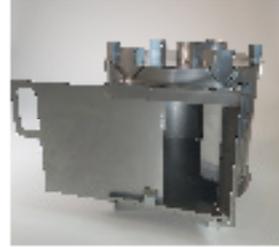
Design Iterations.



Early Sketches The stove looking inside First 3D CAD model Second 3D Model Final alignment: Flat pack Model Final alignment: Flat pack Model

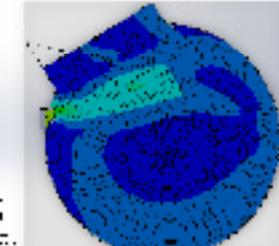


Flat Pack Model.



Final Model.

The stove is designed to be assembled with basic tools with no fasteners. The stove is designed to be assembled with basic tools with no fasteners. The stove is designed to be assembled with basic tools with no fasteners. The stove is designed to be assembled with basic tools with no fasteners.



Stress analysis of final model.

Key Features.

- Cost \$16.40
- To fit the flat pack
- 3D modelling
- Simple to use
- Can be used in the tent

Tent Woodfire Stove

Also Caldwell
Industrial Product Design
www.caldwell.co.uk

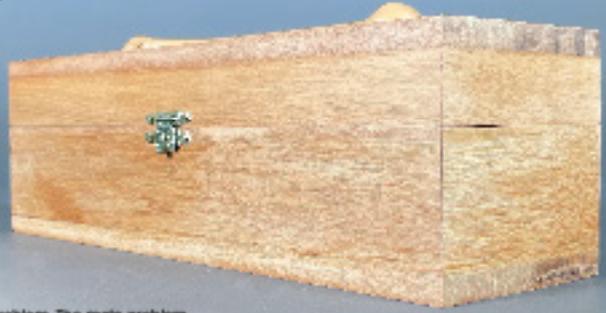
Relief Aid escea.

14 1115 41 111 141111
www.caldwell.co.uk

Student projects: Product Design - Industrial Product Design

WAYFARER ARTISTRY





Project Description

Whakaohia

The project focused on solving one main problem and one smaller problem. The main problem was the potential for growing artists paint brushes or other art supplies getting damaged in their luggage while traveling because of insufficient protection or mishandling. The smaller problem was that artists often don't have a specific storage unit at home for their supplies and will store them wherever they fit.

The solution was a travel storage box with three separate compartments in two sections. The base section is divided into two compartments one for larger art supplies like paint and pencils, and one for smaller art supplies like brushes and sharpeners. The upper section is where brushes would be stored, and it has an additional lid to fix the brushes in place to prevent them moving around. It is durable and ergonomic with rounded travel stress and is aesthetic for home use.







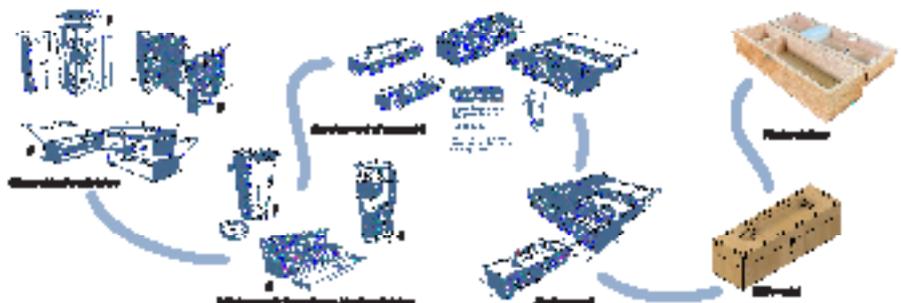





Design Process

Whakaohia hōtake

The process of solving the problem involved research, ideation, prototyping, and testing. The research phase involved identifying the problem and the target audience. The ideation phase involved brainstorming solutions and creating a list of requirements. The prototyping phase involved creating a physical model of the product. The testing phase involved using the prototype to identify areas for improvement and refining the design.



Wayfarer Artistry Box

Artistic Judge (D. BOSTON)

Product Design

2023-2024

www.wayfarerartistry.com

QR CODE



WAYFARER ARTISTRY



Student projects: Product Design - Industrial Product Design



What is SeaBoard?/He Aha SeaBoard?

SeaBoard is a sustainable replacement of the popular glassboard product. Made from recycled glassboard, SeaBoard is primarily made up of glass, naturally occurring and abundant material, because SeaBoard's substrate formed substrate built for fireproof and resistant to seawater and fungi, together seaweed and hemp are the best choice for the inside structure. Why? They provide excellent moisture regulating, the substrate and board strength capabilities while allowing the SeaBoard waste to be completely recycled into fertilizer and made for agricultural use.

Key Value Proposition/Āhuatanga Ahurei

- SeaBoard can offer +900kgCO₂e per tonne of seaweed used in SeaBoard products
- Higher flexural strength than its competitors
- 45% off the flexural properties of its five nearest competitors without the inclusion of harmful materials.
- Seaweed and hemp can be a natural replacement for fiberglass and composites.
- A new seaweed supply chain will create more jobs.
- Any SeaBoard waste can be recycled into agriculture fertilizer/fuel.
- Viable solution for glassboard-dominated NZ market.
- Potential for a global market seeking sustainable building materials.
- One step closer to creating zero-waste construction sites.



Why Seaweed?/Rimuropa?

- Seaweed captures 12 million tonnes of carbon from the ocean annually
- Extremely high yield per hectare
- Drought-resistant, seaweed doesn't release any carbon
- Seaweed is naturally biodegradable, naturally biodegradable, non-toxic, and biodegradable
- New Zealand has optimum conditions for seaweed farming
- Sustainable seaweed farming has the potential to bring huge economic benefit to New Zealand
- Using seaweed allows space for other crops in the same soil used
- Seaweed is biodegradable and can be applied as a soil fertilizer after using SeaBoard

Why Hemp?/Kōkaha?

- SeaBoard utilizes hemp fibre which is a waste product from hemp fibre production
- Creates a circular economy for hemp waste that is destined for landfill
- Hemp fibre is fire resistant, and biodegradable
- The strength properties of hemp fibre is applicable to replacement of SeaBoard
- Hemp captures carbon from the atmosphere as it grows, helping to further reduce the embodied carbon of SeaBoard
- Hemp fibre is ultra absorbent and hydrophobic, providing excellent forms
- Hemp fibre is biodegradable and can be applied as a soil fertilizer after using SeaBoard

Student Name:
Angus Crampton 53940667

Email Address:
acacrampton@gmail.com

Supervisor:
Nick Emerson

Collaborator:
Andy part

SeaBoard

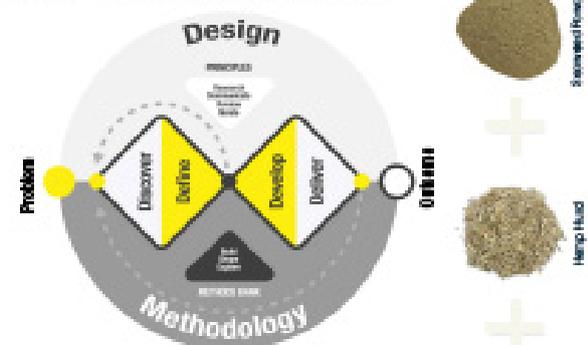
The Problem/Te Rauwau

The major issue, glassboard still remains a staple of New Zealand housing and will be for many years to come due to the low cost and superior performance to other sustainable construction. As New Zealand's population growth and demand for healthy homes increases, new more sustainable methods of building need to be generated. Currently, the built environment responsible 20% of New Zealand's annual carbon emissions and yet it brings the most sustainable materials available for purchase. How sustainable the current products used to be developed to drive the evolution of embodied carbon emissions from complete that New Zealand rules sustainability.

Brief/Kaupapa whakaohua

This project is to build on the existing work of Andy Part and ourselves. The 2023 SeaBoard prototype quickly failed the mechanical properties of interest to drive the development of a more sustainable glassboard product. The project was to assess evaluating and improving sustainable methods for mechanical strength improvement of SeaBoard, while maintaining the sustainability of the finished product.

Design Process/Tukanga Hoahoa



The SeaBoard project followed the double diamond design methodology seen above, throughout to SeaBoard's development to allow the development of a more sustainable glassboard product. The project was to assess evaluating and improving sustainable methods for mechanical strength improvement of SeaBoard, while maintaining the sustainability of the finished product.

Discover

To gain a comprehensive understanding of glassboard and all other important factors in the project, a discovery design stage was completed. Research was gathered on current competitors and the construction industry with a special emphasis on sustainability, public sector inquiries, and building standards.

Define

Building products have to abide by strict standards and regulations to be used as a building stage was defined to determine exactly what an user-friendly competitor would need to make a number of building materials were defined and a product design specification was created.

Develop

The development stage of this project was the longest. A huge amount of testing and prototyping had to be done to create a product that met the requirements of the project. A large amount of testing and prototyping was done to create a product that met the requirements of the project. A large amount of testing and prototyping was done to create a product that met the requirements of the project.

Deliver

Following a successful development stage, a final product was created. The final product was a sustainable replacement for glassboard, made from seaweed and hemp. The final product was a sustainable replacement for glassboard, made from seaweed and hemp.

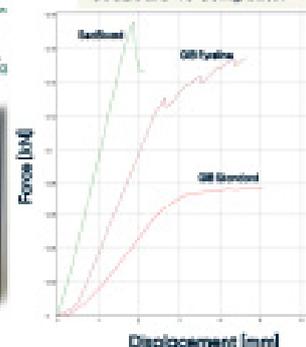
Testing/Whakamātau

The primary method of testing in this project was the use of a 3-point bending rig. This rig was used to test the flexural strength of the SeaBoard product. The rig was used to test the flexural strength of the SeaBoard product. The rig was used to test the flexural strength of the SeaBoard product.



3-point testing

SeaBoard vs Competitor



UC PRODUCT DESIGN

Student projects: Product Design - Industrial Product Design

Shift

Shooting Stick Seat

Walking pole

Trapped bag

Seat

Upper leg "D" shape means the leg can not rotate in collar meaning the holes are always aligned with the pink marking for easier and faster seat height changing.

Seat folds together so can be used as walking pole and has rubber handles so is more comfortable for the user.

Upper leg has tabbed heights to quickly adjust to user preference.

Leg

Base

Screw - Slide - Screw mechanism to change base is faster than original design and does not require detaching components.

Spike for soft surfaces. Base for hard surfaces.

Materials

- Stainless steel used for seat, leg, and base shell is durable and weather.
- PET plastic used for base core is cheap and easily manufactured.
- Butyl rubber used for seat handles and base bottom provides grip and

Abstract

Sport watching parents use "Shooting Stick Seats" to support themselves on the sideline but are frustrated by the lack of comfort and functionality available from existing products. This is most evident for the aging population that suffer back injuries and struggle to stand or use existing products for prolonged periods.

Brief

Redesign the "Shooting Stick Seat" to allow for a more comfortable user experience when spectating sports from the sideline for hour or greater periods without negating from the social aspect of sport watching. The seat must be portable and appropriate for all user sizes and suitable for all surfaces while remaining durable.

Research

A wide range of researching methods were conducted to gain information about where current designs lack and can be improved. The majority of research involved interacting first hand with the target market through methods such as focus groups and surveys. A summary of the research (pictured right) made it clear what the most common problems users experienced with current designs.

Concept development

Using information gathered during research, a set of specifications were generated that aided in the concept development stage. This led to the development of three concepts (pictured below). The one which best satisfied the brief and specifications was then developed into the final solution.

Seat development **Leg development** **Base development**

Prototyping

Throughout the Concept development stage several physical prototypes were created to gauge human interactions and determine important dimensions.

Seat height testing

Seat shape/size testing

Take a Seat

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NEW PRODUCT DESIGN
Industrial Product Design

Student projects: Product Design - Industrial Product Design

ABSTRACT

Sonar Sight was a 15-week project to design and develop a wearable sonar sensor for blind and low-vision individuals. The design to detect the user's obstacles around them to facilitate navigation and improve safety.

The project started with thorough research to gain an in-depth understanding of the problem and potential solutions. Research proved that common concepts were derived from the literature which was developed and refined as a result of both the electronic and physical concepts that were tried out. Research literature provided the final design concept. It is designed to detect the obstacles and support the well-being of blind and low-vision individuals.

BRIEF

Design a wearable harness for the visually impaired. The device will detect obstacles within a defined perimeter the user's field of vision to allow the user to move freely and prevent injury. The device must be comfortable to wear and not require heavy charging or slow usage for a significant amount of time.

RESEARCH

Research about existing products and potential solutions was conducted. Research proved that the most common concepts were derived from the literature which was developed and refined as a result of both the electronic and physical concepts that were tried out. Research literature provided the final design concept. It is designed to detect the obstacles and support the well-being of blind and low-vision individuals.

CONCEPTS

Three different physical concepts were explored and refined. The different electronic concepts were also explored. One with beeping PIR sensor as the concept towards the user and one with vibration motor. Testing revealed that the vibration was the better of the electronic concepts as it provided the user to be in a safe environment and still be able to interpret the communication from the sensors.



The main component is housed inside the back of the harness and powered by a 9V battery.

The back can be opened with a standard buckle. The buckle is placed on the main back and there is a button when the harness is being put on.



The quality of the equipment determines the safety for the harness to come with the motion of the user.

Each of the sensor devices is about 1.2m radius. The sensor unit is made of four sensors positioned around the user will always be surrounded by sensor feedback. Each sensor is housed in a plastic casing: green for front, orange for side, and blue for back. The sensor unit is placed inside the main case which is in the back of the harness.

Buttons on the front and back sensors are made of vibration motors that be positioned vertically on the user's shoulder regardless of the sensor size.

FINAL DESIGN

The sonar sight is a wearable harness fixed with ultrasonic sensors. The sensor provides feedback to the user through vibration motors which are embedded in the back of the harness. The vibration of the motor corresponds to the distance of objects around the user. The data is sent to the user through the motor.

ELECTRONIC PROTOTYPE

The electronic prototype shows how the technology works. The sensor unit is made of four sensors positioned around the user will always be surrounded by sensor feedback. Each sensor is housed in a plastic casing: green for front, orange for side, and blue for back. The sensor unit is placed inside the main case which is in the back of the harness.

Sonar Sight

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sheffield.ac.uk

Student projects: Product Design - Industrial Product Design

Stand Easy

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MCC2014
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Initial Brief

To be able to redesign a walking frame that will be easier to use and allow users to fold it down to a more compact size. The aim is to also create a walking frame that is easier to use, lighter in weight and uses a variety of materials.

Research

I came to my attention that there is a strong alignment when it comes to using medical equipment. People find it difficult to get up with becoming older or medical devices such as walking frames even though I will search this equipment of the world other than to keep performing better.

Brief

Walking frames can have major impacts on people's lives and wellbeing. It allows people to have increased mobility and stability when performing day to day tasks, allowing them to maintain independence. Current walking frame designs are typically heavy, hard to fold down and generally designed solely for functional purposes and support the user around activities and mobility in the home around the house. It is not designed to be used outside the home. It is common for someone to purchase a walking frame, have it delivered to their home, use it for a short period of time and then have it returned to the store. The user is often left with a walking frame that is not designed to be used outside the home. It is common for someone to purchase a walking frame, have it delivered to their home, use it for a short period of time and then have it returned to the store. The user is often left with a walking frame that is not designed to be used outside the home.



Initial Concepts



Concept 1
Users will be able to use the wheelchair when walking long distances outside. Can be used to move it up and down stairs without needing to worry about being stuck.



Concept 2
The handle being designed allows the frame to be folded down into a very compact size. The handle will be able to fold the frame out of the base and will be used as a one-sided walking stick when walking.



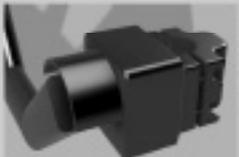
Concept 3
The original design will be able to be used in a variety of ways. The idea is that it will be able to attach into the supports of a walking frame and be used as a walking stick. The user will be able to have the device on the walking frame and use it in any direction such as sitting on the couch or on the bed.

Existing solutions

Existing solutions include such as walkers and users some products that people use to assist with standing up from a chair.



Development




The original concept for the attachment and rotation mechanism allows a user to fold down the required functions. After 3D printing and using the system, it was in the exterior face the product was too large and cumbersome. The design included changing the location of the rotation mechanism to be aligned with the profile of the frame.





Final Product










Student projects: Product Design - Industrial Product Design

Design an Adjustable Transtibial Prosthesis For Amputees in Cambodia

Global View
04/1/2020

UNIVERSITY OF CAMBODIA
1975-2020

INDUSTRIAL DESIGN
1975-2020

PROJECT
1975-2020

Brief

The project aims to design a prosthetic for amputees in Cambodia. The design should be adjustable, lightweight, and easy to use. The design should also be aesthetically pleasing and culturally appropriate. The design should be made from locally sourced materials and be easy to maintain. The design should be suitable for use in rural areas with limited access to healthcare services.

Scope

The scope of the project is to design a prosthetic for amputees in Cambodia. The design should be adjustable, lightweight, and easy to use. The design should also be aesthetically pleasing and culturally appropriate. The design should be made from locally sourced materials and be easy to maintain. The design should be suitable for use in rural areas with limited access to healthcare services.

UCP PRODUCT DESIGN
35 River Street, Singapore
productdesign@ucp.edu.sg

solution

The solution is a prosthetic that is adjustable, lightweight, and easy to use. The design is made from locally sourced materials and is suitable for use in rural areas with limited access to healthcare services. The design is also aesthetically pleasing and culturally appropriate.



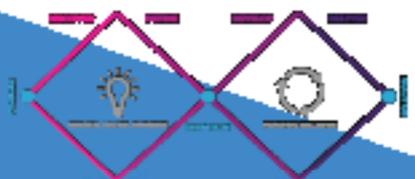
A Design of the socket. The socket is designed to be adjustable and lightweight. It is made from a locally sourced material and is easy to maintain. The socket is also aesthetically pleasing and culturally appropriate.

B Design of the prosthetic foot. The foot is designed to be adjustable and lightweight. It is made from a locally sourced material and is easy to maintain. The foot is also aesthetically pleasing and culturally appropriate.

C Design of the prosthetic knee. The knee is designed to be adjustable and lightweight. It is made from a locally sourced material and is easy to maintain. The knee is also aesthetically pleasing and culturally appropriate.

D Design of the prosthetic ankle. The ankle is designed to be adjustable and lightweight. It is made from a locally sourced material and is easy to maintain. The ankle is also aesthetically pleasing and culturally appropriate.

design process





Meaning of Concepts



Refining and Evaluating Concepts



Final Research



Prototyping



Testing



Final Product



Student projects: Product Design - Industrial Product Design

LoRa Predator Tracking Collar

Introduction

This poster shows the development and final design of a LoRa tracking collar for use on New Zealand predators. This project was done with Chris Mabeur who is a behavioural ecologist at Massey University land care research. The LoRa (long range radio) transmission feature of the collars will transmit the data obtained from the GPS tracker to the researchers through several LoRa Towers. This will make it much easier for the researchers to retrieve the information they need. The tracking collars will be used in Taranaki in an area with several LoRa towers. A problem with the past has by 2020 goal and the methods being used to achieve this is that 3% of the Pest population are often lost. These animals then reproduce or it takes significant resources to keep them under control. This tracking collar will help researchers to understand the behaviour of these animals so this problem can be better understood and solved. The main problem is creating a collar that is light enough to be suitable for a range of New Zealand pests and not be destroyed by a possum or other animals. The drawings that the collar will contain are being developed by others and are not the focus of this project.

Brief

Design a collar to house a LoRa GPS tracking electronics and battery currently being developed for Massey University Land Care Research. The Collar should be suitable for New Zealand's invasive predators. The tracking will monitor house the LoRa technology and battery, not from the predators, signal their movements or justify its behaviour. It also needs to be durable enough to survive the rough and wet conditions of being in New Zealand bush on a predator and unable to be removed by invasive predators in New Zealand.

Aim

To design a tracking Collar housing a LoRa GPS tracker and battery that is suitable for invasive predators found in New Zealand to develop a better understanding of these animals especially the "top 3 percent" of the predator population.

Research

Most of my research was done in the form of literature review and talking with Chris the industry partner for this project. Some of the main things that I found out from this, was that the total weight of the collar should be less than 10% of the animal's weight, what material and process would be most suitable, and details about how possums and other New Zealand invasive predators behave.

Ideation

I used several ideation techniques to generate a wide range of ideas for this project. These techniques were function trees, scenario TBS, mind maps, and morphological matrix. From this, I was able to create 3 main concepts of the LoRa predator tracking collar.



Final Design

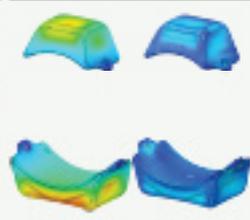
- 3mm wide strap to minimise the effect on the animal's range of motion.
- Hooked to the sides to allow room for the not used make (lightning) it easier.
- Cases are easy to open between uses to charge the batteries, or repair or modify anything.
- Two straps are attached together to make a hole for the wire so it is protected from the animal.
- The straps and it fit against the battery case so it is comfortable for the possum and does not get in the way.
- The ball case make the ball heads more comfortable by spreading the sharp edges and making the transition between the strap and the ball head smoother. They also act as a cushion.

Prototyping



A wide range of prototypes was created throughout the design and development phases of this project. These prototypes were both to test specific parts of the design, such as the ball case and the waterproofing of the case and to generally evaluate and refine overall design to find form and potential improvements.

Simulation



I used multiple simulations to rapidly test the CAD model and find weak points in the design that would be improved and parts of the design that are stronger than they need to be where material would be removed to decrease the weight of the design. I did these simulations in Fusion 360.

Pen Testing



The collar was put onto the possum and was left overnight in a pen. The test was largely successful. The collar was not damaged and when it was taken off the possum and there were no signs of redness of the skin or any patches. This confirms that the pressure was able to be evenly and correctly around the pen but that the collar was matching the movement of its head. This was later fixed.

Development

CAD development was extensively used to make a variety of drawings and potential iterations of the design. These were informed largely by the CAD model itself, the prototyped version of the design, simulation, prototyping and testing. Several different aspects were extensively developed, such as the internal fitting, what materials, material tolerances, wire joining mechanism and position, join between the strap and material around the ball.



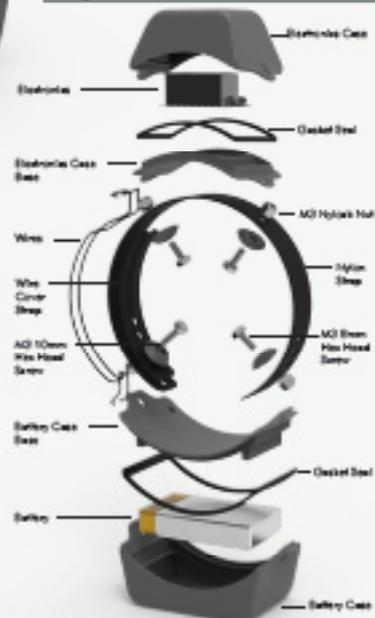
Concepts

Concept One Concept Two Concept Three



To select a concept to develop further I used several methods. I prototyped each of the concepts, got feedback from Chris from Massey University land care research and evaluated the concept against each other using a weighted convergence matrix. The chosen concept was concept one.

Exploded View



LoRa Predator Tracking Collar

Ben Petrie
Product/Industrial Design
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Student projects: Product Design - Industrial Product Design



Introduction

There is growing concern about cognitive decline and dementia, particularly among older adults. This project aims to address this issue by developing a mobile app that provides cognitive training and social interaction for older adults.

By using the app, older adults can improve their cognitive skills and social interaction. The app is designed to be user-friendly and accessible to older adults, with large text and simple navigation.

The User

The target user is older adults (65+) who are looking for cognitive training and social interaction. The app is designed to be user-friendly and accessible to older adults, with large text and simple navigation.

