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UC Mechanical Engineering

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Newsletter for our Alumni & Friends, **Winter 2020 Special Edition**

Fight against Covid-19

UC Mechanical Engineers and Med Student Daughter Develop Face Shield for Healthcare Workers

Associate Professor Don Clucas, Distinguished Professor Geoff Chase, Technical Officer David Read, and medical student Emma Clucas have designed face shields for health workers. Leveraging 3D printing, Associate Professor Clucas designed an initial prototype that met all the requirements but took too long to manufacture.

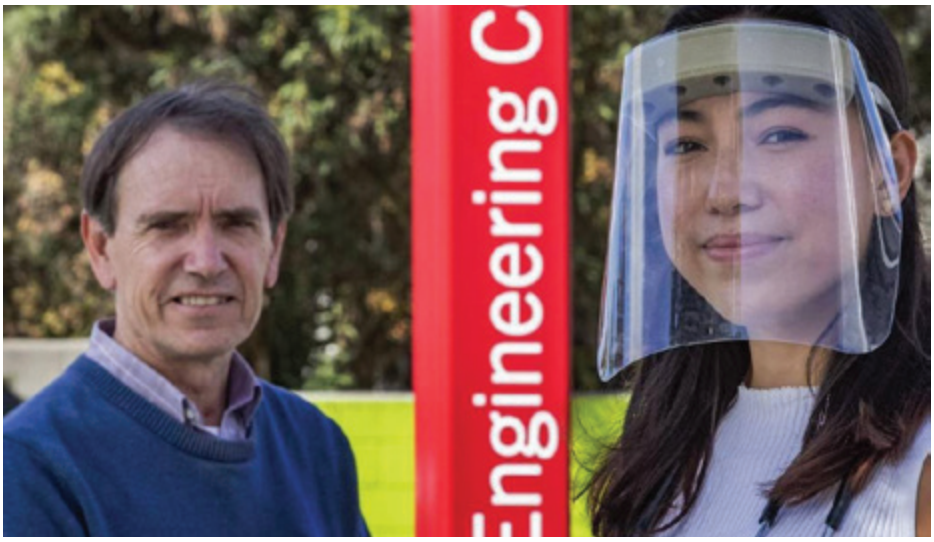
"We looked at the 3D version and decided, for mass manufacture, it wasn't a suitable option because you just can't make them fast enough," Associate Professor Clucas said. "Emma and I worked on it and after considering many design options we went full circle and chose a design which is very similar to what the nurses and doctors have been using at the hospital for many years. Sometimes it is better to go with something that has been proven to work by the actual users than risk failure with something new and untried, especially during these uncertain times. We did some re-engineering to make it suitable for local manufacture."

Design input was provided by Associate Professor Clucas' daughter, Emma, whom is a 5th year medical student at the University of Auckland. "I've been working side-by-side with dad, we're very lucky we're in the same bubble at home so he's had an extra set of hands," she said. "Although I have limited experience, being a student I'm still able to provide some knowledge and potential application (for the shields) in hospitals and other healthcare facilities."

A further design constraint was presented in the acquisition of materials as stated by Associate Professor Clucas, "Our biggest problem is getting materials during lockdown, for example the rubber foam and the elastic band. We knew they were available, we just couldn't contact the people who supply. That's understandable."

To remedy this problem, the team turned to laser cutting materials for assembly. Fortunately, they were allowed special access to the Department of Mechanical Engineering Advanced Manufacturing Lab. Utilizing the available technology, a face shield could be cut out of material in around 30 seconds. Seven different prototypes were made and tested at Christchurch Hospital. The one of the designs was made freely available online.

For more information, check out the great stuff article at: *www.stuff.co.nz/national/120696045/christchurch-engineer-and-med-student-daughter-design-covid19-face-shield*



Associate Professor Clucas and his med student daughter, Emma Clucas

Head of Department

Kia Ora,

COVID-19 has brought its share of challenges to the tertiary education sector in general and Mech@UC in particular. What started with having to accommodate a few international students unable to travel to UC because of travel restrictions quickly became the full lock-down which we have experienced for better and for worse.

With a few weeks' notice, staff and students had to transition to online education. All staff had to carefully rethink their pedagogy and teaching styles to best engage with the students remotely and find creative ways to replace traditionally face-to-face activities, like labs and exams. One of the highlights was a take-home lab where students learned the basics of heat transfer by cooking food in the kitchen. Students also had to quickly adapt their study habits and rise to the challenge of becoming self-starters and independent learners. Looking back, it is amazing what was achieved in so little time, and while there is no doubt online education offers attractive opportunities going forward, staff and students alike were reminded of the value of face-to-face interaction, particularly in our hands-on mechanical engineering degree for which teamwork is so commonplace.