The app is designed to be user-friendly and accessible to older adults, with large text and simple navigation.

Cognitive Decline and Brain Flexibility

Cognitive decline is a natural part of aging, but it can be slowed down by using cognitive training and social interaction. The app is designed to provide cognitive training and social interaction for older adults.

The app is designed to be user-friendly and accessible to older adults, with large text and simple navigation.



Puzzle Rush

Puzzle Rush is a cognitive (rehabilitative) mental agility training app that challenges and stimulates the users' brain to increase brain flexibility and mental agility, which will allow users to prevent and recover from cognitive decline.

Playing games and puzzles that challenge and stimulate the users' brain can increase the users' mental agility. The app is designed to be user-friendly and accessible to older adults, with large text and simple navigation.

Puzzle Rush has two game modes, one that involves the user to engage with the app daily to keep their brain active while also keeping their brain active, which also gives the user something to look forward to. The second mode is for social interaction, where users can compete with their friends to see who can complete their task (puzzles) faster than the other. The app is designed to be user-friendly and accessible to older adults, with large text and simple navigation.

With the portability and accessibility of smart devices, Puzzle Rush allows the user to play anytime, anywhere and whenever they please. In addition, allowing the user to connect and play with friends and family across the country.



Business Opportunities

Getting early promotional assistance for our app

- **Marketing:** Develop a plan of the target market, advertising, public relations, and social media.
- **Partners:** Find a partner to help with the app, such as a developer, designer, or marketer.
- **Feedback:** Get feedback from users and other stakeholders to improve the app.
- **Support:** Provide customer support for users who have questions or issues.

Investment opportunities from companies with similar digital services around here for the elderly.

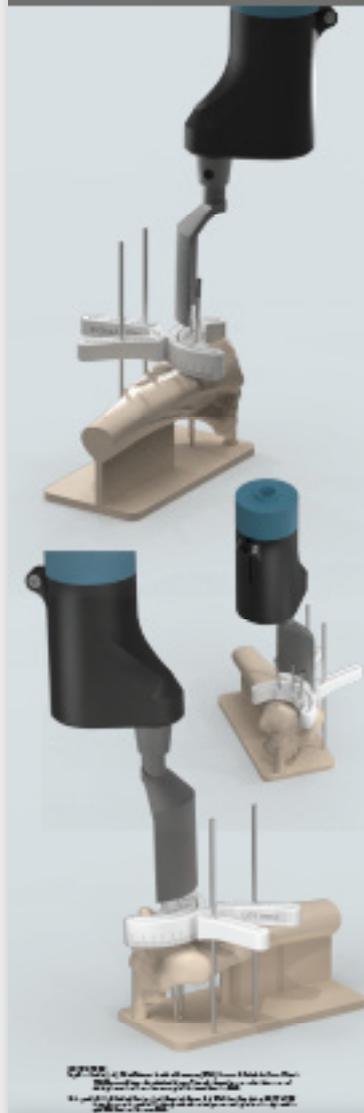
Extended life to work, long-term care, and other services for the elderly.

Helping the elderly to live better and longer by providing cognitive training and social interaction.

RSA Agile Ageing
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 RSA AGILE AGEING
 UG & PRODUCT DESIGN

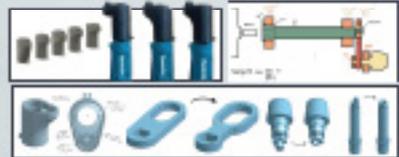
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Abstract *Tuhinga Whakarapopoo*
 A section of the Central Otago Regional Council (CORC) is one of the most common in a jurisdiction to get with 80% of all dog bite injuries being CORC (see The Dog Watch, 2012). TPLO (Tibial Plate Leveling Osteotomy) is a surgery designed to help dogs be able to return to their full physical capabilities. With TPLO surgery becoming a common practice, more veterinarians are wanting to be trained to perform this specialist surgery. With some TPLO cases costing up to \$1000-\$2000 (OssAbility, 2016 & Medical Devices, 2012), there is a large number of entry level markets for these instruments. These span from entry level to help reduce the cost by providing a low cost alternative that veterinarians can use to train and upskill before investing in a TPLO saw for the practice.

Project Brief *Kaupapa Whakaohau*
Aim: This project will design and build an adaptor for a cheap, domestic power tool that will be used to perform TPLO and that veterinarians can use to practice surgery.
Scope: The adaptor should be able to be made in low cost materials using readily available materials during production and assembly phase.

Ideation *Whakaoro*
 Following conducting primary research through online surveys and informal meetings, a main message came that good and powerful tools with their own strengths & controlled ergonomics make use useful to reduce which concept was the best according to the product design specifications, which then formed the project's initial tasks. From these initial stages of ideation, prototyping and refinement work, conducted to achieve a final CAD (computer aided) product. Before a final stage of the design process, with differences of the design increasing the refinement through the project.



Technical Aspects *Nga Wahanga Hangarau*
 The first main challenge was to create a 90° rotation from a rotating shaft. This was achieved through using an offset shaft paired with a follower which was fixed onto the output shaft on the opposite end. Using a pin ensuring the offset could be reduced using the distance between the two centers of rotation and half the desired angle. If this mechanism is assembly simple and lightweight and reduce the desired rotation, which has been verified through prototyping. To ensure the components are able to withstand the forces applied during the use of the tool, FEA (Finite Element Analysis) was conducted to analyse the geometry and identify any weak points in the design.



PDS REVIEW *Arotake PDS*

ID#	Appl/Version	Target	On Issue
1	CONCEPT	CONCEPT DESIGN	NO PROBLEMS
2	CONCEPT	CONCEPT DESIGN	NO PROBLEMS
3	CONCEPT	CONCEPT DESIGN	NO PROBLEMS
4	CONCEPT	CONCEPT DESIGN	NO PROBLEMS
5	CONCEPT	CONCEPT DESIGN	NO PROBLEMS
6	CONCEPT	CONCEPT DESIGN	NO PROBLEMS
7	CONCEPT	CONCEPT DESIGN	NO PROBLEMS
8	CONCEPT	CONCEPT DESIGN	NO PROBLEMS
9	CONCEPT	CONCEPT DESIGN	NO PROBLEMS
10	CONCEPT	CONCEPT DESIGN	NO PROBLEMS
11	CONCEPT	CONCEPT DESIGN	NO PROBLEMS
12	CONCEPT	CONCEPT DESIGN	NO PROBLEMS



TPLO Training Saw
 Bryn Parish
 Industrial Product Design

Email: brynp@OXII@gmail.com

OXII
 OXII
 OXII

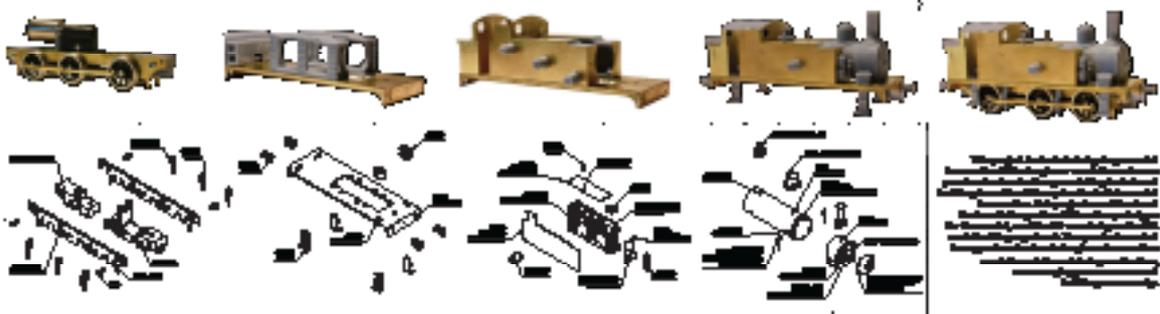
OXII PRODUCT DESIGN
 OXII
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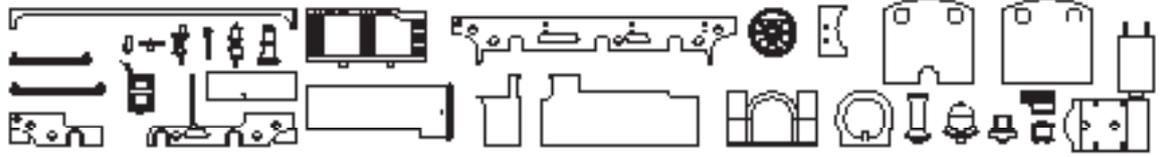


Beginner Model Locomotive Kit Set.

Assembly Process



Kit Components



Design Process:
This is the design process I went through to develop the product and how it met user needs and wants.



Chloe Rowland - 14000007
 Confined Product Design
 Model Construction - Construction Kit

UCB PRODUCT DESIGN

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UCO PRODUCT DESIGN
Te Kura Hanga Otiringa



MIND SYNC



Design Brief:

There are some long-standing negative perceptions and mental ability in older adults. The aging brain can continue to function actively and effectively if we recognize its needs for challenge, exercise, exercise and more. In 2020 Braggie and Dixon show that the effects of aging on the brain can be slowed and reversed if we proactively engage in certain behaviours. This brief wants you to create something that motivates people to engaging behaviours that maintain and develop "brain power" and improve the quality of their mature years.

Research

Found study that 'Improvement of Cognitive Functions through Structured Finger Movements using Visual and Tactile Information'. Where a complex combination of finger movements requiring active sensory processing may efficiently activate both cognitive and motor areas of the cerebral cortex. Structured finger movements that require the integration of sensory information and motor tasks are related to high-level mental processing that require the integration of sensory information and motor tasks. Such movements may activate the frontal area as well as the sensorimotor area, which is directly related to cognitive and motor functioning. Thus, a variety of structured finger movement combinations can be used in an exercise protocol as a simple exercise intervention to develop and/or maintain cognitive functions of the brain with the goal of improving cognitive abilities or delaying cognitive decline (Ding 2023). This supports my decision to take the project in this particular direction.

Aim:

This project's goal is to design, produce, and deliver a product for individuals aged 65 and up that engages their motor and memory skills.

Ideation



After evaluating a number of the ideas sketched from the brainstorming and after at the start of the design stage, I finally settled on the chosen idea concept. The chosen concept is a hybrid of two concepts, one of which has a foam-filled cloth wrapping it, which is the green component, and the other which has a primary body constructed of wood with a living hinge structure pattern. It can be oriented with either two or one hand, whereas the other has a flat top surface composed of living hinges that light up. The one-shaped finger circle in the centre when pressed. When you play it, a speaker in the lower circle will create a sound to indicate which colour needs to be pressed. So, based on the evaluation, a combination of these two would be more engaging.

Concept Development



Concept development began with trying several ideas and forms, as shown in the first image, followed by a laser cut experiment to see if the living hinge worked. The third image is a 3D print that also trial of what cut model to evaluate what adjustments need to be made, as well as a trial of how can be held. The final 3D print prototype is seen in the fourth image.

CAD



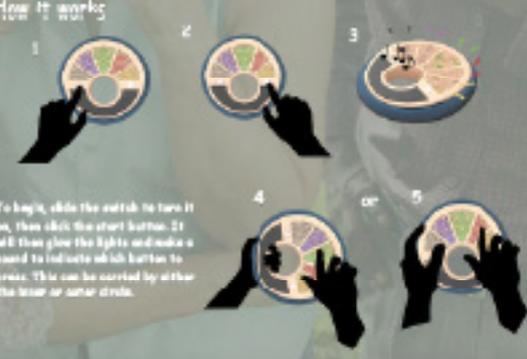
A combination of physical prototypes and CAD modelling aids in the development of the final design.



Final design:

This device generates sounds, light, and a textured touch, which is a combination of sensory information to help your mind develop. Acoustic is composed of biofoam, for ease of manufacture and light weight to carry, especially for the elderly. The design also helps it appear more custom and less like a toy in order to attract the attention of target users.

How it works



To begin, slide the switch to turn it on, then click the start button. It will then glow the lights and make a sound to indicate which button to press. This can be carried by either the base or outer circle.

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MENTOR
Mark Chen

UCO PRODUCT DESIGN
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Student projects: Product Design - Industrial Product Design

DOMINIC BELL, 2022

KAITIAKI

“IMAGINE A FUTURE WHERE OCEAN PROTECTION IS A PART OF OUR NATURAL PRODUCT SYSTEM”

FINAL DESIGN

The final design is a neoprene chest harness with a GPS tracker for ocean protection. The harness is made of neoprene and has a chest strap and a shoulder strap. The harness is designed to be comfortable and easy to use. The harness is made of neoprene and has a chest strap and a shoulder strap. The harness is designed to be comfortable and easy to use.

This harness is made of neoprene and has a chest strap and a shoulder strap. The harness is designed to be comfortable and easy to use. The harness is made of neoprene and has a chest strap and a shoulder strap. The harness is designed to be comfortable and easy to use.

KAITIAKI APP

The Kaitiaki app is a mobile application that allows users to track their location and share it with others. The app is available on both iOS and Android. The app is designed to be easy to use and provides a clear interface for tracking and sharing location data.

DESIGN PROCESS

The design process for the Kaitiaki harness involved several stages, including research, concept development, prototyping, and final production. The design team worked closely with the client to ensure that the harness met all requirements and was comfortable to wear.

TECHNICAL INFORMATION

The Kaitiaki harness is made from neoprene and has a chest strap and a shoulder strap. The harness is designed to be comfortable and easy to use. The harness is made of neoprene and has a chest strap and a shoulder strap. The harness is designed to be comfortable and easy to use.

1. ON/OFF AND MARKER BUTTONS

2. KNIFE HOLDER

3. SHOULDER STRAP

4. PAU BUTTONS

5. CHEST STRAP

6. MONOCOLOUR NEOPRENE OUTER

7. PATTERNED NEOPRENE INNER

8. GPS SYSTEM

9. LOGO IMPRINT

Kaitiaki

Dominic Bell | 10091822

Industrial Product Design

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ADAPT ASCEND

Brief - Whāinga

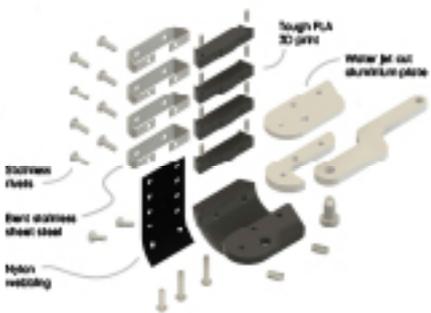
To improve backcountry accessibility for adaptive skiers through enhanced interaction with rope tow infrastructure.



- 1 Apply Gripper
- 2 Contract
- 3 Ascend

Scope

The simple rope tow has long been an efficient means of alpine ascension. commonplace throughout the club fields of New Zealand, skiers use a 'Nutsack' damping device to grip the rope, ascending the mountain via a tethered harness. This requires the use of both hands, which is problematic for adaptive skiers who use outriggers for stability. An opportunity was hence revealed to enhance rope tow accessibility for the adaptive community.

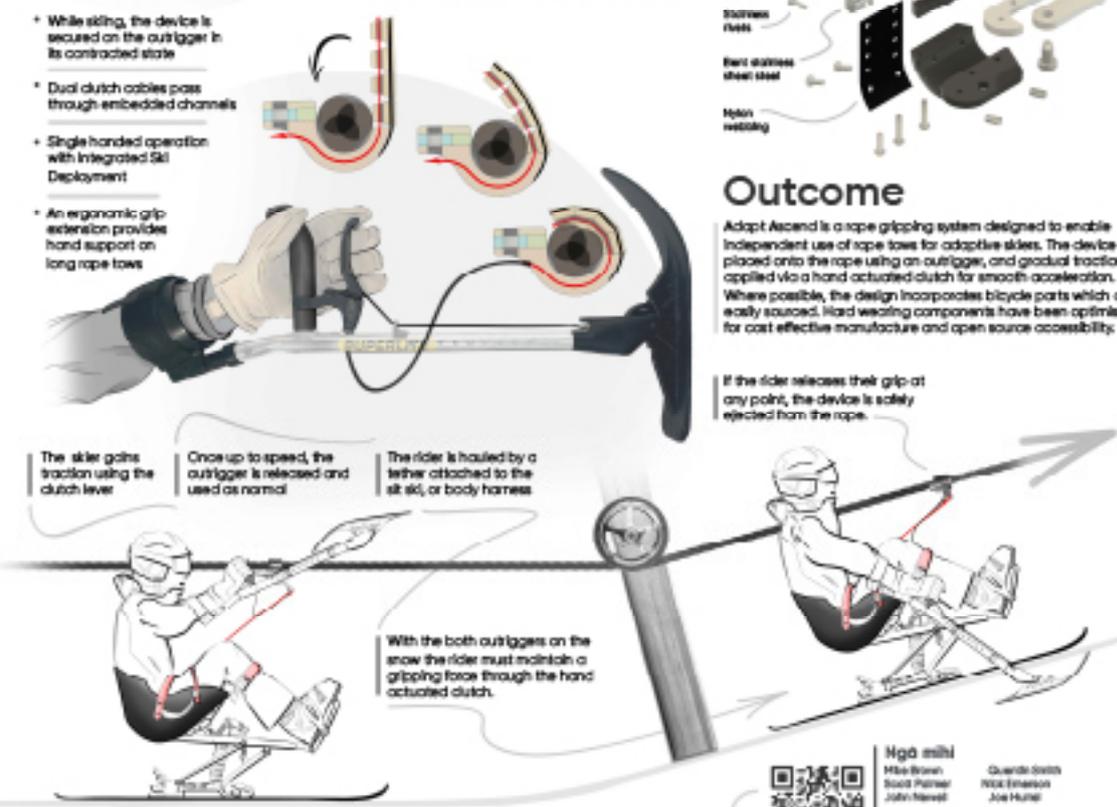


- While skiing, the device is secured on the outrigger in its contracted state
- Dual clutch cables pass through embedded channels
- Single handed operation with Integrated Ski Deployment
- An ergonomic grip extension provides hand support on long rope tows

Outcome

Adapt Ascend is a rope gripping system designed to enable independent use of rope tows for adaptive skiers. The device is placed onto the rope using an outrigger, and gradual traction is applied via a hand actuated clutch for smooth acceleration. Where possible, the design incorporates bicycle parts which are easily sourced. Hard wearing components have been optimised for cost effective manufacture and open source accessibility.

If the rider releases their grip at any point, the device is safely ejected from the rope.



The skier gains traction using the clutch lever

Once up to speed, the outrigger is released and used as normal

The rider is hauled by a tether attached to the ski, or body harness

With the both outriggers on the snow the rider must maintain a gripping force through the hand actuated clutch.

Adaptive Backcountry Snowsports
Edward Parker
Industrial Product Design

www.adaptascend.com
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summit
1611 Emerson

This project is open source. Scan the QR code to discover more.



Ngā mihi
Mike Brown, Lead Partner
John Newell
Quentin Smith
Nick Emerson
Joe Hurst

UCw PRODUCT DESIGN
The Kettle Design Centre

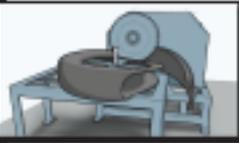
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RETYRE EXTRACTION PROCESS

A new way of making the most out of a bad situation.

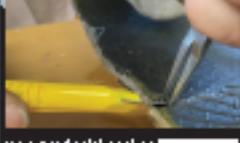
MANUAL **AUTOMATIC**












DISCOVER

In the United Kingdom, around 4.5 million used car tyres are not recycled, left in dumpsites and motorways with no clear options for their disposal. The project aims to provide a new end-of-life option for car tyres, reducing the amount of waste sent to landfill and providing a valuable resource for the automotive industry.

DEFINE

This project aims to generate another end-of-life option for car tyres, utilising their qualities in providing a worthwhile product/service.

DEVELOP

Once the direction of the project was clear, it could be developed. After approximately 1000 tyres were used to be processed for new purposes, then a process was made that is safe, simple and provides grip, which are all advantages. The extraction process to be used needed to be safe, more efficient, and more reliable. The aim of the project was to produce a method that could be done commercially, according to relevant governing regulations.

DELIVER

The outcome of this project was a new end-of-life option for car tyres, which can be used in a variety of ways, such as a safe, efficient, and reliable product. The method used to produce a rope, the most basic use of the tyre, is simple, weather proof and can be made to any length and diameter required.



This QR links to a video demonstrating this process. It takes the viewer through from the collection of the tyre, to the production of the rope. It also outlines methods and their choosing.

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Student projects: Product Design - Industrial Product Design

VINE KIND

AIM

Design a guard for young plants with a particular focus on site culture. For both large and small scale operations.

DESIGN FEATURES

- Pest protection
- Herbicide protection
- One-piece design
- Flat pack for storage
- Durable front closure mechanism
- Reduced install time
- Polypropylene composite
- Mass manufacturable

SMALL SCALE



- Stake attachment
- Fold away wire attachment
- Self supporting

LARGE SCALE



- Wire attachment
- 4 step install
- One-piece design
- Flat pack



DESIGN PROCESS



RESEARCH

IDEATION

CONCEPT DEVELOPMENT

FINALISED CONCEPT



Vine Kind

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CONCEPT
MARKET RESEARCH
INDUSTRIAL PRODUCT DESIGN
MARKET RESEARCH

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Student projects: Product Design - Industrial Product Design

GROW

the reuse recycle system

The System

Introduction

Grow is a facile trough plant pot system, designed to reduce the amount of plastic plant pots entering the landfill. This project was inspired by the love of plants and the growing conviction of single use plastic plant pots in the garbage.

Brief and Aim

The brief for this project was to develop and design a circular loop on plastic plant pots by implementing a new recycling/returning system, with incentivised reward for users. The objective was also to ensure the enjoyment of it and the strong focus behind the project. The aim was to cut down on the amount of plastic plant pots that ended up in landfill.

The Problem

Due to the worldwide continuation of plastic plant pots, a large amount of them fail to be reused or recycled in an appropriate manner. At a facility, the plant pots are left in the landfill. These plastic pots take time to fully break down in the landfill, which leads to the release of toxins into the soil. Because the production industry in New Zealand is expanding so rapidly, there are 11 million pots in the issue. It is critical to rethink the idea with an appropriate solution.

The Solution

The solution is a three pot return based system. The system, the plant pot and the user. The Grow system incentivised users the idea of users purchasing their plant while using an incentivised deposit. Once finishing the plant pot they receive the deposit back. This is where the journey for the plant pot begins, starting with a recycling process and an incentive. The user that gets the incentive process and the user that fall due to storage are collected and incentivised to be recycled into the system. They are then recycled into the system and ready for reuse.

The 'grow' plant pot is a pot that has been specifically designed to include mechanism while lowering the risk of damage. The alternative idea was to create a pot that is able to be reused the plant pot without adding the cost. The plant pot is made from 100% recycled polypropylene, with added strength due to the inclusion of wall thickness.

The growing community included the grow user. This layout included users to interact with members of a local community who share their interest in plants. You can check your plant pot on the grow app and find out how many plant pots you've been out of landfill. Along with being able to see how many plant pots you currently have in your possession, you can also view your deposit and collect them out.

The Solution

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Design Process

When it came to designing the solution, the design thinking process was implemented. This method was chosen as it provided a systematic approach that allowed iteration in creating a user-centred solution. The iterative process and the flexibility to be between different stages, makes it possible for user interests to be met. There were the main features that appeared in the project.

Grow - The Reuse Recycle System

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politecnico di torino

Student projects: Product Design - Industrial Product Design

maimoa

planet approved

Problem

Maimoa Ltd is a Pet and Horse brand that is focused on including sustainable and regenerative elements into the forefront of the industry. Our brand partners are dominating the industry and have done for a long time, however, now is the time for change. Maimoa is replacing harmful materials such as nylon for sustainable, regenerative substitutes to craft new leashes that use natural dog collars. Materials such as hemp mesh (natural strongest fibre) and PLA, a bio-degradable polymer are used to make this 100% natural phone a reality.

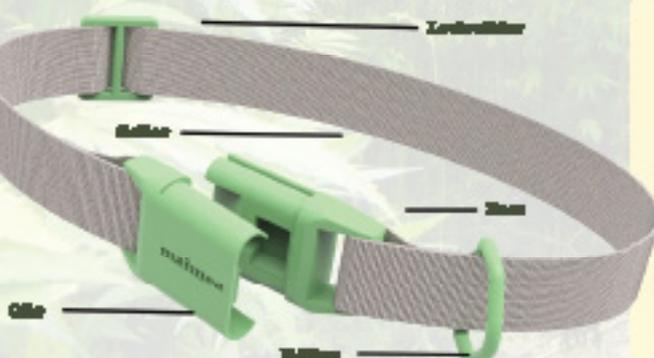
Twist Release



Fry Release



Components of Collar



- City Buckle**
 - The front facing component of the buckle uses optimized snap-fit mechanism to connect the collar. Material: PLA
- Twist Bar**
 - Connects to the City Buckle with a groove to ensure the buckle fastenability. Material: PLA
- Lock Holder**
 - Allows the collar to be adjusted without increasing Material: PLA
- Strap**
 - Attachment point for a lead, leash and registration tag Material: PLA
- D-Ring**
 - All Components are attached to the collar material: Hemp Mesh



Product

The Maimoa snap-fit buckle reimagines the so commonly seen nylon buckle with the environment, user and dog being the center of attention. The buckle is connected one on top of the other removing the possibility of catching the user's finger or the dog's limb/skin in between the parts. This also greatly improves the alignment issues that were prominent with existing buckles. The simple and durable design brings a new look and feel to converting two ends of strap while making 100% natural.

UC PRODUCT DESIGN

Te Kura Hanga Otinga

Website: [maimoa.co.nz](#)
 Instagram: [@maimoa](#)
 Facebook: [maimoa](#)
 Email: hello@maimoa.co.nz

SCAN
for FOLIO



Student projects: Product Design - Industrial Product Design

Geroldine Moffat 55760144

THE POLYNESIAN VOYAGE

How might we support all families, carers and communities play more creatively at home

RSA Brief

The RSA Student Design Awards is a competition for emerging designers that has been running since 1924. Every year they release a set of briefs for designers to choose from which tackle pressing social, environmental, and economic issues through design thinking. For my first year project, I have decided to design to the RSA brief "Play Play". This brief interests me in particular because I have always been interested in the way children play and how it can impact childhood development. I think it is important now more than ever to explore different ways to play at home, especially in a world of lockdowns and pandemics.

The Problem

Family lives have become busier and more stressful over recent years due to the pandemic and the increased need for parents to work more hours. This has resulted in strained parent-child relationships which can have an impact on a child's development. These children need to explore activities that promote positive engagement with other family members. It will also be beneficial for children to be exposed to a variety of multicultural values while learning new skills.

The Process

Discover

To explore different aspects of this topic I researched different ways to highlight the needs of families and address the experience of play at home. These included the impact of COVID-19, parent-child relationships, and multi-generational households. This information was gathered so that I could create a brief outline of the topic. By doing this I could explore the individual stories a family may experience in a world where children are not playing as much as they once did. I also researched the use of board games through the generations, especially with children. I found that board games have a long history and are a great way to spend time with family and friends. I also researched the use of board games in schools and how they can be used to teach children about different aspects of Polynesian voyaging. I also researched the use of board games in schools and how they can be used to teach children about different aspects of Polynesian voyaging. I also researched the use of board games in schools and how they can be used to teach children about different aspects of Polynesian voyaging.

Analyse

Using the information gathered I created a series of personas that represent different types of families. I used these personas to explore the needs of different types of families and how they might play at home. I also explored the use of board games in schools and how they can be used to teach children about different aspects of Polynesian voyaging.

Ideate

Through the ideation and research I developed a series of ideas to create a board game that would be suitable for families of different sizes and ages. I explored the use of board games in schools and how they can be used to teach children about different aspects of Polynesian voyaging.

Evaluate

The creation of the game is a complex process that involves a lot of research and development. I explored the use of board games in schools and how they can be used to teach children about different aspects of Polynesian voyaging.

The Solution

For my first year project, I designed an interactive board game that teaches children aspects of Polynesian voyaging techniques used to navigate to New Zealand. My goal was to create an interactive activity to support positive family relationships through learning knowledge from the past. This game is centered around learning the different techniques used to navigate to New Zealand, which is the key technique used to navigate to New Zealand. The game would involve the player to navigate their journey through the ocean.

Over the course of the project, I explored the use of board games in schools and how they can be used to teach children about different aspects of Polynesian voyaging. I also explored the use of board games in schools and how they can be used to teach children about different aspects of Polynesian voyaging.

The Polynesian Voyage

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Student projects: Product Design - Industrial Product Design





BIOFORGE

Forging a greener tomorrow

The BioForge aims to transform Christmas Island landscapes to improve the well-being of people, plants and the economy using regenerative vertical gardens.



Reduce Green House Effect

Provide Ecological Function & Biodiversity

Improve Air Quality

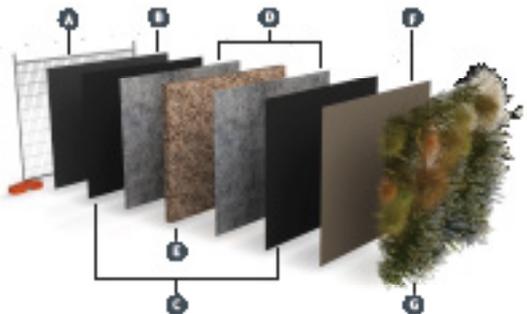
Improve Urban Resilience

Improve Human Health & Wellbeing



Product
The BioForge is a regenerative Christmas Island native plant wall system that improves the well-being of people, plants and the economy using regenerative vertical gardens.

Problem
Christmas Island is a remote island with a high population density and a high level of urbanization. The island is facing a high level of urbanization and a high level of urbanization. The island is facing a high level of urbanization and a high level of urbanization.



A. Drainage Layer
A drainage layer to collect excess water and prevent it from reaching the plants.

B. Geotextile Filter
A geotextile filter to prevent soil from washing away.

C. Growth Media
A layer of growth media to support the plants.

D. Insulation
A layer of insulation to protect the plants from extreme temperatures.

E. Plant Layer
A layer of plants to grow on the wall.

F. Back Panel
A back panel to support the wall.

Product Lifecycle

Initial
The BioForge is a regenerative Christmas Island native plant wall system that improves the well-being of people, plants and the economy using regenerative vertical gardens.

Install
The BioForge is a regenerative Christmas Island native plant wall system that improves the well-being of people, plants and the economy using regenerative vertical gardens.

Operate
The BioForge is a regenerative Christmas Island native plant wall system that improves the well-being of people, plants and the economy using regenerative vertical gardens.

End
The BioForge is a regenerative Christmas Island native plant wall system that improves the well-being of people, plants and the economy using regenerative vertical gardens.

BioForge Vertical Garden

Product Design Team
2023/24



UCP PRODUCT DESIGN
Industrial Design

Student projects: Product Design - Industrial Product Design

FIREFORM

Operating the Fireform tool set.

The Fireform tool set is incredibly easy to use, as within the series of plastic tubes there is a simple 8 step process to the operator of the product.

1. Starting with the set of tools in its storage bag with all the tools hanging off the show, simply remove the brush and the poker tongs from the back on the handle of the show.

2. Now hold the top protruding handle back up into the handle of the show to keep it horizontal to the bag.

3. Next you can adjust the angle of the show handle to either straight, at a 45 degree angle or even back into a 90 degree storage position. Adjust the angle by moving the handle up.

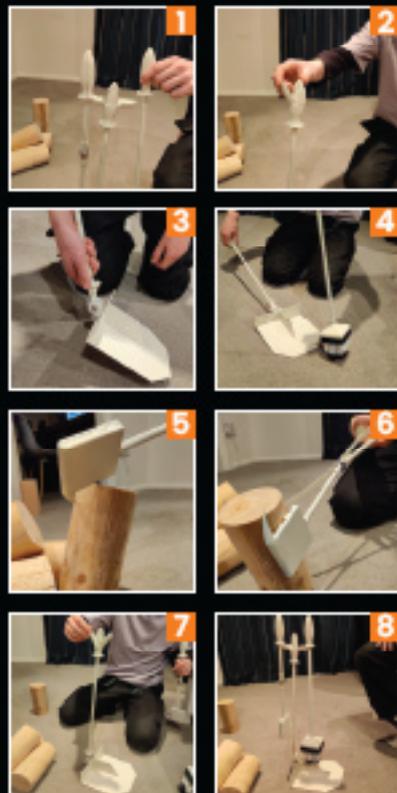
4. Attach the dust to the top of the brush in order to empty ashtrays and around the fireplace.

5. The poker tongs can be used to push or pull logs and other objects inside the fire, if necessary for wood to burn the fire.

6. The poker tongs are also for operational used in the long direction to push up and move logs inside the fire. They can also be used to place fuel inside the fire too.

7. To return the brush to the storage position, fold the show head back to 90 degrees and hold out the brush handle to the side.

8. Lastly, hang the brush and poker tongs back on the handle of the show.



The Fireform tool set is a product designed to facilitate your living space. This set of tools is designed to be elegantly held and used every day to take up the load around your fireplace. Every year, millions of people use a set of tools for hanging in your fire.

There are 2 main parts to the set of tools which are the show, brush and poker tongs. The show has a handle, a rotating ring designed to allow the show to be positioned at 3 different angles for ease of use. When folded into the 90 degree position, it also acts as the storage holder for all of the other tools. The show head features a curved, semi-circular design that allows the brush to be attached when moving around the shape of the brush. It also features a circular hole when moving in light areas or corners.

The brush is designed for sweeping both soot and the dust. The poker tongs are used to push moving logs, handle sticks. Carrying in the poker tongs to the set, this is so they can sweep up the powdered ash without having it up into the air. The set tongs are longer than the brush so as they can sweep down to allow the brush to be used to sweep the top of the brush.

The poker tongs have a dual purpose. They are designed so that when the tongs are closed, they can be used to push and pull logs inside the fire or sliding split sticks. When the tongs are open, they can be used to grab and hold logs and other sticks inside the fire and to push them away from your hands when placing logs on the fire.

Almost the entire set of tools is manufactured in cast aluminum, stainless steel, and stainless steel, and the show which is a solid and robust construction. All material is made to be made in a way that is easy to use and the handle of the tool is made to be made in a way that is easy to use.



An example of a newly made roof coating of the Fireform Solution.

The design process

The design process of the product began with our many weeks of sketching with the initial sketching and then prototyping. This was the part where I had the most fun with making and testing ideas. Once I had a few ideas that I was happy with, I went to develop a few viable concepts.

The next stage was to take the final concepts and thoroughly make them into a reality. This was the part where I had the most fun with making and testing ideas. Once I had a few ideas that I was happy with, I went to develop a few viable concepts.

After more development, sketching, I moved into the prototyping stage, then I played with my ideas in both pencil and digital space to make them look like they could move on to the final production.

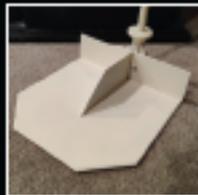
Once the model was finished, I was able to finally see how the product looked and functioned. There were lots of changes here, such as changing all of the angles, however, since the model was complete, I could not prototyping the final product. This consisted of a set of 3D printing or real to making materials such as aluminum.



On the handle of the show there are a pair of handles that fold out to allow the show to be hung. These handles fold out with the brush and when not in use, they are easy to display when it's time to pick up the tool set.



Attached to the base of the show there is a rotating ring that allows you to lock the show into different angles depending on the current use of the tool. It can be locked at 0, 45 and 90 degrees allowing for 3 working positions. The 90 degree locked angle is in its storage position.



The show head itself is a 90° fold allowing them your conventional show. Now you can see that it is divided into two parts. The show head, hanging in a wide angle and light corner without lifting the show that you're already hung.



The poker tongs feature a simple design that allows the tongs to open and close with ease. Each end of the tongs is designed to be long enough where when closed, both handles hang inside and fold back. When in the open position, the tongs can act as a push and pull tool to be used for pushing logs.



The brush is designed to come 2 main purposes. The first being to sweep up the soot and dust from the fireplace. The second purpose is to sweep up the large dust on the sides of the fireplace. The brush is made of a soft, flexible material that allows it to sweep around the outside of the brush.

Fireform - Modern Fireplace Tools

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Student projects: Product Design - Industrial Product Design

SkimTek

HYDROFOIL SKI BISCUIT



In the early 2000s, flying foil biscuits, known as kite tubes, were invented. They allowed wind drag against their large bodies to become airborne, allowing a rider to fly the biscuit behind a boat, although their uncontrollability and propensity for reaching dangerous altitudes resulted in many injuries and deaths, subsequently leading to bans and recalls.

This foil biscuit was designed to provide that same feeling of flight with a unique ride offering, at a controlled height and in a safer manner than kite tube forgoers. It needed to be easily fitted to a foil biscuit, durable and capable of surviving an occasional grounding or collision with a water obstacle, and fun to ride.

Features

1. Main Foil: Produces the lifting force that raises the biscuit from the water. The cross section was optimized using Ansoft FEA, an extension for Fusion 360 that generates optimal aerodynamic and hydrodynamic shapes. The dihedral (upwards) angle of the foil provides roll stability, and ensures the biscuit will return to upright when tilted.

2. Fuselage: Connects the hydrofoil components together, and provides pitch and yaw stability. The fuselage can be flipped upside down to change the angle of attack of the lifting foil - this reduces the overall lift produced by the foil, making the ride more suitable for fewer or lighter riders. If the lift was not reduced, the biscuit would reach its maximum height at a lower speed due to the lighter foil, which would not be an engaging ride.

3. Stabiliser: Most hydrofoil stabilisers produce lift to offset the rotational force of the main lifting foil - as the lifting force is not directly under the centre of gravity, it creates a rotational force pitching the nose upwards. However, as the biscuit is being towed, the tow rope counteracts this rotational motion, keeping the biscuit level - thus the stabiliser only needs to provide pitch and roll stability, and not lift. The stabiliser is a strut design, also optimized using Ansoft FEA.

4. Mast: Connects the hydrofoil to the biscuit, and acts as a lever for the rider(s) to transfer directional force by shifting their bodyweight. This changes the direction of the hydrofoil, and therefore changes the attitude and/or direction of the biscuit relative to its position behind the towing boat. Three connections at either end allow for easy removal from the biscuit, or rotation of the fuselage.



• THREE RIDERS

• 20 KNOTS

• SOAR ABOVE THE WATER

Design Process



The double diamond design process was used throughout the project, to encourage divergent and convergent thinking at different phases of the project. The discover phase was dedicated to researching suitable water toys and existing hydrofoil uses, and the popularity and target market of foil biscuits in New Zealand. The define phase converged this initial research to create a Product Design Specification, and determine the ideal handling characteristics of the biscuit. The design phase involved creating 1/3 scale prototypes of different hydrofoil geometries, and physically testing them to determine how different hydrofoil characteristics affect handling. Finally, the deliver phase involved finishing the different hydrofoil components, and creating a final full scale prototype with the optimal handling characteristics.

Hydrofoil Ski Biscuit

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Student projects: Product Design - Industrial Product Design

CULTURE PAD

Brief / Kaupapa whakaahua
How might we support all families, users and communities to play and learn more readily at home?

Press Play is an NZQA C&P competition brief that involves creating opportunities of learning outside of the school environment and moving into the home environment. The approach will focus more on reimagining play and learning conditions that allow play to thrive.

The Problem / Te Raruraru
Data shows 58 percent of students are regularly going to school, down from 84 percent in 2018. The biggest decline were coming from primary school and Māori and Pacific students.

This assignment's main focus will be on catering for those who do not consider attending or from lowly educational settings. Unfortunately, the majority of this demographic are of Māori/Pacific descent.

Aim / Whāinga
To design a device that allows for remote learning for children of home who are affected by negative financial and social circumstances by reimagining play and learning conditions for learning through play.

- Must encourage learning, not boredom.
- Must be inclusive for all genders and ethnic backgrounds.
- Aim to provide experiences for New Zealand culture.
- Making Māori traditions.

Internal Features / Nga Waahanga

- Open up device screen with curved edges glass with substrate.
- LED strip is glued to fit flush with screen edges.
- LED strip will light up the background screen.
- Microcontroller board for digital and LED control.
- Wired plastic protective screen.
- USB-C port.
- Battery pack connected to USB-C port.

Size and Dimensions / Whakatakoaki gahata

The exterior dimensions are shown here. The main screen area is large enough to hold an A4 piece of paper. The height of the main casing is 100mm.

Three Concepts / Nga kaupapa matua e toru
The three leading concepts that were identified from the ideation phase were a good start into fully development. Concept 1 talked in proper design mechanism and had a simplistic design pattern. Concept 2 had all features necessary for enhancing kit including a handle. Concept 3 main purpose was to serve as a small mechanism that can create a personalized flip book.

I decided to move forward with concept 2 while implementing certain features from concepts 1 and 3 such as a digital screen and paper holders.

Drawing Process / Tukanga Tuhituhi

Māui and the Sun were used as the initial text. The drawing process is an early or three-step process that consists of firstly drawing in the outline, colouring in the outline, then colouring between the lines. The user's creative freedom during the drawing process to add features of their liking or even adding different colour variations.

Materials / Rauemi
The main product is divided into multiple sections: the main casing, flip holders, handle, battery and LED strip.

- The main casing is made from injection-moulded ABS.
- The flip holder is made from compression-moulded polycarbonate.
- The handle is made from injection-moulded ABS and is bolted to the top of the casing.
- The battery is made from aluminium magnesium alloy and is connected to the casing through a sliding pin.
- The screen is custom cut and imported in a curved shape and is made from aluminium oxide glass.

Abstract/Tuhinga whakaarapopoto
Essentially, the Culture Pad is a paper holding drawing pad that includes stand-outlines in custom cut paper. The process of using the gadget involves following the lines and words that are intended to be drawn on by the supplied colouring pens. It is a line colouring activity that is the end result will form a personality made along for the user to e.g. being an A4 screen that is powered by a battery and brightness slider, being too heavy been solved. The process of drawing involves slotting the custom printed paper along the screen through the holders then sliding another take a canvas on top. The user will then turn the power on and adjust the LED brightness to the preferred intensity. The screen will appear and will act as a guide for the user to follow with their tip pens. Once the page is completed, add it into one and complete the process again until you have enough pages to turn a great story!

The Culture Pad utilizes all senses required for cognitive development. Keep your children occupied for hours on end without forcing to worry about negative exposure.

The product is targeted towards:

- Early Childhood Education and school children - aged 4-10
- Parents/Coaches - low-income/low school, government benefit, the market segment needs cheap-access to a device that can help children improve their drawing and writing skills through an easy process of use.

Items that are included with the product include:

- 48h-drawing pen casing
- 11 different felt pens - gel based with the Crayola 'Triplepoint' range of coloured felt pens
- 10 sheets of custom cut A4-paper
- Dogleg
- USB-C Charging port

Process of Use

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Student projects: Product Design - Industrial Product Design

Nature Fall

A sustainable solution for the modern day playground

Project Brief

With the ever-growing effects of climate change being felt around the globe, the need for environmentally sound products in every industry is more apparent than ever. Nature Fall's goal is to challenge the use of oil-based foam fall protection, both chemically and physically in playgrounds today. Nature Fall aims to design a fully sustainable playground mat that has the safety, environmental, and longevity attributes as its foam, but based on nature.

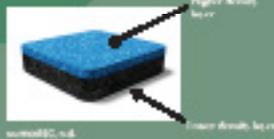
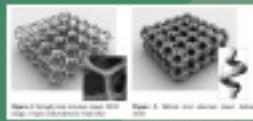
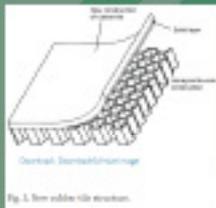
Purpose

Foam fall based materials dominate the playground surfacing industry. Synthetic plastics and rubber are common used, which are harmful to the environment and costly and up to the landfill. For common playground mats, only last for 4-6 years, this becomes an issue as huge amounts of these non-renewable and non-recyclable materials are being made in an industrial level. This project hopes to find out a different, and sustainable alternative to help ensure the preservation of the environment.



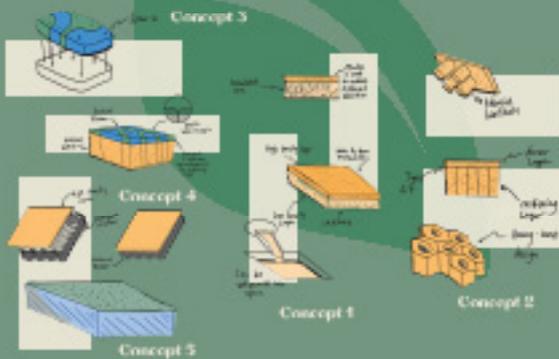
Discover

The approach for this stage of the design process was to take a step back and uncover the main components of the problem. Comparativizing the problem meant that it can be tackled at different angles. Research on materials, existing products in the market, and other possible solutions such as the study of Huang & Chong to the mechanical properties of a honeycomb structure (2007).



Define

Building off the information gathering from the discovery stage, concepts were generated using different techniques and methods that improve current market products and also generate novel solutions.



Develop

After choosing concept 4 as the final concept, a series of FMEA failure modes and effects analysis were done to the concept, such as the over-all product, customer experience, and installation. This is to ensure that every element that composes the over-all success of the product were analyzed and any issues were mitigated.

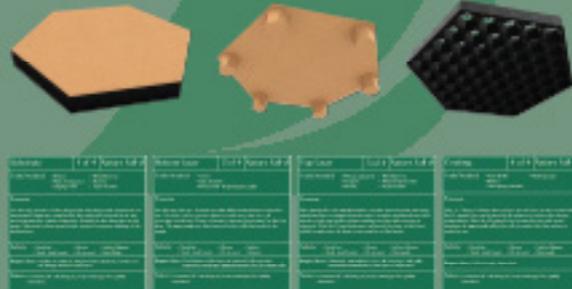


Failure Mode	Failure Effect	Failure Cause	Severity	Occurrence	Detectability	RPN	Control Plan
Mat not installed correctly	Child falls through mat	Improper installation	High	Medium	Low	12	Provide clear instructions and training for installers
Mat degrades over time	Mat becomes unsafe	Material degradation	High	High	Medium	36	Use high-quality, durable materials and schedule regular inspections
Mat is difficult to clean	Mat becomes unhygienic	Material texture	Medium	High	Medium	18	Use easy-to-clean materials and provide cleaning instructions
Mat is too expensive	Project budget exceeded	Material cost	Low	High	High	36	Source materials from cost-effective suppliers and optimize design for cost efficiency

FMEA

Deliver

This stage focuses on the over-all execution of the solution. From defining the product's 3D modelling, design & technical features, manufacturing process and installation. This is to ensure that the product embodies the solution to the problem.



Nature Fall

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Tu Ki Te Waahi

Stop in Place Snowboard Brake



Brief: Runaway snowboards have created a danger to all mountain users due to modern snowboard leashes becoming shorter and an ever-increasing number of snowboarders not using a leash.

The current market is made up of leashes that connect from your bindings to your boot, keeping your snowboard constantly attached to you. This is intended to prevent your snowboard from racing down the mountain without the user on it. However, this system is flawed as you are unbound from your board before securing your leash, so when at the top of the mountain, you place the same ski of your board running away from you when placing your leash on as when you are putting your bindings on without a leash.

A solution must be implemented where runaway snowboards can be prevented without the need for a leash and that does not rely on user input. It is crucial that this solution will not hinder the edge of the snowboard or be of a significant weight that will disturb the balance and feel of the snowboard.