Prof Mathieu Sellier

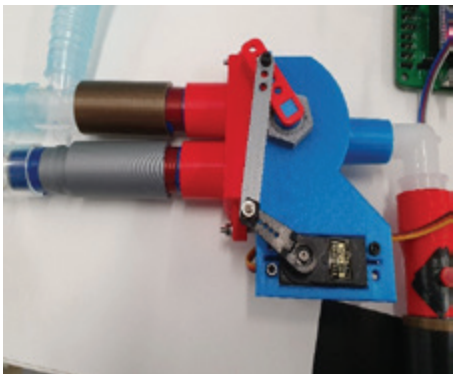
This newsletter showcases some the exciting research which occurred in the department to fight the spread of COVID-19 and help ICUs cope with ventilator demand. These projects, which delivered timely, practical solutions in times of crisis illustrate perfectly the strength of biomedical engineering in Mech@UC. This newsletter also introduces Dr Tim Giffney, whom we welcome to the department. Sadly, we also say farewell to Prof. Krumdieck, who has accepted a Chair in Energy Transition at Heriot-Watt University in Scotland.

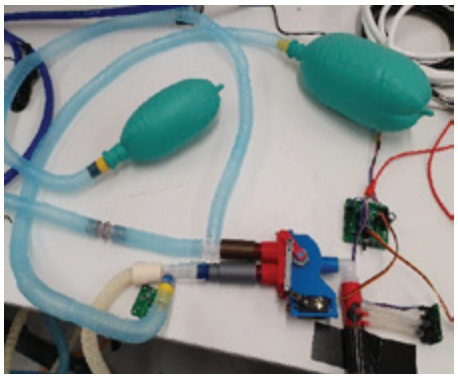
I hope you enjoy reading this newsletter.

Stay safe and stay connected.

Mathieu

Fight against Covid-19





Above: From PhD student Lui Holder Pearson and Distinguished Professor Geoff Chase worked on the simple low-cost piece of technology that doubles the capacity of ventilators.

New UC Technology Doubling Ventilator Capacity Could Save Thousands of Covid-19 Patients

Distinguished Professor Geoff Chase, in collaboration with a team of doctors and engineers, have developed a simple application of fundamentals and manufacturing robotics to enable a single ventilator to be used with two patients at the same time, while personalising the care for each.

The secret to this novel ventilator is an active valve concept. This uses advanced manufacturing and mechatronics to create a sensor driven control system that switches from each patient alternatively in what is called "in series" breathing. This makes the double ventilator a low-cost (< $100) extension to current ventilator technology and is shown to be safer than having two patients breathing from one ventilator at the same time, also called "in parallel" breathing. The team plans to make the design and software freely available as an "open source" after testing is complete.

"We believe this can, and will, save countless lives internationally by doubling ventilator capacity and sparing doctors from having to make terrible end-of-life care choices," Prof Chase explains. "This is a clever technology. It's very simple, quickly implemented, and low-cost, but high impact, solution. We can have the first prototypes ready in one to three months, or faster, and pilot-trial tested quickly after that. We will develop them locally and then make them available internationally with freely available software and designs to be 3D printed in hospitals."

Perhaps most critically, in a world filled with potentially dangerous ideas about ventilating patients during this pandemic, this concept ticks all the boxes for safety and personalisation. In particular, six different international critical care societies published a list with over 10 main reasons not to ventilate patients "in parallel" due to safety and risk concerns. Prof Chase and colleagues published this concept in the leading journal Critical Care, showing how this concept of "in series" breathing meets each and all of the concerns noted. This article is freely available at: https://ccforum.biomedcentral.com/articles/10.1186/s13054-020-02945-z

Speaking of freely available, Prof Chase notes the entire system, its software, and its design will be made open-access and freely available to be used worldwide.

You can also check out the articles at: *www.canterbury.ac.nz/news/2020/new-uc-technology-doubling-ventilator-capacity-could-save-thousands-of-covid-19-patients.html and https://www.canterbury.ac.nz/news/2020/group-of-uc-engineers-invent-answer-to-global-demand-for-ventilators-amid-covid-19.html*