Aim: Develop a simple, easy to use and malleable product that ensures the user's snowboard comes to a stop within five metres of the board being released from their control. In turn, this will increase the safety of ski fields and help bring an easier user experience to all snowboarders.

Final Outcome: Through testing a prototype of the kit, skit ski field, the Tu Ki Te Waahi snowboard brake kept a static board on a 10 degree slope of rest. On a 20 degree slope, it stopped the snowboard at an average of 0.6m. Dropping a snowboard from a height of 1m while walking, the snowboard brake successfully stopped the board at an average of 1.6m on a 10 degree slope and an average of 3.9m on a 20 degree slope.

These results show that the Tu Ki Te Waahi snowboard brake successfully met the project's brief and aim and is a product that can serve a purpose in today's ski and snowboard market.



Brake Engaged

When the snowboard brake is engaged, the hook gets caught in the snow and brings the board to a stop. Through the use of a torsion spring, the brake can only be disengaged by the user standing on the lever, in turn rotating the rod, and lifting the brake out of the snow.

Brake Unengaged

While the brake is unengaged, the snowboard rider is securely strapped to their board through their bindings. When the rider's foot presses down on the lever, the rod rotates, releasing the brake from the snow and off the ground, allowing the user to snowboard as they please.

Stakeholders Review



As someone who has used many snowboard leashes in the past, I enjoyed the fact that this was a more secure and easier to use product. It was a nice change from the standard leashes that are used today.



I have used a lot of snowboard leashes in the past, but this one was a lot better. It was easy to use and it was a lot more secure than the others I have used.



The Tu Ki Te Waahi snowboard brake is a design that should have been designed many years ago. It has had a lot of feedback from the market, but it was not until now that it was implemented into the market.



It is a really interesting design, and the fact that it is a snowboard brake is a really interesting concept. I think it is a really good idea and it is a really good design.



The Tu Ki Te Waahi snowboard brake is a really good design and it is a really good product. I think it is a really good idea and it is a really good design.

Scan to discover more of my design work:



Tu Ki Te Waahi - Stop in Place Snowboard Brake

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Student projects: Product Design - Industrial Product Design

PROD314 CAPSTONE PROJECT

29191458
JOSHUA CAMMOCK-ELLIOTT ASSIGNMENT 3

concepts

Concept 1 prioritised portability and weight over all other specs. It featured a 2.0 kWh battery capacity and therefore enabled portability by being incompatible with vehicle.



Concept 2 prioritised stabilising as a wheel took over all other specs. It featured a 2.5 kWh battery capacity and included ball bearings for preventing a wheel from being stuck during charging.



Concept 3 prioritised battery capacity over all other aspects. It featured a 7.2 kWh battery capacity and was made portable by the inclusion of a wheel and handle system.



problem

I will design a portable EV charging solution

Electric vehicles require industrial level infrastructure to charge their batteries. This presents a global problem in high density urban areas. Charging stations are expensive, large, and don't charge individual batteries fast enough to service a saturated EV environment. It is likely that many consumers will be unable to conveniently charge their vehicles to use them when needed.

ideation

I completed comprehensive ideation and identified three different design solutions. I selected the best method to generate design pathways. This choice of method directly impacted the problem specifications, ensuring that each pathway generated met the specifications set by the problem while still being diverse and unique.

Through the use of a function tree and morphological chart I defined three distinct pathways that later on identified specifications in different ways. The main overlap between battery capacity and size/weight and prioritising one or the other proved to establish different concepts.

final design

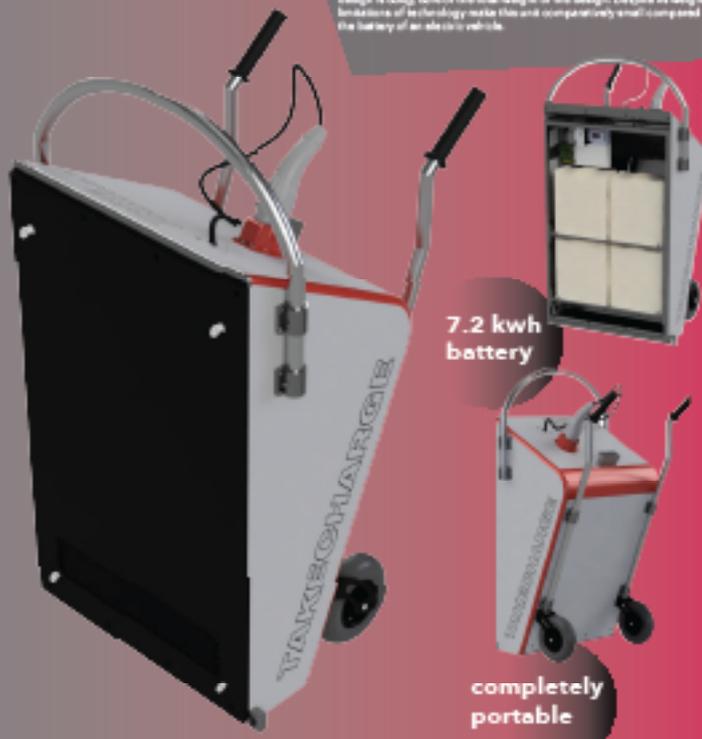
TAKECHARGE

This final design will empower an EV charging service called TakeCharge. TakeCharge will allow charging units to EV's parked in high density urban environments. Units will be designed to be used on vehicles and will charge overnight, before being picked up again. TakeCharge would seek to help users in convenience to get about their range anxiety and encourage those special to enter the growing EV market.

The major design decisions I had to make was to either create a product that had a big and heavy battery or a small but portable battery. This design I go means the latter option. The shell in its highest point is but 71cm tall. The base is width to 1130mm, and 1200mm respectively. The total weight of the design is roughly 120kg, the weight of the batteries I have chosen to represent batteries I may choose in a working design is 100kg, 40% of the total weight of the design. Despite its weight, limitations of technology make this unit comparatively small compared to the battery of an electric vehicle.

design features

-  **User can book time / place for charge. Takecharge enables convenient charging**
-  **Units designed to fit aesthetic of EV's already present in the market**
-  **Unit can be attached to vehicle wheel preventing theft of units during charge process**
-  **EV plug can be switched and swapped depending on users EV compatibility**
-  **Inclusion of RMC board allows for remote viewing and control of unit charging process**



7.2 kWh battery

completely portable

Prod314 Assignment 3 - Takecharge

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BRUNNEN
TakeCharge

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Student projects: Product Design - Industrial Product Design

GROW HOME GREENHOUSE



THE PROBLEM

- High city density
- Supply chain issues
- Physical and mental health struggles
- Disconnection from nature

THE AIM

To design a product that helps individuals grow their own food in their homes. This can be done by creating a product that is easy to use, affordable, and sustainable. The product should be able to grow a variety of vegetables and herbs, and be able to be used in a variety of settings, such as indoors or outdoors.

INTRODUCTION

The project aims to explore a potential solution to the problem of high city density and the resulting issues of supply chain, physical and mental health struggles, and disconnection from nature. The product is designed to be a simple, affordable, and sustainable way for individuals to grow their own food in their homes. This can be done by creating a product that is easy to use, affordable, and sustainable. The product should be able to grow a variety of vegetables and herbs, and be able to be used in a variety of settings, such as indoors or outdoors.



1. EXPLORING THE PROBLEM

The project explores the problem of high city density and the resulting issues of supply chain, physical and mental health struggles, and disconnection from nature. The product is designed to be a simple, affordable, and sustainable way for individuals to grow their own food in their homes. This can be done by creating a product that is easy to use, affordable, and sustainable. The product should be able to grow a variety of vegetables and herbs, and be able to be used in a variety of settings, such as indoors or outdoors.



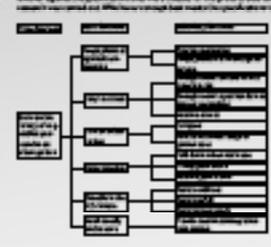
CONCEPTS

The project explores the problem of high city density and the resulting issues of supply chain, physical and mental health struggles, and disconnection from nature. The product is designed to be a simple, affordable, and sustainable way for individuals to grow their own food in their homes. This can be done by creating a product that is easy to use, affordable, and sustainable. The product should be able to grow a variety of vegetables and herbs, and be able to be used in a variety of settings, such as indoors or outdoors.



2. CREATING IDEAS

The project explores the problem of high city density and the resulting issues of supply chain, physical and mental health struggles, and disconnection from nature. The product is designed to be a simple, affordable, and sustainable way for individuals to grow their own food in their homes. This can be done by creating a product that is easy to use, affordable, and sustainable. The product should be able to grow a variety of vegetables and herbs, and be able to be used in a variety of settings, such as indoors or outdoors.




3. DEVELOPING IDEAS

The project explores the problem of high city density and the resulting issues of supply chain, physical and mental health struggles, and disconnection from nature. The product is designed to be a simple, affordable, and sustainable way for individuals to grow their own food in their homes. This can be done by creating a product that is easy to use, affordable, and sustainable. The product should be able to grow a variety of vegetables and herbs, and be able to be used in a variety of settings, such as indoors or outdoors.



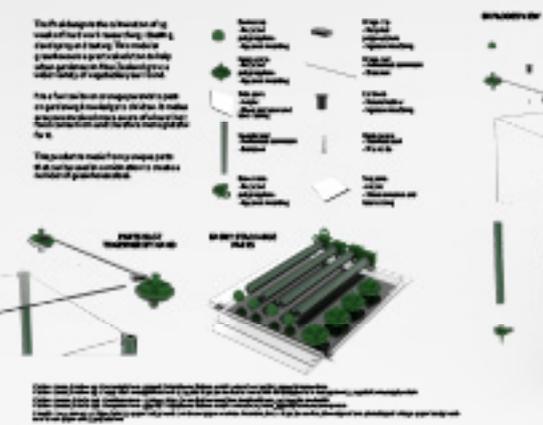
FINAL DESIGN

The project explores the problem of high city density and the resulting issues of supply chain, physical and mental health struggles, and disconnection from nature. The product is designed to be a simple, affordable, and sustainable way for individuals to grow their own food in their homes. This can be done by creating a product that is easy to use, affordable, and sustainable. The product should be able to grow a variety of vegetables and herbs, and be able to be used in a variety of settings, such as indoors or outdoors.



4. THE FINAL DESIGN

The project explores the problem of high city density and the resulting issues of supply chain, physical and mental health struggles, and disconnection from nature. The product is designed to be a simple, affordable, and sustainable way for individuals to grow their own food in their homes. This can be done by creating a product that is easy to use, affordable, and sustainable. The product should be able to grow a variety of vegetables and herbs, and be able to be used in a variety of settings, such as indoors or outdoors.



Grow Home Greenhouse

Kate Atkinson
Product Designer



www.kateatkinson.co.uk



Student projects: Product Design - Industrial Product Design

RECIRCLE

a reuse system for iron supplements



This project re-imagines pharmaceutical packaging by offering a re-use solution for iron supplements as an alternative for the single-use packaging that currently dominates the market. This provides health and environmental benefits combined with a more sustainable method of retaining their iron supplement without the waste.

EMPATHISE

1. Current iron packaging is unsustainable! Currently, iron supplements come in a plastic bottle designed to be used once and then disposed of. This contributes to single-use plastic waste in recycling bins in our environment.
2. Our recycling systems are overwhelmed! New content like plastic recycling capability and advanced reuse create the necessary infrastructure to continue to improve.
3. Confused Consumers! Consumers may be uncertain over and quite wary of products that do not clearly communicate their recyclability because they lack time, motivation or sufficient information.

DEFINE

Project Direction:
The main goal is to provide an environmentally sustainable solution for long-term use with consistently clear instructions that are easy to read and understand.

Safety Considerations:
Safety factors were critical because it is vital that the quality of the iron supplements is preserved until their use beyond their date.

Our Market:
The target market we focus on is the regular use of iron supplements and our health and environmental concerns. Women were identified to be the primary demographic of iron supplement consumers.

IDEATE

Iron supplements were considered from a capsule that is in a soft, mold-suppressing, water and then plastic bottle.

Key Features:

1. QR code for relevant info and recycling information
2. Reusable cap
3. Recycled/recyclable materials
4. Sustainable materials



PROTOTYPE AND TEST

1.



Wasteful
Single Use
Bottle Design

2.



Single-use plastic

3.



Recycled from
recycling
of mixed plastic
in use

4.



3D printed base,
water and cap

5.



Modeling with
an existing
bottle

6.



QR Code Label
with
recycling
info

Recircle Bottle



Recircle App



SCAN ME!



Recircle System

The Recircle bottle is reusable and can be refilled at the consumer's local pharmacy.

Information about health, proper dosing instructions, suitable water, and other important information is available on the Recircle app. Consumers can scan a QR code on the product label to find this information.

DO THE APP-DEED YOURSELF BY SCANNING THE QR CODE.




Recircle Iron Supplements

Pharmaceutical
Manufacturing
Retail

© 2024 Recircle System

LIFE PRODUCT DESIGN

Student projects: Product Design - Industrial Product Design

STRATO CYCLONE

WHAT?

The StratoCyclone is an all-in-one package created to collect and store samples of small particles from the atmosphere for scientific research.

Flown onboard an aircraft at 45,000ft for weeks at a time, it is designed to filter out any Microplastics and Interplanetary Dust Particles present in the air and store them safely to be analysed on the ground.

WHY?

Scientist researchers have had to use manual or semi-automated Dust Particles (DPs) to test Microplastics.

DPs are small thousands of separate circular discs, a round surface the diameter is 1mm and 1mm apart. Having their physical and chemical composition gives us valuable insight into subjects such as the formation of our solar system and our planet.

Microplastics are microscopically small pieces of plastic. By detecting numbers of these, researchers will gain an idea of their main plastic pollution in flying around in our upper atmosphere - something that has not been done before.

Existing methods of sample collection have been:

- using to generate particles
- responsible to contaminants
- and
- labor intensive for technicians, who have had to catch and microanalyse particles from a filter by hand.

HOW?

Powered inside an aluminum container via two main components: The Cyclone separator and the 3000rpm motor.

The Cyclone separator allows clean to a clean stream filter that was surface for the speed of the incoming air to filter out particles. (See the model on the desk to learn how this works)

Air is directed from outside the moving aircraft, through the aluminum inlet and into the system.

Particles are separated from the airstream and fall into a container seated beneath, while remaining air escapes through the top, back outside.

The use of a cyclone separator as an alternative to a traditional substrate filter both reduces the chance of **sample damage** to follow regular DPs, while also **eliminating manual labor and human error** - technicians are no longer required to spend hours sifting individual particles out of a filter and under a microscope.

A servo-actuated trigger is positioned at the extension of the inlet. This is to stop the cyclone during an inlets where sample collection is completed, such as during ascent and descent of the aircraft.

The closed critical component of this device is the Friction Filter.

The cartridge houses all of the containers in a greater hole.

A slit is positioned on top, which when rotated by the motor allows it will sequentially open and close the containers in the cartridge, allowing individual containers to rotate towards the bottom to release open, while the other containers are locked shut. (Try turning the disc below to see how it works)

Not only are the containers sealed!

This project has two distinct stabilizer groups:
 One - Interplanetary Dust separators,
 and two - Microplastics and environmental researchers.

Using multiple individual containers also makes it possible to see if different parts of the sky have different particle counts at times.

POST-FLIGHT PROCESS

- 1. REMOVE LID & INLET**
- 2. LIFT OUT**
- 3. POOL HANDLE TO RELEASE MOTOR**
- 4. DISENGAGE**
- 5. APPLY CLAMP & TRANSPORT**
- 6. LIFT OFF**
- 7. OPEN CONTAINER**

StratoCyclone

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UCSD PRODUCT DESIGN
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Student projects: Product Design - Industrial Product Design

ECOHEDRON

LEARN THROUGH PLAY



2-4 Players
Ages 8+

Magically fits to your
couch to create a fully
functioning ecosystem.

PROBLEM

New Zealand's biodiversity landscape is extremely unique and beautiful - however, human impact and the loss of species has caused over 4000 NZ species to be threatened or at risk of extinction. Despite these alarming facts, the education system in New Zealand has failed to reach its potential in teaching the younger generation about the crisis and its on. This education provision needs much greater investment to ensure children will have the tools to respond.

BRIEF

To design a fun and engaging children's game for 8-12 year olds which integrates age relevant education on the biodiversity loss crisis in New Zealand.



DISCOVER

To kick off the project, primary and secondary research was carried out to better understand the target market and product scope. This included research into the cognitive development of 8-12 year olds, game functions, existing products, New Zealand biodiversity and a detailed user journey, which was refined by year 8-12 primary school teachers. It was discovered that the majority of 8-12 year olds have little to no knowledge around environmental issues, as it is not mandated within the NZ curriculum - leaving it up to teachers to incorporate it within their lessons.

DEFINE

Based upon the research conducted, product design specifications were then developed (summarised below).

- Must engage players for 15-20 mins.
- Must be a multiplayer game.
- Must be suitable for 2-4 players.
- If sharp edges, sharp corners or small parts are present, a warning label must be attached to packaging.
- Must implement biodiversity loss specifically in a NZ context.
- Must encourage direct hands-on learning.
- Must be abstract, use muted primary colours and simple words.
- Must be priced within \$20-\$30 NZD.

IDEATE

Brainstorming and IDEATE workshops were then used to generate solution sketches. It then played games which revolved around the acquisition of resources which were used to manage when ecological systems fail.



Deliverables: Ideation sketch, the game's form was further developed, resulting into a solution shaped game play with regulatory files.

PROTOTYPE

Low fidelity prototyping was undertaken to embody the general concepts. Using cardboard, the game was created and iterated with 3 players. Once suggestions and feedback were received to adjust for value based benefits.



All physical prototypes are then evaluated for the ergonomics and user appeal of children. Users were given the chance to register the die.

The design process followed was a combination of the double diamond (define, deliver, define, deliver) and the IDEATE thinking model.

HOW TO PLAY

To set up the game, players each receive a Biocore (the Ecohedron die) and place it face down. The aim of the game is to be the first player to fill your Biocore with 4 bird tiles, 4 food tiles and 4 environment tiles - essentially creating an ecosystem. Each tile has a corresponding themed colour. Bird tiles are blue, food tiles are yellow and environment tiles are green. Each side of the Biocore has a coloured sticker, which relates to the tile colour that must be attached. The twist is that each player is only allowed to place one of each tile type on their Biocore. E.g. if a player already has a 'Food' tile attached, and they pick one up again they must put it back. Action cards are the core learning point of the game, as they discuss issues such as pest activity, biodiversity loss and climate change.

DESIGN DETAILS



Die

Includes 1 Biocore made from solid HDPE for even weight/density when rolling.



Tile

Includes 40 tiles made from HDPE with high quality PVC graphic stickers and magnets.



Biocore

Includes 40 core pieces made from HDPE with high quality PVC stickers and magnets.



Action Cards

Includes 20 Action Cards made from cardboard with a wear resistant varnish.

- 1 Components placed into their respective containers.
- 2 First player selects a Biocore.
- 3 Player matches corresponding resource tiles to their Biocore.
- 4 Next player selects a Biocore.
- 5 Player picks up a corresponding resource tile.
- 6 Player matches a tile from another player's Biocore to their own.
- 7 The first player to fill their Biocore wins the "Ecosystem".



ECOHEDRON

Laura Cant
Industrial Product Design
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LCW PRODUCT DESIGN
LONDON COLLEGE OF THE ARTS

Student projects: Product Design - Industrial Product Design



Kind Cup is an alternative to current conventional single use coffee cups. Kind Cup is designed to fold flat, reducing packaging volume during transport and storage in cafés. Kind Cup includes an integral lid built into the flat pattern of the cup enabling it to eliminate the need for a separate plastic lid. When unfolding the Kind Cup simply squeeze the sides for it to pop open and ready to be filled.



Prototyping

Prototyping was one of the most important features to get to the final design for this project. 1:1 models were made as part of Kind Cup's development. Model making provides key information straight away as opposed to digital CAD only processes in which risks often occur to happen perfectly.



Testing

Testing was a key stage in prototyping to ensure the design was feasible and needed in identifying which areas in a model required attention. Testing was done through working alongside key stakeholders who would provide specific and detailed thoughts that may be missed. Other forms of testing included using the cup and understanding its current limits to then modify and improve the following design.



Kind Cup

Ilan Hooper
Industrial Product Design
www.ihd.co.uk
Email: ilan@ihd.co.uk

Other projects by Ilan Hooper



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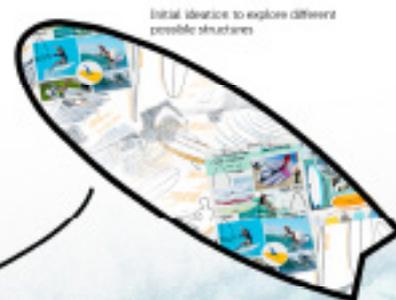
Eco Core

High performance doesn't mean high environmental cost

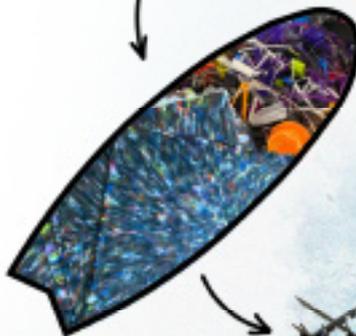
The problem

Surfboard development has come a long way from the traditional solid planks of wood of the past, to lightweight performance based polystyrene boards. However, this evolution has come with its downsides in the form of environmental issues. These foam blanks produce a lot of waste. This project aims to re-design the internal core of surfboards, making them more sustainable, pushing the next step of surfboard evolution.

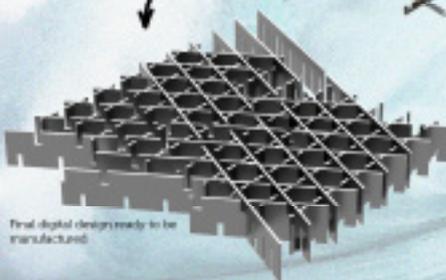
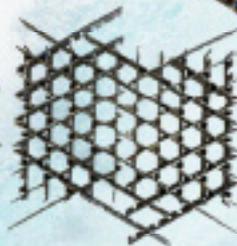
Design process



Physical prototyping to test feasibility of initial ideas



Collection, shredding and formulation of recycled plastic sheets



Final digital design ready to be manufactured

Material

Through intensive research and prototyping a variety of different materials I found that polylactic acid (PLA) would be best suited for my core. PLA has great material properties that will perform similar, if not better than traditional polyurethane (PU) foam while minimising the footprint of surfboard manufacturing. This material is also very prominently used for 3D printing, leaving a lot of waste material which can be repurposed in the manufacturing of these cores.

Final solution

This design reflects on areas that I am very passionate about, both environmental issues and outdoor activities, trying to influence the next step of sustainable design in industries. Recycled PLA is used to create the modular surfboards eliminating PU foam creating a structurally sound surfboard that embodies all aspects of surfboard design.

Project title

Lochiel Espiner
Industrial Product Design

Email Address
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SUPERVISOR
Nick Emerson

INDUSTRY COLLABORATOR
Individual Brief

UC **PRODUCT DESIGN**
To create things that change



Student projects: Product Design - Industrial Product Design

OPTISEATS

The Process

Discover - To start off this project I researched the topic from a detailed project plan. This helped to define all the steps I would need to successfully design, produce and I referred back to these throughout the project to help guide to I then did a literature review which included the initial research and looked at the existing products in similar fields that also solve the problem of light weight under high stress.

Define - From the knowledge items in the discover stage about generative design I then designed some initial versions of the potential geometry and evaluated using the same, and where their previous geometry. This helped me predict the expected shape that the generative design would create so I could confidently define the potential geometry. I also tested some initial generative design processes.

Develop - I made the initial CAD model to define the generation and produce the first conceptual concepts and evaluate them to see their design set up. After the first generative design I did three more iterations of the set up and three conceptual solutions. When tested the best model with compression and tensile testing, and compared them against a datum model that was the benchmark. The set up model was not the most successful and is my final set up.

Deliver - I then evaluated the final concept sets and did several iterations on each including the form, material manufacturing, and cost evaluations. This led to a refined final design and generative design set up that I can use for any design development. In this time, I did have a CAD file that I can use to manufacture my design to evaluate as a primary reference. This will then be produced through a prototype, prototype, and final.



The Opportunity

In high performance sports, especially cycling, every gram counts when it comes to your performance. In this project I am looking at a new way to use a design and from the use of developing digital programs can help with the mass optimization process. With the evolution of modern design and digital CAD programs we can use mass optimization to design perfectly weighted products. One area to explore that I can be analyzed through these modern programs is the seat and the saddle attachment to this project will design a lighter, and more performance than ever before seat for the best performance and comfort of the rider.

Aims

To evaluate the developments in modern technology of CAD technology and integrating it into the high-performance sport of cycling and produce new set of cycling seat products.

Define the essential User Requirements of a racing bicycle saddle and develop a detailed Product Design specification for an additively manufactured, Manufacture to cost model.

Explore various design through 3D-print software techniques, analyze the appropriateness of these concepts and select a viable solution for development.

Validate the design proposal through appropriate load and conformity testing, prepare technical data for printing and manufacture.

The Solution

For this project I created an AI design process that can be automatically from model to model, be able to be additively manufactured, and optimized to be a primary design. With the development of all the new generative design technology, I want a clear design to use generative design because it is the best 3D-print design tool on the market for my required requirements. My design is currently a generative design set up that can be altered from person to person, to create the mass optimal, like seat possible, to make sure they are not carrying around any extra unnecessary weight. The key variables that can be changed are my design and weight of the saddle, angle of seat, length of saddle, seat-post clamp, and other developments of the manufacturing, loading, materials. The model I have made is design for reliability (see display, and I have marked with throughout this project. The next step to this project will be making the testing seat that will fit onto all the seat substructure.



Beta Collection

Getting the necessary information to understand the seat is one of the hardest elements to make into product successful. This is because one of the hardest steps for my project will be gathering all the information needed to make the system work and its structure. The information that is needed to the riders weight, knee angle, sit base positions, riding position, and seat-post profile. The only way to get the beta data without buying the equipment is connecting with a studio that is specialized, who are a first class like company who use the equipment for a lot of the top high performance athletes in their industry.



Model Generation

Once all is finished the data is available to put into the generative design setup. This set up has been tested to be the most successful for strength to weight ratio and will produce the most optimal model possible. Parametric alterations will be added to the set up to show the final product is successful product. This will mean changing variables such as the length of the saddle, the forces acting on it, and the shape of the seat post connection. Once the generative design has converged, a model will be selected and slight changes will be made to the model to improve the structure of the final model.



Manufacturing

The next stage to the design process is the 3D printing. In this stage the post-processed printing will take around 22 hours to complete. After the completion of the print, because it is in titanium the model will require post processing/heat manufacturing. This process will involve heating the model off the heat, removing support material, and sanding, which will be done by different machining processes such as grinding. The final model will be sand and polished for a smooth finish.



Deliver

In this stage of the product cycle the model will all be assembled together. This will mean attaching the seat post, and putting the seat cover on it. This will all be packaged up together and sent out to the customer, ready to be used without any assembly needed. The customer will have to put some and like ready to ride. The seat substructure is designed to be long lasting so will not need to be replaced, however padding and covers can be replaced, replaced every year, the seat cover will be able to be when off and changed any time required.



Design Process

Opti-Bike Seats

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Industrial Product Design
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SCAN ME

Supervisor
Nick Emerson
PRODDA

UC PRODUCT DESIGN

Student projects: Product Design - Industrial Product Design

QUICK GUARD

This project is a look into the ways the products specifically those used by lifeguards in New Zealand are designed. The look is not on knowing the overall time it takes to put on and take off the jacket, with the ultimate goal being to improve rescue response times. Throughout the design and development process ideas were tested, evaluated and refined to produce a product that will be an improvement to the jackets on the beaches and in the water around New Zealand.

Major points of focus when researching, where the requirements and regulations set by Surf Lifesaving New Zealand and Maritime New Zealand for lifeguards, this was key for moving forward in the design process. Manufacturing processes, materials, contemporary clothing and existing product where all main research focus points.

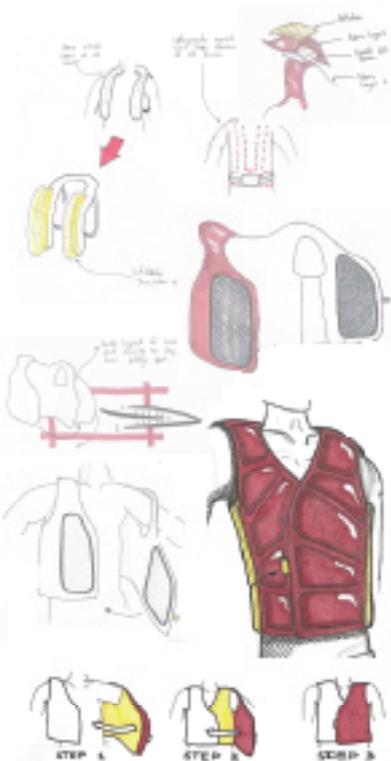
The project began with a planning phase where the brief, aims and objectives were set. The initial research phase was run where the necessary information for the project was gathered. Following this came the ideation and conceptual phase where ideas where refined and a final direction was found. Research was continued along with the prototyping and testing phase which helped to finalise a small details for the first prototype.

Throughout this design and development process a lot was learnt about New Zealand's maritime safety and regulations, the manufacturing methods used to produce the jackets on a large scale as well as small scale. The materials used in the jacket manufacture. All of this new information learnt lead to a final product that was the original goal of improving the speed in which a lifeguard is able to put on and off.

DESIGNED BY LUKE KEY



DEVELOPMENT



FEATURES



- Quilted reinforcement on upper back for extra protection and support, this was used to provide extra support and protection for the upper back and spine.
- Large area of padding along the sides for extra support and protection for the torso and spine.
- The side padding allows for extra support and protection for the side of the torso and spine.
- The reinforcement area is made of a quilted material that provides extra support and protection for the upper back and spine.

SCAN ME



Quick Guard

Lukey Key
Product/Industrial Design
LUKEYKEYDESIGN.CO.UK

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Student projects: Product Design - Industrial Product Design

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PARK UP

Recycled for Recreation

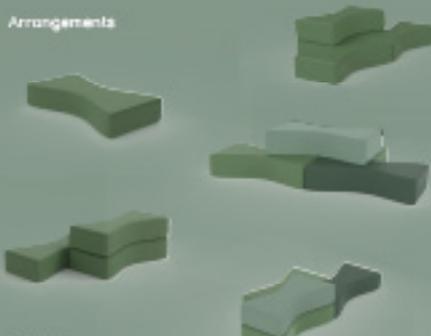


PROBLEM
Ōhaka Avon River Corridor once was a residential area, holding up to 6000 homes. However, since the 2010 Christchurch earthquakes, damaging homes due to poor sites, the land has become neglected. The corridor is 900 hectares and 10km long. The city is ready to reclaim its estate as it sees its potential to restore it. The Christchurch City Council plans to transform the corridor into a jewel in the Christchurch crown with the application of recycled plastic.

SOLUTION
PARK UP delivers an alternative approach to street furniture accessible to the general public throughout the Ōhaka Avon River Corridor. Household HDPE provides design flexibility, opposed to traditional materials. Formed through rotational moulding, PARK UP design is purpose-built to adapt to varying locations along the Avon River, offering more public spaces will help increase user interaction with the area, which will help regenerate the communities spirit.

Achieved through repeating units that can be stacked upon each other (3 units maximum height) to create a range of different forms by adjusting the number and arrangements of the identical units. Large arrangements of 4n units are to be placed along Ōhaka Avon River Corridor hotspots as will meet the demand and needs of users in the area. Quieter locations will vary from 1-3 units to balance the surrounding environment. As each unit is 1000mm x 640mm x 330mm.

Arrangements



FINISH
PARK UP comes in two textures and three different tones. The varying textures, 20 RA and 50 RA are to help users interpret that the unit is made from recycled materials. Three tones of green used are to help the design blend in with its surroundings and not take away from the location. As users responded with negative opinions to a stand-out design and were very hesitant about the use of plastic in park areas.

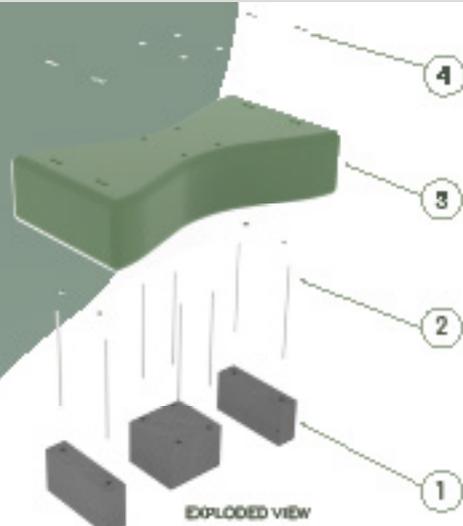
DESIGN PROCESS

DISCOVERY
Diverse the project's potential. First by exploring all aspects of the project. This is found by several layers of research that all interconnect. From the research we are able to identify problems and solutions creating our PDS. These can be implemented into our design phase.

DESIGN
All the research and findings from the discovery phase we are then able to focus on the solutions. As we generate ideas we continuously converge and diverge to ensure we explore all available options.

DELIVER
Converge all concepts available to determine the chosen concept through a controlled convergence matrix. Manufacturing and materials will be finalised to make the product feasible. By the end delivering a well refined product that will be ready for the market. Prototype is crafted to validate the design.

EXPLODED VIEW



The design is made from 4 components, thanks to rotational moulding.

1. The design is fixed securely to the ground, laying evenly on concrete foundations to avoid theft.
2. Reinforcement bars are fixed vertically in the set concrete.
3. The form of the design is fixed in place by slotting on the reinforcement bars into the precast holes of the cavity.
4. Epoxy glue is used to fix plastic plugs into the holes of the form to avoid harm to others and damage to the product.

LEISURE **WORK OUT**



USER
PARK UP geometry provides a large range of use for the general public. The small height of one unit is appropriate for children, for adults a height of two components will be appropriate. The height of the design allows families to take a break from their leisurely walk for children to rest or play. Alternatively, users can utilise the units to enhance their workout. They can do this by jump squating onto the units, running up and down the units or using the elevated surface, for press ups, lunges and more.



PORTFOLIO



PARK UP - Recycled Urban Furniture

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UCW
University of Canterbury
Product Design
Faculty of Engineering

Student projects: Product Design - Industrial Product Design

HeaTable

Brief/abstract

The brief for this project was to design a table that is both functional and aesthetically pleasing. The brief was to design a table that is both functional and aesthetically pleasing. The brief was to design a table that is both functional and aesthetically pleasing.



Table Foot Design Study

How it works

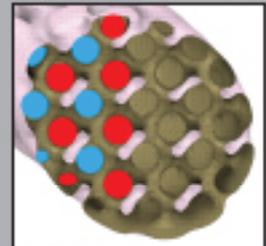
The HeaTable is composed of a central core with a compressor and the table top which is placed. The table top is made of a material that is both functional and aesthetically pleasing. The table top is made of a material that is both functional and aesthetically pleasing.

The table top is made of a material that is both functional and aesthetically pleasing. The table top is made of a material that is both functional and aesthetically pleasing.

The table top is made of a material that is both functional and aesthetically pleasing. The table top is made of a material that is both functional and aesthetically pleasing.



Technical drawing of table top



3D rendering of table top

Ideation/development

The ideation phase of the project started with looking at different shapes that could be used to create a table top. The ideation phase of the project started with looking at different shapes that could be used to create a table top.



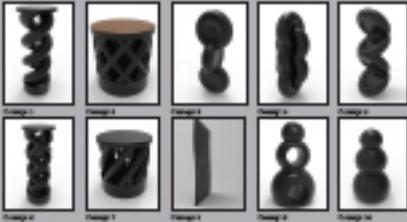
Hand-drawn sketches of table top



Hand-drawn sketches of table top

Choosing a concept

After the ideation phase, the next step was to choose a concept. The concept chosen was a table top that is both functional and aesthetically pleasing. The concept chosen was a table top that is both functional and aesthetically pleasing.



Grid of 10 table top concepts

Final design

The final design of the HeaTable is a table top that is both functional and aesthetically pleasing. The final design of the HeaTable is a table top that is both functional and aesthetically pleasing.



3D rendering of final HeaTable design

HeaTable

Table top
400x400mm
Industrial Product Design
2020-2021
www.heatable.com

Industrial Product Design
University of Applied Sciences
Hamburg
www.productdesign.haw-hamburg.de

Student projects: Product Design - Industrial Product Design

Meal Delivery Trolley

Christchurch hospital Campus

Project Overview

This project aims to design and develop a 'Meal Delivery Cart' (MDC) for the Christchurch Hospital. The solution will try to minimise the moving and handling risk to the staff operating the trolley, making it easier and safer to use. Parts and components will aim to be sourced locally within New Zealand to minimise costs and allow for easy maintenance. The design solution will still comply with food and safety requirements. A robust design process will be implemented to produce the best possible design solution. The project intends to be finished by 14/11/20.

Design Methodology

I chose the 'Double Diamond' design methodology as the primary technique used in this design process. The double diamond technique allows diverging and converging to filter through design solutions. The design process isn't always as straightforward as one would make it out to be. It tends to involve lots of going back to the drawing board and starting things over. The Double Diamond technique accounts for these iterations by integrating different stages of 'Diverging' and 'Converging' into the process.

Prototyping

Early Ideation

I explored loads of different ideas in the early ideation phase, and eventually I had to converge my thinking and explain the most practical solutions. These turned out to be ideas involving the handles and emergency brake system.

Final Design

The trolley I have designed incorporates an emergency brake system, having an emergency brake on the trolley was a safety feature I deemed almost essential to implement. Most of the musculoskeletal injuries caused by the trolleys happen when users have to use physical force to stop the trolley suddenly. By utilising an emergency-assisted brake system, users won't need to exert nearly as much physical force on the trolley to bring it to a complete stop. The handles on the trolley fold inwards to reduce space when being stored. The lowest tray height on the trolley has been raised so that users don't need to bend over as far when loading/unloading trays. The size of the trays used in the trolley has been reduced by 20% to make the trolley lighter and more manoeuvrable.

Final Design

Existing Solutions

There are two types of meal delivery trolleys found on the Christchurch hospital campus, plastic trolleys and metal trolleys. Most staff have demonstrated that they prefer plastic trolleys over metal ones. The trolleys can only be pushed from one height, there is no emergency braking system, no parking brake, and the trolleys are very heavy when fully loaded - lots of room for improvement. Other existing designs include an electronic system that facilitates assistive movement and handling/loading.

Deliver X

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UNIVERSITY OF
 CANTON
 COLLEGE OF ENGINEERING
 THE UNIVERSITY OF CANTON | 2020-2021
UCV PRODUCT DESIGN
 3D Modelling | 2D Drawing | CAD
 presentation

Student projects: Product Design - Industrial Product Design

CITY haven





Project Problem Discovery

The problem was discovered through a series of interviews with homeless individuals in the city of London. The interviews revealed that many homeless individuals struggle to find a safe and secure place to sleep at night. This led to the discovery of the need for a homeless shelter that could provide a safe and secure place to sleep at night.

Research and Brief

The research and brief phase of the project involved a series of interviews with homeless individuals in the city of London. The interviews revealed that many homeless individuals struggle to find a safe and secure place to sleep at night. This led to the discovery of the need for a homeless shelter that could provide a safe and secure place to sleep at night.

Defining the Concepts



The defining concepts phase of the project involved a series of sketches and prototypes. The sketches explored various furniture and shelter concepts that could provide a safe and secure place to sleep at night. The prototypes were used to test the feasibility of these concepts and to gather feedback from homeless individuals.

Sketching On Site



Sketching on site was a key part of the design process. It allowed the designer to observe the needs and preferences of homeless individuals in their own environment. This led to the development of a shelter that was specifically designed to meet their needs.

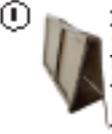
Service Design

The service design phase of the project involved a series of interviews with homeless individuals in the city of London. The interviews revealed that many homeless individuals struggle to find a safe and secure place to sleep at night. This led to the discovery of the need for a homeless shelter that could provide a safe and secure place to sleep at night.

Billboard Company Strategy

- Why Billboard?** - Billboards are a highly visible and effective way to reach a large audience. They are also a cost-effective way to reach a target audience.
- Why London?** - London is a major city with a large population. It is also a city with a high density of billboards.
- Why Homeless Shelter?** - Homeless shelter is a social issue that affects a large number of people in London. It is a problem that needs to be addressed.

Design Detail Development



1. The shelter structure is made of a lightweight material that is easy to transport and install. It is also designed to be weather-resistant.



2. The shelter structure is designed to be easy to assemble and disassemble. It is also designed to be portable.

Smaller Components



3. The shelter structure is made of a lightweight material that is easy to transport and install. It is also designed to be weather-resistant.

Delivery of Materials and Manufacturing



- Material:** - The shelter structure is made of a lightweight material that is easy to transport and install.
- Manufacturing:** - The shelter structure is designed to be easy to assemble and disassemble.

City Haven Homeless Shelter

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Student projects: Product Design - Industrial Product Design

GearGuard™

PROBLEM

640,000 tonnes of plastic waste is lost into the ocean every year from commercial fishing. This lost fishing gear destroys ocean health as it continues to kill fish for decades. One of the causes of fishing gear loss is fishermen being unable to reliably track their fishing gear, meaning that once fishing gear is lost it is very difficult to recover, if at all.

SOLUTION

A Cost Effective fishing gear tracker to minimise fishing gear loss rates, fishing gear replacement costs and environmental harm. This tracker will enable a circular economy of fishing gear, aiding in creating a sustainable fishing gear supply chain.

APPLICATIONS

Mussel floats and aquaculture

Craypots, Lobster traps and Crab pots

Drift nets, Gill nets and Trawl nets

ACTIVATION

VALUE PROPOSITION

Current fishing gear recovery practices are extremely inefficient and the people who lose fishing gear generally have nothing more to do with it. This is due to two reasons. Firstly the costs incurred in trying to recover lost fishing gear often is greater than replacing it, and secondly fishing companies don't have any tools to reliably locate lost fishing gear.

This has created an opportunity for a cost effective, strong and reliable solution for locating fishing gear. GearGuard provides this while adding an extra degree of functionality through its modular mounts.

GearGuard is a set and forget solution for locating fishing gear from home, it opens up the ability for fishing companies and ocean clean up organisations to work together to create a truly sustainable marine food chain.

WHY NOW?

New technology

The technologies which are available in the remote device space are now at a point where this project is actually viable.

New behaviour

Fishermen have been aware of their plastic pollution impact ever since the inclusion of plastics in fishing gear in 1950. There is an increasing trend in fishermen looking for solutions to their plastic waste, especially those that help retain their efficiencies, or make them better.

New regulation

The Marine Stewardship Council has just passed new regulation requiring members to use best practice around fishing gear loss by 2025.

GEARGUARD

Charles Goodwin
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UCW **PRODUCT DESIGN**

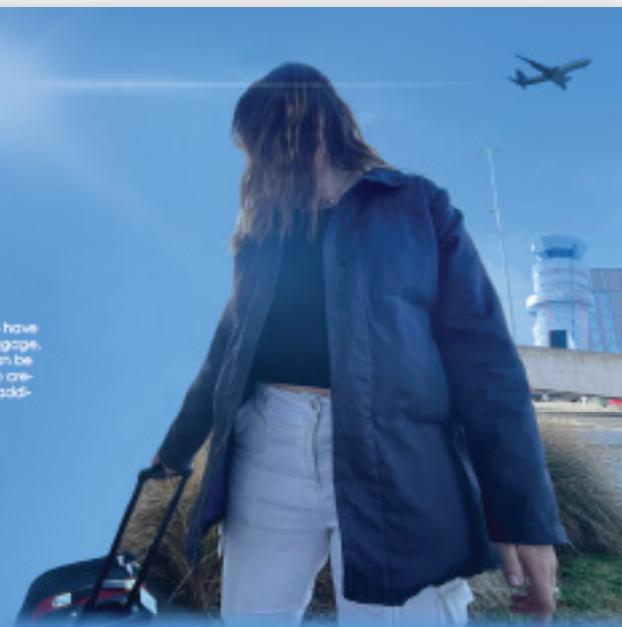
Dr Karen Morgan-Orlidge

Student projects: Product Design - Industrial Product Design

PACK-IT JACKET

Wearable Luggage

The Pack-It Jacket is designed specifically for the traveller who always seems to have overweight bags. The jacket has a total of sixteen pockets for storing excess luggage, creating a puff-like jacket when filled with items and can fit around legs, it can be worn in two different lengths as well as having the ability to zip-off the sleeves to create a vest. Simply fill the jacket with items and wear it on the airplane to avoid additional luggage fees.

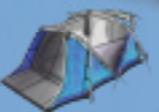



Design Features

Minimalistic - The jacket has been made in the colour black with simple, robust, urban style to work with busy through leads over the years and withstand the test of time.

Durable - The jacket is made using only the best materials and features to extend the product's cycle of the jacket and reuse longevity for years of use.

Sustainable - Designed with a sustainable ethos, the shell is made from organic hemp which is carbon negative and a very sustainable material. The lining is made from abandoned football kits which divert waste away from landfill.

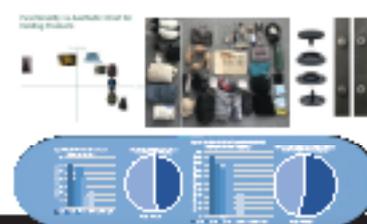




The Process

Research - Initial research was conducted to identify user requirements and to understand the current market for wearable luggage. This involved conducting interviews with potential users, analysing competitor products, and reviewing industry trends. The research also identified key design challenges and opportunities for innovation.

Concept - A series of conceptual sketches and prototypes were developed to explore different design solutions. These included variations in jacket length, sleeve options, and internal compartment layouts. The goal was to create a design that was both functional and aesthetically pleasing.

Prototyping - A series of physical prototypes were created to test the design and materials. These included a basic shell prototype, a prototype with internal compartments, and a final prototype with all design features. The prototypes were used to evaluate the jacket's fit, functionality, and durability.





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Student projects: Product Design - Industrial Product Design

UPCYCLE HEAVEN

HELPING TO REDUCE 450 MILLION PAIRS OF SHOES FROM OUR LANDFILLS!

AMBITION:

SecondLife is a nonprofit social enterprise. To design a fun-wearing, durable children's sandal using a combination of upcycled and recycled materials. The first step was to create a business model for children. Once a child grows out of the sandal their parents will have the opportunity to trade them for a new pair. The old pair will be recycled and donated to the business. The main aim of this project is to raise a general purpose of an alternative model for children aged 4-10. The project's ambition is to make a sustainable and joyful social enterprise. To use a number of upcycling principles to provide an eco-friendly model.

There are many ways to make a profit. The PROBLEM is that many of the ways to make a profit are not sustainable. For example, if you have a lot of shoes that you don't want, you can either throw them away or recycle them. But if you have a lot of shoes that you don't want, you can also use them to make a profit. This is the idea of the project. To use a number of upcycling principles to provide an eco-friendly model.

ELEVATING GLOBAL YOUTH + POVERTY

A fresh social enterprise model!

The mission is to help children in need by providing them with a pair of shoes. The shoes are made from recycled materials and are designed to be fun and durable. The shoes are sold at a price that is affordable for children in need. The shoes are also sold at a price that is affordable for children in need. The shoes are also sold at a price that is affordable for children in need.