Our Staff

Dr Tim Giffney Joins the Department as a Lecturer

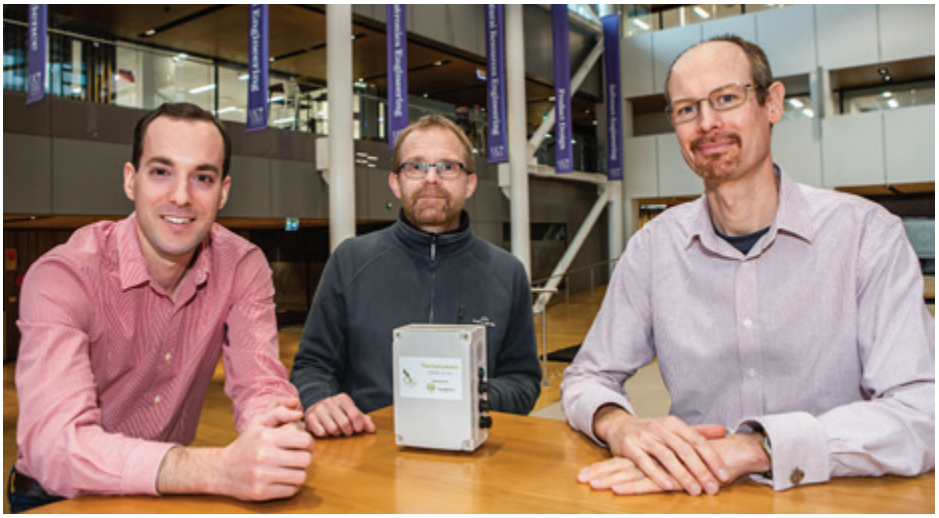
Dr Giffney received his PhD in Mechatronics Engineering from the University of Auckland where he worked as a lecturer since 2017. He brings expertise in sensing and 3D printing as well as an interest in developing new devices for agriculture. Dr Giffney's main research focus is the development and application of materials that combine sensing, actuation, and structure, also known as functional materials. By combining 3D printing with functional materials, he aims to produce complex integrated systems that mimic nature. This research promises to enable the creation of mechatronics devices that match the close level of integration that can be found in biological systems such as the human finger, where nerves, muscles, and bone provide sensing, actuation, and structure with an elegance not yet matched by machines.

"I love the freedom to develop new technologies, to have a small piece of the future on your desk (even if it usually doesn't quite work yet) and be a tiny part of driving humanity forward." Dr Giffney says about university life. "It is a privilege to teach and supervise the students here, and I am impressed by what they achieved in challenging circumstances this semester." with respect to the hardship caused by Covid-19.

In his free time, Dr Giffney enjoys landscape photography and diving and is looking forward to exploring the South Island both in and out of the water. As a keen diver, he has plans to explore the Pohatu Marine Reserve in Akaroa.

www.canterbury.ac.nz/engineering/contact-us/people/tim-giffney.html

Fight against Covid-19



From Left to Right: Dr Tim Giffney, Technical Officer Julian Phillips and Prof Mark Jermy

An image from the camera: to the left of the person's face, the bright circle is the constant-temperature plate of the calibrator

UC Mech Engineers Adapt Predator Sensing to Humans

UC Mechanical Engineering technical officer Julian Phillips, Lecturer Tim Giffney, and Professor Mark Jermy have developed a temperature reference to calibrate thermal imaging cameras for the human body.

The cameras are repurposed low-cost systems developed by the Cacophony Project and Christchurch-based manufacturer 2040, originally used to track predators in the field. A proper human temperature reference is crucial in adapting the technology for crowd fever detection operations as explained by Dr Giffney.

"Objects at close to human body temperature only emit a very small amount of radiated heat, which is difficult to detect in the camera sensor. This means it is not easy to make an accurate thermal camera that is insensitive to external conditions", Dr Giffney explains. "If thermal imaging cameras are deployed for temperature screening, this stable temperature reference can help with accuracy. We hope this stable in-frame temperature reference could be useful as a simple, rapidly deliverable approach."

Tests carried out by local firm 2040 and Callaghan Innovation utilised about 30 soldiers and police were used as a baseline for the cameras and a system was developed that would be self-calibrating for a wide array of thermal imaging cameras. "By putting a stable temperature source in view of the camera, the system can continuously check its reading, and make adjustments," UC Engineering technician Phillips says. "The main challenge in developing the reference was coming up with a design that could be rapidly built with minimal resources, and from local supplies as international freight was at an almost complete standstill."

The device was featured in Stuff and Medtech core. For more information, please check out the news article at: www.canterbury.ac.nz/news/2020/uc-engineers-aid-development-of-thermal-imaging-cameras-to-spot-covid-19-symptoms.html

UC Engineer Rethinks "Business as Usual" in a Post Covid World

UC Mechanical Engineering Professor Susan Krumdieck sees Covid as a learning opportunity for New Zealand. Professor Krumdieck has carried out research into every type of renewable energy and energy efficiency. Out of her research group's work in sustainable energy, has emerged the field of Transition Engineering.

This is a movement within the engineering and technology professions that works directly on the downshift of fossil fuel production and adaptation of all energy systems to 80% lower energy supply.