With the project's focus on upcycling, the goal is to create a sustainable business model. The project is designed to be a social enterprise that can help children in need by providing them with a pair of shoes. The shoes are made from recycled materials and are designed to be fun and durable. The shoes are sold at a price that is affordable for children in need. The shoes are also sold at a price that is affordable for children in need.

MATERIAL SELECTION:

The main material used for the shoes is recycled rubber. The shoes are also made from recycled plastic and recycled fabric. The shoes are designed to be fun and durable. The shoes are sold at a price that is affordable for children in need. The shoes are also sold at a price that is affordable for children in need.

WIND-UP:

The shoes are made from recycled materials and are designed to be fun and durable. The shoes are sold at a price that is affordable for children in need. The shoes are also sold at a price that is affordable for children in need.

THE INSPIRATION

THE PROCESS

THE SOLUTION

SECONDLIFE

Provenance Project is a social enterprise.

www.provenanceproject.com

www.provenanceproject.com

UCM PRODUCT DESIGN

Product Design

Student projects: Product Design - Industrial Product Design

Custom Chocolate Bar Mould Making

INTRODUCTION

This poster contains the work and process of the custom-made chocolate PLA chocolate bar mould project that provides manufacturing the product locally rather than overseas. Creating a mould and a design that is unique to the customer allows them to stand out among the other chocolate bars.

The aim of this project was to create a custom chocolate bar mould with the same theme as logo and 3D design of each grade and theme as a rectangular bar with a height of at least 75g and it is possible to manufacture a chocolate bar mould only.

The objectives for this project were to explore the different methods of making 3D models of the mould and the final chocolate bar mould, research what is currently out there in terms of chocolate bar moulds, compare and/or expand to the mould products and come up with chocolate bar design and manufacturing of the mould.

BRIEF (Kaupapa Whakaahua)

The University are a chocolate-making business company that are currently working on a new range of bars to be 'Chocolate bars and new a custom chocolate bar mould of their logo and 3D design of each grade and each theme into a rectangular 75g chocolate bar. They wanted to know if it is possible to make their moulds locally rather than overseas.

There are two objectives for this custom chocolate bar mould-making project brief. The first objective requires the exploration of the different methods for creating a physical 3D model of the chocolate bar mould and provide an appropriate summary, including of chocolate production, final quality, cost and other information relevant to the project. The second objective also requires exploration of different methods but of the final chocolate mould from the 3D model with moulding to be final size, with the industry size, standard, ready-to-use and how many bars per mould. This includes the industry standards of both regions included and the material's properties, for each method used, cost in a quality, precision, finish quality, cost and other relevant information of the project.

RESEARCH

This is the starting of the project, where the brief is introduced from the client. From the brief, background research is gathered such as information on the company themselves, how they produce their moulds, what chocolate they use and if the custom chocolate bar moulds they use. Further research was required on the other chocolate bar designs were looked to get some idea of what the other chocolate bar moulds, chocolate bar mould materials to know what materials are being used to be the mould and manufacturing methods to make the chocolate bar moulds that are not made in the industrial scale and size.

IDEATION

The research gathered is then translated into product design specifications to achieve the client's needs. For the chocolate bar mould, development was made and completed as a final unique chocolate bar design. The design for mould explores various colours, the material and 3D/2D/1D using various materials with price and cost of using the material. Manufacturing methods of the chocolate bar mould were also put into action with price and custom using a particular manufacturing method to produce the product. A chocolate bar mould made to compare produced mould and price of the final chocolate bar.

PRODUCT DEVELOPMENT

From the various manufacturing methods and mould materials, the development of the chocolate bar mould is back to the industry representative. The final product decisions were made for the mould size and design made in a mould. The mould was made in a mould, being a series of rectangular cavity moulds under the mould or have a flat surface with either flat and chamfered side or 45-degree. For the design were either standard 0.5mm or 1mm high with either standard size of the design or surface. After some evaluation, the bar is shown mould with standard surface of 1mm and don't edges because the bar design. Throughout the development of the product, during the design and development stages in the design and development process, there was a lot of feedback in terms of how the cavity volume were being made and the various production of mass, density and volume and printing a mould of the chocolate from the industry was a good idea as feedback from the industry collaboration was being used that there were errors in the cavity mould size. To find out what feedback and what did not, prototyping and tests were made as the prototyping cavity were the single cavity moulds with the experimental cavity volume. The prototypes were mostly made from PLA, a filament used in 3D printing but there was one prototype made from two thin acrylic glass together. To get an idea of chocolate bar mass of 75g or more just during the design and high on the mould and bars of the mould, all the chocolate bar in the process, these prototypes were held for use during the chocolate, pouring into the mould and then waiting into the fridge to be taken out and weighed for the correct mass. As the prototypes had a large size, mass of the prototype was being made, extra mass needed for the mould with the whole chocolate bar mould and being used to an amount of chocolate bar.



3D model of chocolate bar mould, manufactured via 3D print and made from PLA



3D model of chocolate bar when chocolate is poured into the mould and set

THREE FINAL CONCEPTS (Nga kaupapa matua e toru)

Concept 1
This concept had the logo and the 3D design that has been created in high. The surface of the 3D design that are suitable for get that engraved into the chocolate bar when being made. However, other chocolate bar designs normally have the lines engraved.

Concept 2
This concept was the best one has selected 3D design and logo but the lines of objects and the design are engraved instead. These objects are engraved 0.5mm as discussed with the industry representative, but 1mm was too high and by half of the.

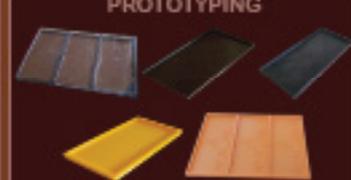
Concept 3
This concept is the best one better than the other designs as better than the other designs made the design on the industry representative has said that it would be the right one the design to stand out more. So, the lines of objects were made 0.5mm to stand out better.

TESTING



After the prototyping of single cavity moulds were made, the testing was made. The aim of the testing was to see if the cavity volume of the mould can achieve at least between 75g. The testing was conducted on the logo and design engraved into the chocolate bar with use of a few grams of chocolate mass. As bar is being made, the test results were in the different sizes of chocolate bar and include measuring and weighing of a 100g chocolate bar testing into several of some prototypes to make sure of the mould. Firstly, the bar had got to a weight of 75g. This will give the final weight known with either engraving the logo and design into the chocolate bar.

PROTOTYPING



Most of these prototypes directly above were 3D printed and made from PLA. It is a good idea to use the material to use when the mould things to keep the material from the bar to get the chocolate when get done than the mould. Other prototype was made to get an idea of the actual size of mould. The other mould is made from thin acrylic which the material can be used in the 3D printer. These prototype moulds were used to be tested in a few amount of testing in the cavity volume while getting the volume of 75g or more being into consideration that the engraving of the logo and design will keep all bits of chocolate off the bar and it is being being, density of the chocolate does vary in size and mass of the chocolate bar.

PLA Chocolate Bar Mould

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Student projects: Product Design - Industrial Product Design

ESCAPADE

Outdoor Communications Device

BY REUBEN BEARPARK
ID: 43788627

AIM

Develop a simple, easy to use and marketable product that allows users to communicate easily and have on demand location data on group members when needed, all without the use of traditional infrastructure such as cell networks or internet.

BRIEF

Currently there are only a few products on the market that combine two-way communication paired with OnDemand location tracking of users, for outdoor adventure use. One common and very popular example of this is the Garmin in-reach mini. However, this device is very expensive, costing around \$650 making it less accessible to its users. The primary use of the InReach mini is to notify outside parties about the wellbeing and progress of its users.

While this is important it's also critical to have a cheap, reliable communication and location link with people you may have along with you, in case of separation or if members wish to explore individually.

As This product is intended to be used by the Adventurer, it should be usable in a variety of situations and weather conditions. Being able to withstand being dropped, and exposure to elements such as hash sun, rain, snow and dirt.

It's important that this device is easy to use, small and light. As a large bulky device will more likely be left behind and won't suit anyone trying to go outdoors.

Product Features

- 10 - 20 KM Messaging (LORA technology)
- Accurate location tracking piggybacked off phones GPS.
- long battery life (multiple days)
- small, lightweight and portable
- IPX4 water resistance.
- Tough and Durable (Tested to MIL-STD-810)
- Easy messaging though app on phone.
- Different colour options available
- Easy to use
- Cheap and accessible
- NO cost to message
- Replaceable antenna
- Replaceable components
- Sunlight readable E-ink display
- Aesthetically pleasing.



ESCAPADE Outdoor Communications

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Euan Courts

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Student projects: Product Design - Industrial Product Design

CANINE CLEAN

Taking care of your best friend's dental health

PRODUCT BRIEF
The aim of this project was to design a product that helps to prevent development of plaque and tartar on canines teeth. As dogs grow old their dental health starts to deteriorate. This can further lead to other health problems as well.

PROJECT ABSTRACT
Canine Clean aims to develop a product for dogs that helps to maintain their oral hygiene. A product was developed using the double diamond design process. In the initial phase of the project, research was conducted to discover the problems. A product design specification document was established. Later the problem was defined more and ideation was done using different techniques in accordance to the PDS. Out of the 4 ideas that were generated during the ideation process 1 was selected using the datum concept evaluation technique. The chosen concept was developed more until the final solution was achieved. To deliver the product to the client appropriate materials were chosen using the GD&P Delta Edupeck. Manufacturing process and packaging was also determined at this stage.

IDEATION

TOOTHBRUSH RINGBAND ACCESSIBLE TOOTHBRUSH MODIFIED BONE CHINE MOUTHPIECE CLEANING

These are some of the initial ideas, after concept evaluation along with our activities, concept 4 (Mouthpiece Cleaning) was chosen later the chosen concept, it was further developed and structured the final primary process sketch.

PRODUCT DESIGN SPECIFICATIONS

Target Market	Dog owners, dog groomers, vets animal shelter workers and dog breeders
Size	The product should be handy, it should be able to fit in the palm. Dimension should not exceed 100mm x 100mm x 50mm.
Use	Should use only one hand as other hand would be used to calm the dog.
Weight	Should be less than 400 grams.
Time to clean teeth	Less than a minute, 3-4 back and forth movement enough.
Performance	If used regularly, the product should prevent formation of plaque and tartar. It should be convenient for the user. It should help the dog owner to develop habit of cleaning their dogs teeth.
Process	It should be a fun process for the dog, it should not make the dog anxious.
Ergonomics	Should be able to enter/fit dogs mouth swiftly. Should not traumatize the dog, should be a fun process. Should not have sharp edges.
Material	Silicone Elastomers
Product Lifetime	Used up to 1 year
Recyclable	Yes
Biodegradable	Yes
Antibacterial properties	Yes

PRODUCT DEVELOPMENT

ITERATION 1

ITERATION 2

FINAL PRODUCT

MATERIAL SELECTION

Chosen Material - Silicone Elastomers
Manufacturing Process - Silicone Die Casting

PRODUCT IN USE

Canine Clean goes inside the dogs mouth and fits around their teeth. It uses friction from silicone elastomers to clean the teeth. Few strokes in and out of the mouth is all that it would take to improve the dogs dental hygiene. Silicone elastomers are antibacterial, soft and gets clean easily. It can be cleaned easily by water. Silicone is also quite durable so it would easily endure dog bites.

Project Title - Canine Clean

Student Name - Rishabh Bhatt
Industrial Product Design

www.omegaengineering.com

www.omegaengineering.com

INDUSTRIAL PRODUCT DESIGN

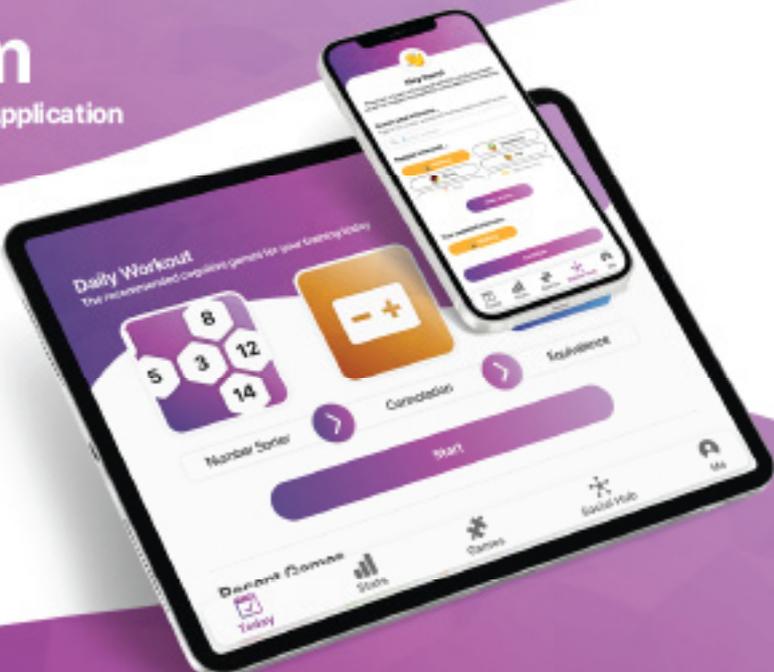
RISHABH BHATT

Student projects: Product Design - Industrial Product Design



Bloom

Mental Agility Application



Introduction (Tīmatatanga)

Possessing a good state of mental agility is key towards living a happy and healthy life. With the world population rapidly growing, the percentage of senior citizens is escalating. Therefore, it is more important than ever to push healthy lifestyles and encourage mental growth. Bloom is an application which enhances an individual's mental well-being by providing cognitive games and social connection.

The Process (Te Tukanga)

Through interview sessions and thorough research, I have gained valuable insights and developed an educated understanding of the key elements which can enhance one's mental agility. This application has been designed to cater towards the senior citizens of today and more importantly, the senior citizens of the future. The application underwent development and a high-fidelity prototype was created to aid usability testing amongst the targeted age group. The application was then evaluated against a predetermined set of usability principles which thoroughly assesses the user interface of the application known as the Heuristics for User Interface Design developed by Jacob Nielsen in 1995.

The Key Features (Āhuatanga Matua)



Today

Keep track of your daily to-dos and jump into our suggested cognitive workout regime to start off your day. The central hub of Bloom.



Social Hub

Want to fill your afternoon? Get involved with the Social Hub. Just tell us your interests and we will find event suggestions near you.



Games

Test your problem solving, language, maths, speed, and your memory skills with our Cognitive games feature.

Combat passive media consumption with our TV Trivia feature. Play solo or with friends and make your media consumption constructive.



My Website



App Prototype

Bloom [Mental Agility and Well-being Application for the Elderly]

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DESIGNED BY
Wendy Chung

IPD
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Auckland University of Technology

Student projects: Product Design - Industrial Product Design

TETRA reefscape

The Issue.

Coastal reefs are one of the most diverse ecosystems in our world. It protects coastlines from storms and erosion, provides habitats for many marine organisms, and supports our fishing and tourism industries. Ocean acidification, climate change, pollution, overfishing, and many more factors are killing these ecosystems. To counter this, many companies and organizations worldwide are working to restore and rebuild these habitats through artificial reef structures, providing the structures in which coral can grow and inhabit. These structures use multiple different materials, however most popular is concrete. This is due to these materials being heavy, insoluble in water, and able to be cast into complicated three-dimensional structures. However, these are not the most sustainable and suitable materials. Concrete, in particular, is quite harmful to the environment due to the CO₂ emissions released when making cement. Concrete in reef structures often gets covered in microalgae rapidly which inhibits the ability of any coral reef development.

The Design Process.

My design process started with a sketch of a tetrahedron.

Next, I explored various materials and their properties.

Then, I developed a digital design that could be manufactured.

Finally, I prototyped the design using 3D printing.

Learn more about this project and process.

Project Aims.

- to develop a sustainable cement substrate for artificial coral reefs.
- to design and prototype a structure that enables (and raises awareness of) coral reef development and restoration.

Material.

My chosen material is a concrete mix consisting of sawdust, ash, and seaweed powder. This was the best performing material from my material testing process, proving the most favorable material to move forward with. Seaweed is a rapid growing natural material that is renewable and biodegradable, making it an excellent option for material production. Seaweed also assists in deterring coral-eating fish and predators from reef environments, assisting coral's rehabilitation and development. My developed seaweed-concrete material assists in the reduction of cement production, utilizing seaweed's favourable rheological properties as a binder for concrete.

The Solution.

The design of TETRA is biomimetic, heavily inspired by the natural reefscape that populate our waters. The adaptable tetrahedral design allows great customisability, versatility, and community engagement. I believe that my design is aesthetically pleasing and would provide great benefits for not only environmentalists and coral reefs around the world, but also locals who are able to interact with these installations. The design provides great scalability with a focus on accessibility, adaptability, and ease of manufacture and assembly. Overall, I am very proud of this project and the end design outcome. It reflects a commitment to trying to improve upon existing materials in order to create a more sustainable future for our natural habitats and people alike.

Modular
Versatile
Biophilic
Functional

2023 Images of TETRA and its use in a reef habitat structure and garden exhibit in a public sector of coastal water design.

TETRA Reefscape

Samuel Adam Roberts
Industrial Product Design

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DESIGNED BY:
Hossein Najaf Zadeh

UCWP PRODUCT DESIGN
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Automatic Lego Brick Organiser

Purpose

The purpose of this project was to design a product that could help people to organise their Lego bricks. The product was designed to be a stack of trays that could be used to store and sort Lego bricks.

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Details

The product was designed to be a stack of trays that could be used to store and sort Lego bricks. The product was designed to be a stack of trays that could be used to store and sort Lego bricks.

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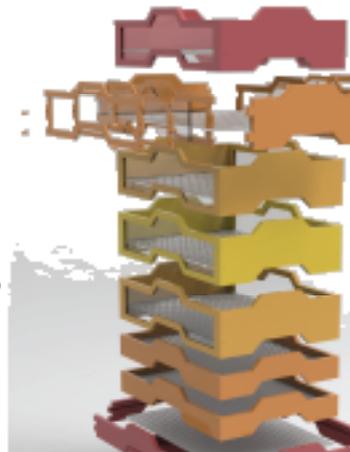


Figure 1: 3D CAD model of the Lego brick organiser.

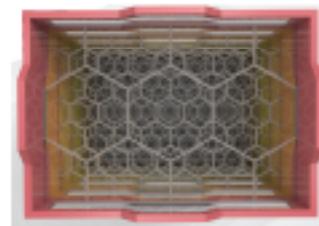


Figure 2: Photograph of the physical prototype.

Prototype Testing

The prototype was tested by placing various Lego bricks into the trays and observing how they fit and how easy it was to sort them. The testing showed that the trays were effective at organising the bricks and that the design was user-friendly.



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The testing showed that the trays were effective at organising the bricks and that the design was user-friendly.

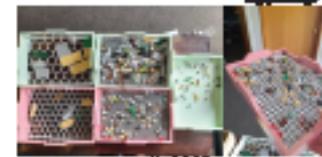


Figure 3: Photograph of the prototype being used to sort Lego bricks.

Available Filter Sizes

Filter Size	Description
1x2	Standard 1x2 Technic brick
1x3	Standard 1x3 Technic brick
1x4	Standard 1x4 Technic brick
1x6	Standard 1x6 Technic brick
1x8	Standard 1x8 Technic brick
1x10	Standard 1x10 Technic brick
1x12	Standard 1x12 Technic brick
1x16	Standard 1x16 Technic brick
1x20	Standard 1x20 Technic brick
1x24	Standard 1x24 Technic brick
1x30	Standard 1x30 Technic brick
1x40	Standard 1x40 Technic brick
1x48	Standard 1x48 Technic brick
1x60	Standard 1x60 Technic brick
1x80	Standard 1x80 Technic brick
1x100	Standard 1x100 Technic brick
1x120	Standard 1x120 Technic brick
1x160	Standard 1x160 Technic brick
1x200	Standard 1x200 Technic brick
1x240	Standard 1x240 Technic brick
1x300	Standard 1x300 Technic brick
1x400	Standard 1x400 Technic brick
1x480	Standard 1x480 Technic brick
1x600	Standard 1x600 Technic brick
1x800	Standard 1x800 Technic brick
1x1000	Standard 1x1000 Technic brick

* Other sizes available on request.

UC PRODUCT DESIGN
Te Kura Hanga Otanga



Figure 4: QR code linking to the product page.

Lego Brick Organiser

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UC
UNIVERSITY OF CANTON
PRODUCT DESIGN
TE KURA HANGA OTANGA

Student projects: Product Design - Industrial Product Design

COBRA

Collapsible Electric Guitar

Animation

Design Process

The main goal I wanted to achieve was for the guitar to fit inside an everyday backpack. The design process started around the folding of the neck and the tensioning of the strings as this was the biggest hurdle to overcome. The neck needed to be rigid one in the playing position which meant a stable hinge system and the strings needed to be tensioned and detensioned easily. The collapsing of the body came after the neck system. I wanted to find a good balance between the body being small and compact and it looking good and being comfortable.

Lower Prototype

Hinge Prototype

Body Prototype

Design Details

Neck

The neck folds through the use of a concealed hinge. To lock the neck in place bolts are threaded through the two facing plates. A lever system above the neck allows the strings to be tensioned for playing and detensioned for travel.

Body

The body consists of a center piece and two wings that can fold in and out through metal bars. The body can be locked into the out position through spring loaded pins.

Features

- Headless design
- Two humbucker pickups
- 3 way selector switch
- Volume control pot
- 24.75 inch (628.65mm) scale length

59%

size reduction

Cobra Collapsible Electric Guitar

DESIGNED BY
Sebastian Krey

Sebastian Krey
Product & Industrial Design
0043 202018
0043 1700000000

EcoRoll

Hard Cable Cover

Thomas Hughes 07544613

The Brief

To redesign polymeric hard cable cover into a lighter, thinner and sustainable product to use and install.

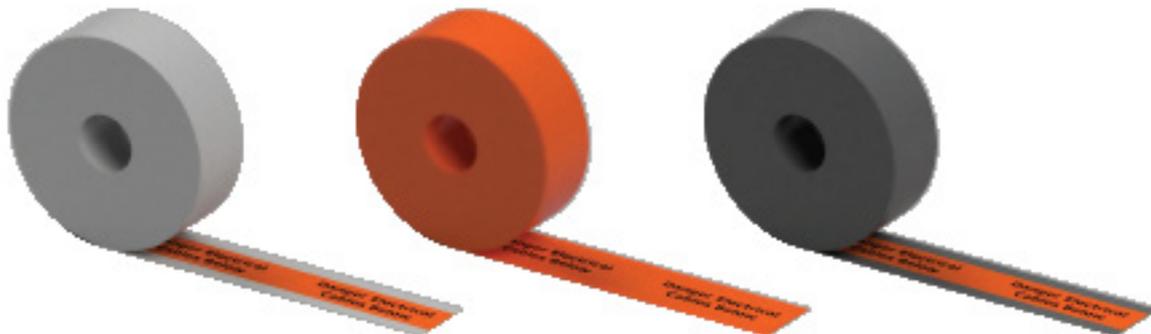


The Problem

Protective cable covers are vital in preserving electrical services buried underground. They protect buried cables and prevent expensive damage to them by excavation equipment. These covers need to last for years underground without degrading. In Australia and New Zealand they must meet the AS4702-2000 standard for Polymeric Cable Protection Covers.

High Density Polyethylene (HDPE) is the preferred choice for current products due to its low price and good mechanical properties. However, at 5mm thick it does not meet the standard and causes the weight of a 200m roll to be quite heavy. This can be hazardous to people in transportation, handling and installation.

The challenge was to find a new material which meets the standard yet is lighter and costs no more than the current product.



The Solution

The EcoRoll is a hard cable cover made from Nylon 66 designed to be lighter, thinner and safer to install. The EcoRoll still meets the AS4702-2000 standard at 3mm thick.

- Safer to install - lighter & smaller, reducing risks of crushing/serious injury.
- Easier to install - no large machinery required.
- Easier to transport - weight savings means less loads and lower emissions.

The EcoRoll comes in 200m long rolls at 300mm wide however these can be varied where needed.



Nylon 66 belong to the polyamide family and

- Has very good hardness
- Is wear resistant
- Has high mechanical strength
- Is easily machined
- Has low electrical conductivity

Installation sites can vary in size so the EcoRoll offers flexibility in how it is installed.

For larger sites it can be installed as demonstrated on the left. Here the end has been fixed in the end and it is walked along by the machinery. For smaller sites it can be walked out by hand.

EcoRoll: Hard Cable Cover

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DESIGNED
BY
THOMAS HUGHES
INDUSTRIAL DESIGN

LCW PRODUCT DESIGN
INDUSTRIAL DESIGN

Student projects: Product Design - Industrial Product Design

Design:
The part was designed using generative design software on Fusion 360. The set up includes applying load cases and constraints, defining preserve and obstacle geometry, and setting objectives and manufacturing methods. Once all of these are accurately developed the software can create designs that meet the requirements. The chosen design is an aluminum 7075 part that weighs only 644 grams. This is a 35% reduction of mass from the 987 gram original upright.

Simulate:
Simulation is used to analyze how the designed part will function under certain loading conditions. The original upright and the generatively designed upright were simulated with identical load cases to check performance. Simulation, however, tends to not always provide identical results to how a part will perform, so further testing is typically needed.

Test:
Real world testing of the part was done using a jig that could test multiple load cases using an Instron tensile tester. The results show the generatively designed part outperforming the original design, despite weighing at a significantly less mass.

Implement:
Investment casting was used as the manufacturing method as it allows for unique shapes that other types of casting and 3D printing operations cannot allow. First the upright was printed as a PLA part then a plaster mold was set around it. The PLA is then burnt out of the mold leaving an empty cavity where molten aluminum is poured into. This left a part in the desired geometry however significant post processing is necessary to fit the part up.

Problem/Scenario:

Formula Student racing is a sport that requires incredibly meticulous levels of refinement to create parts that meet performance standards whilst weighing minimal mass. The combination of a reliable vehicle that weighs a minimal amount is what creates a winning car.

Generative design is a recent technology that uses AI to create optimized geometries based on stress patterns resulting in lightweight parts that meet a criteria. This makes generative design fantastic for high performance race cars so they need to have high functionality whilst weighing as little as possible.

The aim for this assignment is to explore the potential of generative design for an upright which is a part of the suspension assembly which connects the wheel and breaks to the suspension arms.

Solution:

Through generative design, various parts were produced that were then analyzed against each other and tested. The final design chosen was a part that showed evidence of outperforming the original design while weighing only 644 grams.

Generative Design for Formula Student Race Cars

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AMERICAN
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UCV
PRODUCT DESIGN
Product Design Centre

Student projects: Product Design - Industrial Product Design

In New Zealand alone, 80% of children aged 3-7 are regularly consuming packaged food. Over half of these children are struggling to open these packets so it's clear that existing packaging has not been designed for the user. In spite of the push on eco-minis, packaging remains indispensable to time poor parents and plays a significant role in minimising food waste by preserving goods. Global pollution – and the role that packaging plays in that – is a serious problem that we must find solutions for. However, it is crucial that these solutions do not inadvertently create or exacerbate other environmental problems.

Throughout the design process, environmental impact must be considered through both the immediate and distant impacts. Plastic packaging is responsible for the lowest immediate impact when compared to alternative materials. However, it comes with significant latent impacts such as pollution. Alternative materials require a greater consumption of resources and energy to produce, resulting in higher immediate impacts and putting their viability in question.

To best address environmental impacts, packaging must be designed to avoid landfill.

Yoghurt Pouch

AIM: WITHOUT SACRIFICING ON CONVENIENCE, IMPROVE THE ACCESSIBILITY OF SINGLE USE YOGHURT PACKAGING FOR 3-7 YEAR OLDS IN A WAY THAT INSPIRES INDEPENDENCE AND REDUCES ENVIRONMENTAL IMPACT.



An innovative form of Cradle-to-Cradle design, this single-piece packaging greatly improves the accessibility of the product by providing a designed mechanism that conveys the opening force to the packaging seal. This allows children of all ages to open the packaging with confidence, inspiring independence. The slight flex of the opening tube provides space for children to gently squeeze the packet and pour the yoghurt into their mouth, for the occasions when a spoon seems boring.

Manufactured from recycled HDPE with existing thermoforming techniques, the lightweight packaging is designed to meet for efficient transport from the manufacturer. The package contains a thermally sealed, before labelling and folding the opening tube down. LDPE labels are recommended to facilitate recycling after use. By designing the packaging waste to be easily washed and with accordance to NZ-wide kerbside recycling requirements we can close the loop of the product-cycle and send the material around again.

Happy Lunches

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Student projects: Product Design - Chemical Formulation Design



Student projects: Product Design - Chemical Formulation Design

CHEEK

LET ME GET BETWEEN YOUR THIGHS

CHEEK
SKINCARE FROM THE BOTTOM UP

B*TTOMS UP, BABES

BUTT-OBSESSED ENOUGH SAID

CHEEK is a skincare brand that is giving the butt the attention it deserves. This project came as a result of a year of experience with a lack of products in the market targeted to what I thought were niche concerns. Little did I know they were very common yet just not talked about. CHEEK is all about creating functional products that help women feel more confident to get their cheeks out, while normalizing conversations about these skin concerns. This project includes four of the original cheek care solutions: Rub My Lips, Tight Bye Bye, Tight Bye Bye, and Smooth Cheek. The solutions include: Rub My Lips - a lip scrub, Tight Bye Bye - a laser-like tanning brush, and Smooth Cheek - a soothing repair for razor bumps.

CHEEK

Student projects: Product Design - Chemical Formulation Design



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SCHOOL OF ENGINEERING



EDEN

Plant Care

EST. 2022

EDEN is a luxurious houseplant agrochemical company designed to
"Preserve Nature's Beauty".

The brand mission statement is to produce high-quality household products that care for your plants and protect our environment. Striving to provide consumers with effortless and sustainable alternatives to household agrochemicals that they will be proud to display with their plants, EDEN wants to educate consumers not only on how to care for their plants but our planet as well. Making Sustainability, Reliability, and Safety, all ingredients are highly researched and backed by science, are 100% renewable, and have a minimalist design to fit into most interior design styles.

EDEN's target market are women aged 25-55 who are looking for luxurious, easy ways to care for their houseplants. We want to differentiate from our competitors by creating a desirable product that has value beyond its function alone. Some houseplants can cost around \$500 to purchase, so providing a luxury plant care option that feeds into the desires and needs of this market is exactly what EDEN has done.



Plant Protector

EDEN's Plant Protector is a natural, non-toxic, and biodegradable solution for protecting your houseplants from pests and diseases. It is formulated with essential oils and natural extracts, making it safe for your plants and the environment. The product is easy to use and provides long-lasting protection, ensuring your plants stay healthy and vibrant.



Solid Fertilizer

EDEN's Solid Fertilizer is a nutrient-rich, slow-release formula that provides your houseplants with the essential nutrients they need to thrive. It is made from natural, sustainable ingredients and is easy to apply. The fertilizer is designed to be used as a top-dressing, providing your plants with a steady supply of nutrients over time.



Tiana Flak

Tiana Flak is a student at the University of California, San Diego, who is currently studying for her Bachelor's degree in Chemical Engineering. She is a member of the UCSD Student Engineers' Society and is passionate about sustainable design and product development.

Student projects: Product Design - Chemical Formulation Design



THE PROBLEM

Travelers are often exposed to environmental stressors such as dry air, dust, and pollution, which can lead to skin irritation, dehydration, and fatigue. The challenge was to create a travel care product that addresses these issues in a portable and effective way.

The product needed to be lightweight, easy to use, and suitable for travel. It also had to be aesthetically pleasing and functional, providing relief from travel-related discomforts.

The solution was a multi-functional product that combines skincare, hydration, and travel support in a single, convenient format.

THE SOLUTION

The solution was a multi-functional product that combines skincare, hydration, and travel support in a single, convenient format. It features a barrier-protecting cream, a rehydration tablet, and travel support capsules.

The barrier-protecting cream uses natural ingredients to create a protective layer on the skin, preventing moisture loss and irritation.

The rehydration tablet provides a quick and effective way to replenish fluids and electrolytes, helping to combat dehydration during travel.



THE BARRIER-PROTECTING CREAM

The Barrier-Protecting cream is a deeply hydrating and soothing product designed to protect and soothe the skin while traveling. The skin formulation was carefully selected to soothe the skin with essential natural oils and vitamins, leaving the skin feeling soft and hydrated.

An integral part of the formulation is the natural ceramide which helps to restore the skin's natural barrier, preventing moisture loss and irritation. It is a natural ingredient that is a blend of natural and synthetic ingredients, and it is a great option for those with sensitive skin.



THE REHYDRATION TABLET

While traveling, it's easy to forget to drink enough water, leading to dehydration. This rehydration tablet is a quick and effective way to replenish fluids and electrolytes.

The rehydration tablet is a natural and effective way to replenish fluids and electrolytes. It is a natural ingredient that is a blend of natural and synthetic ingredients, and it is a great option for those with sensitive skin.



THE TRAVEL SUPPORT CAPSULES

Travel is not always a smooth experience, and it can be challenging to stay healthy and energized. These travel support capsules are a natural and effective way to support your immune system and help you stay healthy while traveling.



ASCEND
YOUR TRAVEL CARE ESSENTIALS



Your Local Garden Protector

Pest Control



AGRI+

Individual Capstone Project

JAN 2024
Chemical Formulation Design
2024-2025
P000000000000

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Barack Keesomere

UC **PRODUCT DESIGN**
Te Kura Hanga Otinga

Student projects: Product Design - Chemical Formulation Design

LU.MI.

LU.MI.

Blue Light Protection



The Problem

The amount of time spent looking at a screen or applying a tanning bed is increasing. With more time on digital screens, people are also using tanning beds and tanning beds, which is the cause of skin damage.

Blue light is emitted from digital screens and tanning beds. It is a form of light that is more harmful than UVB and UVA. It is the most harmful light that is being emitted from digital screens.

The Solution

LU.MI. is a skincare product that is designed to protect the skin from blue light. It is a combination of natural ingredients that are known to be effective in protecting the skin from blue light.



The Active Ingredients

LU.MI. is a combination of natural ingredients that are known to be effective in protecting the skin from blue light. The active ingredients include:

- Hydroquinone: A natural skin-lightening agent that is known to be effective in protecting the skin from blue light.
- Vitamin C: A natural antioxidant that is known to be effective in protecting the skin from blue light.
- Vitamin E: A natural antioxidant that is known to be effective in protecting the skin from blue light.
- Niacinamide: A natural skin-conditioning agent that is known to be effective in protecting the skin from blue light.
- Retinol: A natural skin-renewing agent that is known to be effective in protecting the skin from blue light.

Hydrating Mix

The hydrating mix is a combination of natural ingredients that are known to be effective in protecting the skin from blue light. The ingredients include:

- Hyaluronic acid: A natural skin-hydrating agent that is known to be effective in protecting the skin from blue light.
- Glycerin: A natural skin-moisturizing agent that is known to be effective in protecting the skin from blue light.
- Propylene glycol: A natural skin-conditioning agent that is known to be effective in protecting the skin from blue light.

Water Gel Cream

The water gel cream is a natural skin-conditioning agent that is known to be effective in protecting the skin from blue light. The ingredients include:

- Water: A natural skin-conditioning agent that is known to be effective in protecting the skin from blue light.
- Gel: A natural skin-conditioning agent that is known to be effective in protecting the skin from blue light.
- Cream: A natural skin-conditioning agent that is known to be effective in protecting the skin from blue light.

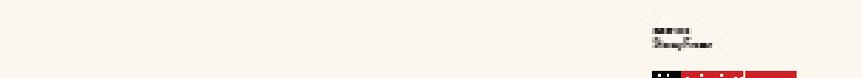
LUMI

Philip McGee
Chemical Formulation Design



LUMI

Philip McGee
Chemical Formulation Design



Student projects: Product Design - Chemical Formulation Design



The Problem

In New Zealand the combination of our laid back 'she'll be right attitude' and the hole in the ozone layer being directly above us, has meant that our melanoma rates are the highest in the world. Each year 300 New Zealanders die from melanoma. The way sunscreen is being applied by the consumers differs greatly from its recommended application and from the way SPF testing is conducted.

The Proposal

We want to educate consumers about the best way to use sun care products in order to get the most protection. Our line will have a focus on changing the way the sun care market is viewed, with an aim to get kids into a habit of protecting their skin every day. Rae wants to provide solutions that are simple and effective, making the margin of error with application of sun care products smaller. Rae will highlight New Zealand throughout the line with the use of native flora. The concept for this product was born out of the concern that consumers weren't applying enough sunscreen. The idea formed to try to find a way to regulate the amount of sunscreen consumers used to ensure they are being properly protected. The desired product would be a SPF that consumers want to use, that didn't feel like a chore when being put on. The ingredients in the after sun product provide the skin with much needed moisture after a long day in the sun. They also have soothing properties allowing some relief to the painful symptoms that sunburn can cause.

The Target Market

As sun burn is more common among people aged between 18-29 this will be Rae's target market. Rae products aren't limited to those who frequent the beach. Instead, Rae is designed to be used every day by anyone exposed to the sun. A typical consumer would be a New Zealander who is looking for sun care products that make use of New Zealand native plant extracts or are looking for products that are made in New Zealand.

Mineral Facial SPF Pods

This is a mono-dose facial sunscreen pod. These are meant to be squeezed into the consumers hands and then rubbed on their face, neck and ears. The pod is an oil based butter encapsulated in a carriage man based shell. The hero ingredient of this product is harakoa seed oil. Harakoa seed oil is packed with vitamin E, antioxidants, phytoesters and omega fatty acids. This will help soothe and moisturise the skin while regulating oil production and encouraging cell turnover. By nature mono-dosing often means eco-packaging, as it was important to me to solve the issue of having a regulated dose

After Sun Cooling Spray

This product is an after sun mist. It is designed to be spritzed on the face after being exposed to the sun. The mist provides a cooling and refreshing feel, helping to re-moisturise and replenish the skin. The mist has two hero ingredients, kanuka honey and harakoa gel. Kanuka honey has anti-inflammatory properties, helping to repair the skin when exposed to UV rays. Harakoa gel soothes and cools the skin, while also providing moisture back into the skin. Other key ingredients in the mist include sodium PCA and panthenol which are humectants, providing moisture to the skin by locking it in and drawing

Student projects: Product Design - Chemical Formulation Design

Endo Soothe

Side-effect free and natural symptom soothing for women living with endometriosis and chronic symptoms.



Scenario

Endometriosis is a chronic condition that affects approximately 10% of women of reproductive age. It is characterized by the presence of endometrial tissue outside the uterus, leading to pain, inflammation, and various symptoms. The condition is often diagnosed late, and treatment options are limited, with many women experiencing side effects from hormonal therapies.

The Endo Soothe project aims to develop a line of natural, side-effect-free products that provide relief for women living with endometriosis and chronic symptoms. The products are formulated using a combination of natural ingredients, including essential oils, herbs, and vitamins, to soothe inflammation and provide pain relief.

The project focuses on creating a range of products that address the most common symptoms of endometriosis, such as pelvic pain, bloating, and heavy menstrual bleeding. The products are designed to be easy to use and integrate into a woman's daily routine.

The Endo Soothe product line is a collection of natural, side-effect-free products designed to provide relief for women living with endometriosis and chronic symptoms. The products are formulated using a combination of natural ingredients, including essential oils, herbs, and vitamins, to soothe inflammation and provide pain relief.

Proposed

The proposed Endo Soothe product line consists of several products, including a spray, a jar, and a tube. Each product is formulated with a unique blend of natural ingredients to address specific symptoms of endometriosis.

The spray is designed to provide quick relief for pelvic pain and bloating. The jar is a topical cream that soothes inflammation and provides long-lasting relief. The tube is a natural supplement that supports overall health and reduces chronic symptoms.

Target Market

The target market for Endo Soothe is women of reproductive age who are living with endometriosis and chronic symptoms. The products are designed to be natural, side-effect-free, and easy to use, making them an ideal solution for women seeking relief from their symptoms.

EndoSoothe Product Line

Soothing Cream

The Soothing Cream is a natural, side-effect-free topical cream designed to soothe inflammation and provide relief for pelvic pain and bloating.

The cream is formulated using a combination of natural ingredients, including essential oils, herbs, and vitamins, to soothe inflammation and provide long-lasting relief. It is easy to use and can be applied directly to the affected area.

Soothing Gels

The Soothing Gels are natural, side-effect-free topical gels designed to soothe inflammation and provide relief for pelvic pain and bloating.

The gels are formulated using a combination of natural ingredients, including essential oils, herbs, and vitamins, to soothe inflammation and provide long-lasting relief. They are easy to use and can be applied directly to the affected area.

Resilience Capsules

The Resilience Capsules are natural, side-effect-free oral supplements designed to support overall health and reduce chronic symptoms.

The capsules are formulated using a combination of natural ingredients, including essential oils, herbs, and vitamins, to support overall health and reduce chronic symptoms. They are easy to take and can be taken daily.

Soothing Spray

The Soothing Spray is a natural, side-effect-free spray designed to provide quick relief for pelvic pain and bloating.

The spray is formulated using a combination of natural ingredients, including essential oils, herbs, and vitamins, to soothe inflammation and provide long-lasting relief. It is easy to use and can be applied directly to the affected area.

The Why

The Endo Soothe product line is designed to provide relief for women living with endometriosis and chronic symptoms. The products are natural, side-effect-free, and easy to use, making them an ideal solution for women seeking relief from their symptoms.

The products are formulated using a combination of natural ingredients, including essential oils, herbs, and vitamins, to soothe inflammation and provide long-lasting relief. They are easy to use and can be integrated into a woman's daily routine.

The Endo Soothe product line is a collection of natural, side-effect-free products designed to provide relief for women living with endometriosis and chronic symptoms. The products are formulated using a combination of natural ingredients, including essential oils, herbs, and vitamins, to soothe inflammation and provide pain relief.

The products are designed to be easy to use and integrate into a woman's daily routine. They are natural, side-effect-free, and provide long-lasting relief for women living with endometriosis and chronic symptoms.

The Endo Soothe product line is a collection of natural, side-effect-free products designed to provide relief for women living with endometriosis and chronic symptoms. The products are formulated using a combination of natural ingredients, including essential oils, herbs, and vitamins, to soothe inflammation and provide pain relief.

EndoSoothe

Marijnke van
Chemical Formulation Product Design

van der
Marijnke van der

Product Design

Product Design

Product Design

Product Design

Student projects: Product Design - Chemical Formulation Design

UC
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CENTRE OF
DESIGN
INNOVATION

ocean & botanicals

ROSE COAST

New Zealand sea salt skincare in plantable wildflower seeded boxes



Proposal:

Rose Coast aims to deliver a modern and sophisticated skincare product line that puts the beauty and health of ourselves and the planet first. The product line combines the healing properties of the ocean through Marlborough Fiery sea salt blended with natural flower botanicals. The use of natural ingredients tie together the overall brand image and focused on ingredient alternatives that work. The cardboard box contains wildflower seeds that can be planted after purchase. The products are targeted towards eco-conscious women aged 20-40 years old, who care for natural products that benefit themselves and the planet. These women want to implement change by putting things into action and make a difference.

The Problem:

Ever since the pandemic, people are looking more towards products to take care of their personal well-being. The environmental problem is that the skincare/beauty industry produces more than 140 BILLION units of packaging globally. We currently see a market filled with recyclable packaging and "green-washing". People put it in the bin and don't know if it got recycled or what difference they contributed towards. The Rose Coast products are packaged in recycled cardboard boxes that have small wildflower seeds throughout the cardboard. The boxes can be planted and will create an abundance of wildflowers when germinated.

Sea Salt Infused Acne Patches

The hydrogel patches have been designed to begin the necessary process of breakout by reducing redness, inflammation, killing bacteria, soothing and healing the skin. The patches are a light blue clear colour and are rounded in shape to easily cover breakouts. The product contains only plant based gums and is New Zealand Made and cruelty free. The acne patches contain Liquid Tolerol as a powerful certified organic bioactive anti-acne ingredient. This ingredient is new to the skincare market and acts as a natural alternative to chemicals commonly used in acne patches. The flower botanical blend is also featured in this product but to a lower percentage.

Sea Salt Scalp & Body Scrub

This scrub gently exfoliates the scalp and body while hydrating the skin and adding shine and luster. The product contains no sulfates (SLS or SLES) or parabens and is cruelty free. The scrub represents quality New Zealand ingredients and is proudly New Zealand Made. The delicate crystals of Marlborough Fiery sea salt is the key ingredient, not seen before in skincare products on the market. This salt is made using a special NO process of solar evaporation. The flower botanical blend of rose, Hydrated, Hibiscus Flower Extract and Calendula Flower Extract to enhance the skin and scalp benefits and create a natural aroma.



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School of Product Design
University of Canteen

Student projects: Product Design - Chemical Formulation Design



Introducing C09:

Biodegradable hair care.

C09 Hair

Anna O'Donnell
General Formulation Design

www.c09hair.com
Biodegradable hair care

C09 is a hair care brand that is committed to sustainable and ethical hair care. Our products are formulated with natural, biodegradable ingredients and are free from harsh chemicals, parabens, and sulfates. We believe in providing the best hair care products that are good for your hair and the planet.

C09



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Biodegradable hair care

www.c09hair.com

Student projects: Product Design - Chemical Formulation Design

EST. 2022

SKINFUEL

Full coverage skincare for men

The Problem

When thinking about the cosmetic industry there is one thing that is certain, that it is always directed and marketed at women and women only. The cosmetic industry is a highly saturated market that has little to no gaps in the market as most has already been created and tested out, so new makeup brands are always on the rise. It has always been designed for the use of women, but over the past few years the industry has spotted the interest of men more and more. Skinfuel wants to create a line of full coverage skincare for men. The goal is to break the social stigma of men wearing make-up. Who says men shouldn't feel 100% confident in their own skin with a little help of makeup. The aim is to create a natural mineral full coverage skincare line that has care for the male skin by adding sun protection and pigmentation to help with future damages and restore past ones. Skinfuel's target market are millennial working men any age above 30, who want to protect and regain confidence of their skin and appearance. Skinfuel has found a niche gap in the market for New Zealand men and wants to pick up the growing trend of men using full coverage skincare.

The Solution

Skinfuel's philosophy is to provide inclusivity, natural and long-lasting full coverage skincare that works to create products that are easy to use. Skinfuel wants to create the most subtle look that can be provided for the men's grooming and skincare. This brand is all about entering a new era for cosmetics and skincare and unleashing your inner confidence onto the surface of your skin and appearance. The formulations are designed to make the skin feel great and create protection at the same time. Men are stereotypically known not to have a skincare routine and not care too much about their appearance. Most of the time this is due to the social stigma that has been created through the marketing targeted at females. Skinfuel offers products that are easy to use, include natural ingredients and locally sourced ingredients from New Zealand. It has included sun protection and is easy to take on the go.



The Products

Scalp & Beard fill powder

This scalp and beard fill powder is the new and upcoming product that will solve the issues of a sparse beard and hair loss in the scalp area. Feeling insecure about your hairline or crown? Just use a dab of the scalp and beard fill powder and you are starting the day with a confidence boost. It is long lasting and stays on the skin for the whole day. It will come with a sponge that can be used in a versatile way, either as a beard powder to fill in a patchy beard or to touch up on the scalp, as many males struggle with hair loss at an early age. The ingredients are partially New Zealand sourced and use a new technology which includes wool powder that has been to stimulate the hair growth and natural pigmentation. At the moment there is no product out on the market in New Zealand that uses New Zealand made ingredients. Caffeine is a proven hair growth stimulant and titanium dioxide powder can be used to protect the skin and scalp from the sun.

Mattifying solid concealer

The concealer is in a solid clay form. The user experience of the product is different compared to other concealers that are used for men on the market. It has SPF protection and uses mineral ingredients to absorb oil. The concealer can be used just to cover a simple spot or treat acne at the same time due to the bauxite clay, whereas the titanium dioxide will provide sun protection. Skinfuel's concealer will provide an awakening effect due to the extracted caffeine and hemp seed oil and hyaluronic acid to nourish the skin. This product will appeal due to the active ingredients providing benefits that are missing in the market.



Skinfuel - Full coverage skincare for men

Ruby Haus
Chemical Formulation Design

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Supervisor
Ali Reza Nazmi

100% PRODUCT DESIGN

phdlogos

Student projects: Product Design - Chemical Formulation Design



THE PROBLEM

Post-covid Covid is the persistence of symptoms and developed long term symptoms between four and twelve weeks after the initial Covid-19 infection. It's associated 10% of Covid-19 cases become post-covid Covid, equating to roughly 11 million individuals in New Zealand alone. A range of symptoms including fatigue, weakness, cognitive decline, hair loss, weight gain, and more have post-covid Covid.

THE PROPOSAL

Echo aims to create products that support those suffering from the long-term effects of post-covid Covid, and promote wellbeing using natural ingredients with traditional medicine and backed by science. With the support of functional medicine such as medicine, omega 3 fatty acids, biotin, hemp seed oil, jojoba oil, and peppermint essential oil, Echo wants to help people to return to a sense of normalcy. The overall product line consists of an energy support, focus & memory, and muscle & joint pain. The range can be purchased separately or as individual 3-in-1 for different symptoms.



echo

Stuart Webber
Chemical Formulation Product Design

100% natural
100% natural ingredients

100% natural ingredients



Student projects: Product Design - Chemical Formulation Design

NOT COFFEE

It's NOT COFFEE, It's Better, It's Cacao!



Product Description:

NOT COFFEE is a plant-based, dairy-free beverage that is made from a blend of cacao, oat, and almond. It is a delicious and healthy alternative to coffee, with a rich, chocolatey flavor and a creamy texture. The product is available in three varieties: Cacao Oat Latte Powder, Brewed Cacao Oat-milk Latte, and Brewed Cacao Latte. Each variety is made with high-quality ingredients and is free from artificial flavors, colors, and preservatives.

Ingredients:

Cacao Oat Latte Powder: Cacao powder, oat powder, almond powder, natural vanilla flavor, natural sweetener, natural emulsifier.

Brewed Cacao Oat-milk Latte: Cacao powder, oat powder, almond powder, natural vanilla flavor, natural sweetener, natural emulsifier, oat milk.

Brewed Cacao Latte: Cacao powder, almond powder, natural vanilla flavor, natural sweetener, natural emulsifier, almond milk.

The Features

NOT COFFEE is a plant-based, dairy-free beverage that is made from a blend of cacao, oat, and almond. It is a delicious and healthy alternative to coffee, with a rich, chocolatey flavor and a creamy texture. The product is available in three varieties: Cacao Oat Latte Powder, Brewed Cacao Oat-milk Latte, and Brewed Cacao Latte. Each variety is made with high-quality ingredients and is free from artificial flavors, colors, and preservatives.

Benefits:

NOT COFFEE is a healthy and delicious alternative to coffee. It is made with natural ingredients and is free from artificial flavors, colors, and preservatives. The product is also a good source of antioxidants and is low in sugar and calories. It is a great choice for anyone who is looking for a healthier and more flavorful beverage.

Usage:

NOT COFFEE can be enjoyed in a variety of ways. It can be served hot or cold, and it can be used in a variety of recipes. For example, it can be used in smoothies, lattes, and baked goods. It is a versatile and delicious beverage that is perfect for anyone who is looking for a healthier and more flavorful alternative to coffee.



NOT COFFEE
Cacao Oat-milk Latte

The Products



Brewed cacao oat-milk Latte

This ready-to-drink latte is made from a blend of cacao, oat, and almond. It is a delicious and healthy alternative to coffee, with a rich, chocolatey flavor and a creamy texture. The product is made with high-quality ingredients and is free from artificial flavors, colors, and preservatives.



Cacao oat-milk Latte powder

This ready-to-drink latte is made from a blend of cacao, oat, and almond. It is a delicious and healthy alternative to coffee, with a rich, chocolatey flavor and a creamy texture. The product is made with high-quality ingredients and is free from artificial flavors, colors, and preservatives.

NOT COFFEE
Cacao Oat-milk Latte

Student projects: Product Design - Chemical Formulation Design

Supervisor | Creative Firm
Chemical Formulation Design
2022

Soule
'Soul to Sole'

Creating products directly from the soil, Soule brings to you Antipodes's first luxury essential care line. The Soule brand ignites passion and encompasses the feeling of smaller nature. The exclusive product line has been carefully crafted to cater to the maintenance of sensitive skin by combining elements of luxury and quality in the user experience.

The range includes the Soule Gentle Cleanser, Soule Ice Skin Refresher and the Soule Active Fine Fragrance. The all inclusive Soule Care Kit is formulated with essential oils and products needed for sensitive weather prone formulation that not only provides moisture but preserves the beauty of the greater community.

Talia Whelan | 2022.02.01
talawh@pmail.com
Talia Whelan

UNIVERSITY OF WYOMING
SCHOOL OF ENGINEERING
ARCHITECTURE

Student projects: Product Design - Chemical Formulation Design

Umood.



you matter



Our mission at Umood is to advocate for your mental health through proven beneficial extracts that will allow you to flourish, because you matter.

Umood's products are aimed at consumers wanting juice or gummies with immunity and mood-boosting benefits, both backed by science. Umood has a company philosophy that "you matter", which emphasises that an individual's health is our main concern. We recognise that when you are physically sick, your mood is also affected, and this is often what prevents you from doing everything you want to and being your best self.

We have two products that brilliantly incorporate our functional extracts. These are a "Vitalling juice" and "Vitalling gummies", both have a full dose of saffron extract and beta-glucan for your daily mental boost and immunity support. Our vitalling juice has a base of cold pressed Hawkes Bay apple and Gisborne orange juice, 200ml in size, so you can enjoy the delicious fruits alongside our extracts. Our vitalling gummies are best for people wanting to get the benefits of our extracts every day in an easy to consume and enjoyable chewy treat. You can have one gummy in the morning then one at night to get the full dose.

Our target market is young New Zealanders who want to take control and live their best life. Busy and bustling people like teachers and students who are trying to balance their work, social life, and exercise, but are often held back by sickness.

In the future, we would like to further characterise the effects of our combined extracts through clinical trials and optimise our formulations for improved shelf-life and sensory properties.



Tom le Fleming

19509047

Chemical Formulation Design,
School of Product Design

Supervisor: Sarah Kinsman

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Circa



TARGET MARKET

Gen Z

- Ages between 17 to 25
- Low to-middle income – recent graduates and students
- Strong values and senses of justice
- Online purchasing behavior
- Beginning to acquire more purchasing power
- Have a strong digital footprint and consume social media often
- Ability to make well informed purchasing decisions
- Most aware of ethical consumers

THE PROBLEM

Burnout & Vegetarianism/Vegans

- Gen Z is reporting some of the highest rates of burnout in the workplace
- Gen Z is struggling with the work stressors
- Lack of power, financial instability, normalization of toxic-culture, inability to unwind
- Lost workplace capital
- Constant overstimulation makes it difficult to switch off at night
- Burnout is a state of emotional, physical and mental exhaustion
- As stress continues, interest and motivation to lead
- More severe effects such as depression and anxiety can occur
- Younger generations are looking for food-options that are healthier and more ethical - these features are associated with plant-based options
- Social media is key in the development of plant-based lifestyle trends and environment conscious behaviours
- There is a risk of becoming deficient in key vitamins and nutrients that are difficult to obtain from a plant based diet, due to low bioavailability
- Deficiencies can cause effects such as weakness, fatigue, impaired brain function, irritability and even depression.

CIRCA RISE & REST

Circa Rise is to support and encourage young individuals in their attempts in changing the world. Circa's product line aims to help restore the digital life bust out individuals aged 17 to 25. This target market is also one of the most likely to be vegetarian and vegan so Circa will also target their products at supporting vegans and vegetarians.

Circa Rise, is formulated with ingredients to help boost energy and cognitive function as well as provide stress support. Designed to help consumers rise in the mornings and tackle the busy day ahead.

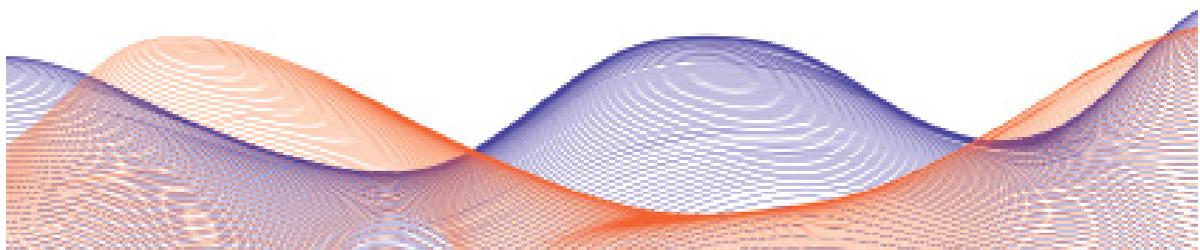
Circa Rise Latte is a functional powdered instant beverage formulated with active ginseng, ginseng and love more with a creamy oat milk base.

Circa Rise Capsules are a more pharmaceutical approach, with amino acids L-Theanine and L-Tyrosine, iron, and vitamin B12.

Circa Rest, is formulated with ingredients to help promote a restful sleep and help with relaxation as well as stress management.

Designed for the generation who aren't sleep, Circa Rest can help to quieten a busy mind/body for the rest day. Circa Rest Latte is a functional powdered instant beverage formulated with active Biotin, Ashwagandha and Passionflower with a creamy oat milk base.

Circa Rest Capsules are a more pharmaceutical approach, with amino acid L-Tryptophan, mineral Magnesium and Zinc and Vitamin B6.



Student projects: Product Design - Game Design

★ WISDOMED WITH CHARGE! ★
 ★ WISDOMED REALITY GAMES! ★
 ★ TAKING FULL FRESH PUNCH ★
 ★ THE ESCAPE ROOMS? ★
 ★ NEW ESCAPE ROOMS CLAIMS ★
 ★ BY YOUR LIFE? ★

LOOK NO FURTHER!
INTRODUCING.....

MR. MARLOW'S MANOR OF MAYHEM


 FEATURING THE LATEST INNOVATIONS IN
 AN GAMING FROM OUR TEAM OF
MASTERSHIP DEVELOPERS!

USE YOUR WITS TO CLIMB YOUR WAY OUT
 OF THE KILLER CLOWN'S MANOR -
BEFORE IT'S TOO LATE!

BE WARNED: THESE AREN'T JUST ORDINARY ESCAPE ROOMS. THESE ARE REAL LIFE ESCAPE ROOMS WITH THE MOST HORRIBLE



**WALK THROUGH THE MANOR
TO REACH THE ESCAPE!**



**WALK OVER THE MANOR FROM
THE OTHER SIDE OF THE**



**GET THE CARD IN ORDER
BEFORE IT'S TOO LATE!**

★ **100% OF SURVEYED PARTICIPANTS WOULD
GLADLY PLAY A GAME LIKE THIS AGAIN!** ★

Mr. Marlow's Manor of Mayhem

Milo Swart (Thomas Brown) | Joyden Pope
Applied Innovation Game Design

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A game to support mental health treatment

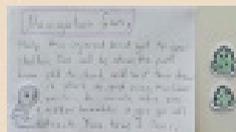


Project Brief

oVRcome is a Christchurch based start-up that uses virtual reality to make mental health treatment more accessible. We were tasked to explore the use of VR gaming as a fun way to engage users of their mild depression program.

How did we make a game for depression?

'Working memory' is the brain's ability to remember a small piece of information and use it to complete a task. Depression tends to weaken working memory, so we have designed a maze navigation game that could help players improve their working memory.



We looked at game ideas based on different brain exercises and areas of depression treatment and prototyped our concepts. For user engagement, we also brainstormed several narrative designs for our prototypes.

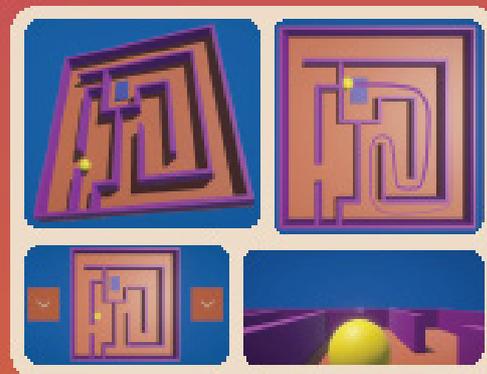


Our VR game challenges a player's ability to correctly remember a path through a maze and retrace that path backwards. The player is shown a path through the maze, then must use guide a ball backwards on that path.

What did we achieve?

To find the most satisfying way to play the game, we developed four ways to guide the ball through the maze using gaze control:

- Tilting the board to roll the ball
- Tracing a path for the ball to follow
- Rotating the board to let the ball drop
- Turning corners in first-person view



We provided several Narrative Design and User Engagement recommendations including:

- An oVRcome Style Guide
- Character/companion ideas and user journeys
- Using 360° videos as the environment

These features would achieve oVRcome's goal to retain their subscribers in a fun and engaging way.

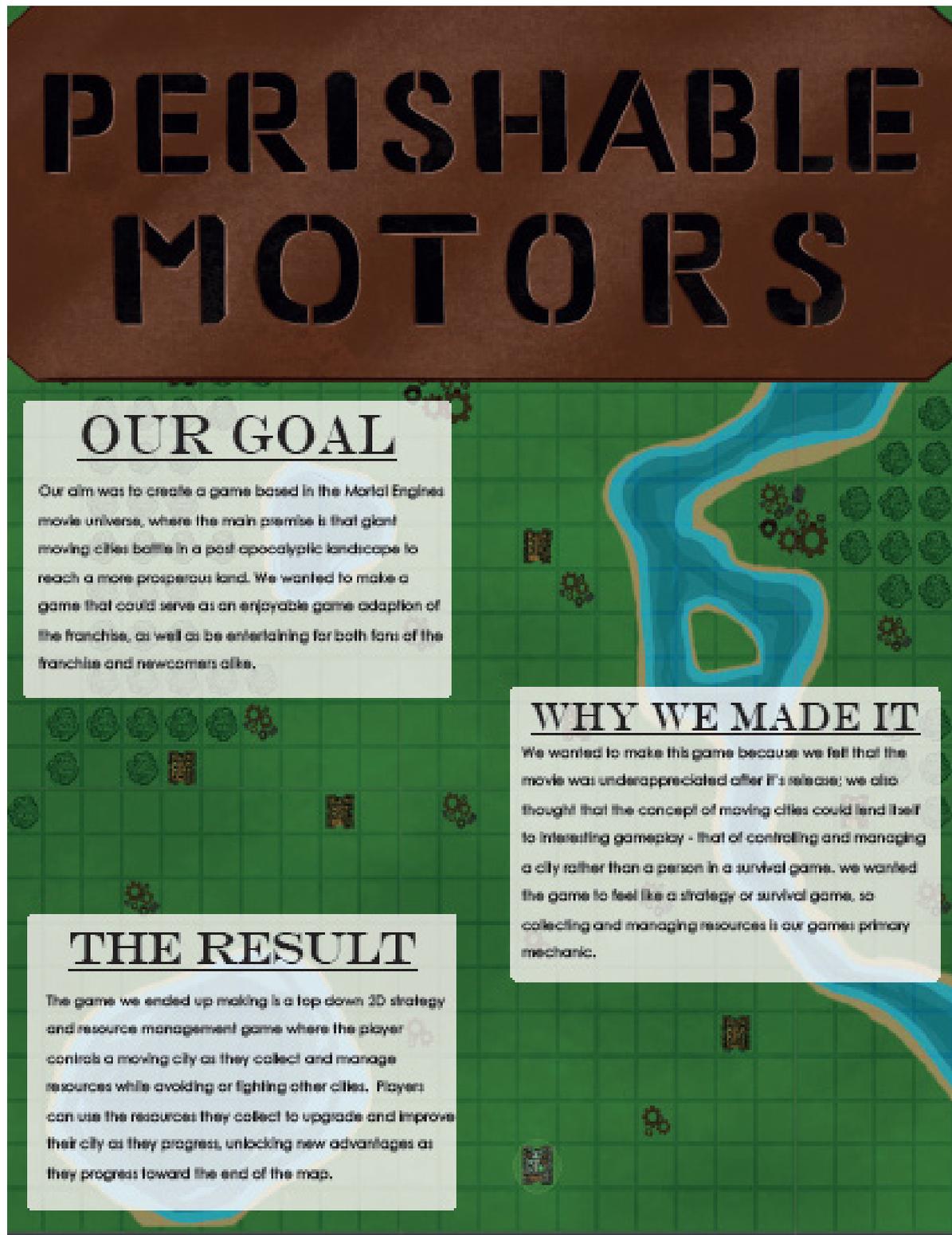
oVRcome: A game to support mental health treatment

Cora Kruger | PhD in Design
Applied Immersive Game Design

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Student projects: Product Design - Game Design



PERISHABLE MOTORS

OUR GOAL

Our aim was to create a game based in the Mad Max movie universe, where the main premise is that giant moving cities battle in a post-apocalyptic landscape to reach a more prosperous land. We wanted to make a game that could serve as an enjoyable game adaptation of the franchise, as well as be entertaining for both fans of the franchise and newcomers alike.

WHY WE MADE IT

We wanted to make this game because we felt that the movie was underappreciated after it's release; we also thought that the concept of moving cities could lend itself to interesting gameplay - that of controlling and managing a city rather than a person in a survival game. We wanted the game to feel like a strategy or survival game, so collecting and managing resources is our game's primary mechanic.

THE RESULT

The game we ended up making is a top-down 2D strategy and resource management game where the player controls a moving city as they collect and manage resources while avoiding or fighting other cities. Players can use the resources they collect to upgrade and improve their city as they progress, unlocking new advantages as they progress toward the end of the map.

Perishable Motors

Adrian van Zuijlen and Cleo Thompson
Digital Innovation Design

resources:
@perishablemotors
@perishablemotors

Game
Screenshot



Student projects: Product Design - Game Design



MĀUI

and the tale of

TAMANUI-TE-RĀ

PROJECT BRIEF

Māui Studios is looking into the development of a third person adventure game that tells the story of the Māori hero, Māui. We were tasked with creating a prototype version of the game. In this, Māui is to defeat the sun god, known as Tamanui-Te-Rā. For the game's design, we were to mix exciting combat-based gameplay with an interactive retelling of the classic story.

PROJECT GOAL

Our goal was to create two levels. An exciting yet challenging boss fight with the sun god, and a tutorial level that introduced the player to the gameplay and story. Both levels needed fluid combat and movement mechanics to make the gameplay exceptional. Finally and with great importance, we needed the god, in all his size, to feel like a looming threat.

BOSS DESIGN

Fighting a sun god is not easy. Tamanui-te-rā comes equipped with devastating attacks to destroy Māui.

Magma Eruption: Fire is torn from the lava and hurled at Māui, leaving a lingering ball of fire.

Colossal Fist: Tamanui Slams his fists on Māui, dealing massive damage but draining the gods energy, leaving him open to attack.

Solar Breath: Fire spews from the Gods mouth. If Māui gets set on fire, his best bet is to Stop, Drop, and Roll.

COMBAT

TAIAHA: Its long wooden body allows quick precision attacks while the sharp greenstone tip cuts through gods.

PATU: The close distance club weapon, carved from greenstone and decorated with war kowhaiwhai is perfect for subduing an angry god.

Each weapon has a unique moveset that can be utilised against Māui's foes in different ways.

MĀORI THEMES

In order to appropriately represent Māori culture, and tell this story, we mix fantasy with history. Our self driven research and consultation with Māui studios, helped us in this regard.

The levels are influenced by native Aotearoa landscapes and Māori Pa for Māui's village in the tutorial level.

The weapons are all based on real Māori weapons with a slight twist.

Māui and Tamanui-te-rā, both wear traditional Piu-Piu skirts.

Māui vs The Sun

Bill O'Neill | Fraser Carson | Hayden McCreedy
Applied Narrative Game Design

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Illustration
Adam Cook | Mark Whelan
Sound Effects
Brad Williams | Jaki Whelan

MAUI STUDIOS
www.mauistudios.com

Submit a project for next year

If you have a project idea - half a page is sufficient at this stage (the brief can be refined later) - please email the following information to engindustry@canterbury.ac.nz:

- Title of the project.
- Contact name and contact details for the project.
- Summary of your expected project outcomes, for example, what you want to achieve or the problem you would like to solve.
- Constraints and/or expectations that need to be taken in to account for the project.
- Type of sponsorship option (individual/group).
- Support (time, resource & equipment) your business/organisation will provide (in addition to sponsorship).
- Any other information you consider relevant.

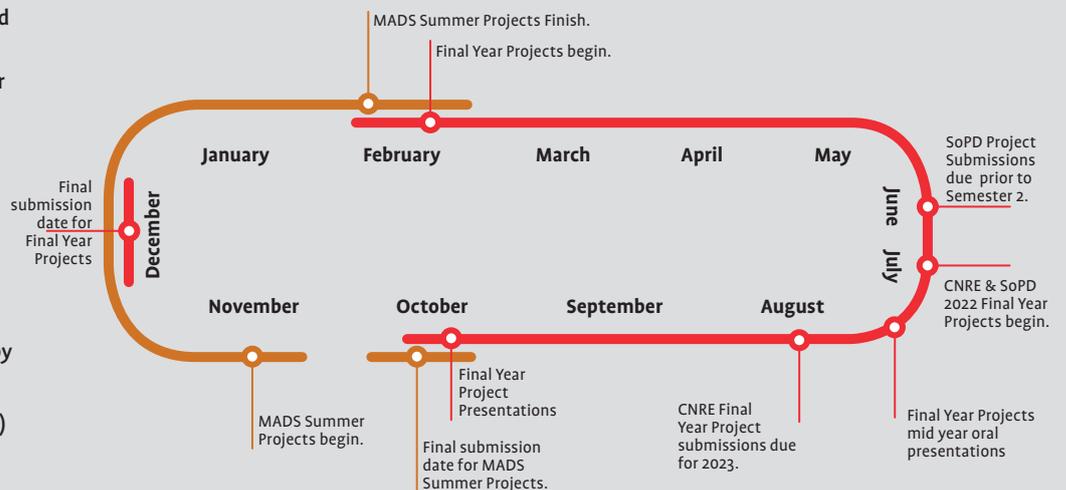
PROJECT TIMELINE:

With exception of Civil & Natural Resource Engineering (CNRE) and School of Product Design (SoPD) the preferred submission date for an idea for a Final Year Project is: **December** for projects to be started the following February.

For CNRE it is **mid-August**, for projects to be started the following July.

For SoPD, FYPs run in Semester 2 only with submissions required by end of June.

Master of Applied Science (MADS) Summer Project final submission date for a project is the end of **September**, for projects to be started in November..



As student numbers are limited, and vary from year to year, we recommend starting this process early to avoid missing out on having your project selected.

Contact us

Industry Engagement Team

Te Kaupeka Pūhanga | Faculty of Engineering

Te Whare Wānanga o Waitaha | University of Canterbury

Email: engindustry@canterbury.ac.nz

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