"All work on sustainability, renewable energy, and green products over the past 30 years has been part of how we got to where we are now, 417 ppm CO_2, well beyond the climate safe range of 350 ppm," explains Professor Susan Krumdieck. "Therefore, there has to be an innovation that changes the course of business-as-usual in order to get onto the emissions pathway that leads to the future with a stabilized climate."

What does Transition Engineering look like? Professor Susan Krumdieck answers, "It looks like hope. People can see how transition projects look quite different, exciting, and how the new homes, buildings, or urban developments would be resilient to the downshift of fossil fuels in the future. They can also see how the transition projects improve quality of life and the environment."

This exciting movement started at the University of Canterbury, but is now a global association with active members in the UK, France, Ireland, Australia and many other countries. An online short course is available with enrolments coming in from around the world, and UC is applying for a credential in Transition Engineering, Management and Policy Communication to be offered this year. For more information, check out the Global Association for Transition Engineering's website *https://www.transitionengineering.org/* or read Professor Krumdieck's book: Transition Engineering: Building a Sustainable Future (CRC Press).

Recent Achievements

Two UC Engineers make it to the Marsden 2nd round

Associate Professor Catherine Bishop, along with Professors Edwin García and John Blendell at Purdue University in the USA, have submitted a second round Marsden fund application.
The project builds on their preliminary theoretical insights into interfaces in electro-ceramics and new experimental characterization methods. They will study ferroelectric materials to understand their life-limiting mechanisms. Ferroelectric devices such as actuators, sensors and capacitors, enable our way of life in energy systems, communications, computing and manufacturing. Many of these ceramics contain toxic lead, and there has been a decades-long search for a replacement, lead-free materials following internationally agreed environmental goals.

The team will develop a new model and experimentally validate it for two lead-free materials. They believe that as-yet-unstudied transitions in ferroelectric interfaces are key to unlocking these complex degradation processes. "We aim to identify the microstructural, processing and loading conditions that minimise ferroelectric aging and fatigue. The outcome will enable the targeted development of novel lead-free materials, reducing toxic environmental waste. Our world-first insights will inform the design of next-generation perovskite solar cells crucial for our sustainable, collective future," explains Associate Professor Catherine Bishop.

Dr Jennifer Knopp, part of the Centre for Bioengineering at the University of Canterbury, has submitted her proposal for the second Marsden fund round.

Dr. Knopp's research focuses on the binding of pharmaceutical drugs to plastic tubing and containers. This problem directly effects the efficacy and precision of the drug delivery to patients. Proteins are important molecules biologically, and many drugs use proteins as a basis. One fundamental property of proteins, important to their job, is that they stick to things - like other proteins or surfaces. However, when it comes to drug delivery that fundamental property is disadvantageous, resulting in unpredictable under-delivery of drug therapies.

This research brings together what is known scientifically and clinically,

to experimentally quantify and understand how insulin binds to typical plastic delivery tubing, enabling unique models of insulin/protein binding mechanisms – important new knowledge with significant implications for clinical drug delivery.

Alumni

UC Alumnus Brings People to New Heights

James Powell graduated UC Mechanical Engineering in 2008. Highlights from his time at UC include the design and racing of go-karts and experience gained working on a private jet. After his graduation, Powell worked as an aeronautical product consultant in Auckland and eventually moved to Airwork where he took over management of their manufacturing. During this time, he earned the position of Delegate of the Director of Civil Aviation (Aviation equivalent of Chartered Engineer).

"I love high performance vehicles and aerospace has some of the highest performance vehicles ever made. Aerospace people are epic. They're super smart, motivated and keen to make things happen. That creates a pretty exciting, positive environment where people do their best work. This is crucial when our goals are so big" Powell explains. This attitude has served Powell well as he became a founding member of Dawn Aerospace, a space transportation company with offices in Christchurch and Delft. Currently, they are commercializing green satellite propulsion systems using proprietary technology and using the profits for the design and development of a two-stage orbital spaceplane.

Powell credits his time at UC as helping him to network and teaching him to prioritise and focus on work that makes the most contribution to a goal. "The high calibre of people coming from UC has really helped set us all up to do some pretty unique things around the world."

Read more: www.canterbury.ac.nz/engineering/schools/mechanical/alumniupdate/alumni-stories/

PHD Project

Aerospace Propulsion & Aeroacoustics Lab

Do you enjoy working on and with high performance vehicles? Do you want to study and improve some of the highest performing vehicles made? Associate Professor Dan Zhao, associate fellow of the American Institute of Aeronautics and Astronautics (AIAA), is looking for high calibre PhD candidates. Both domestic and visiting scholars are welcome to contact Associate Professor Zhao with your expression of interest: *www.canterbury.ac.nz/engineering/schools/mechanical/research/zhao/*

The Dept. Of Mechanical Engineering has become a charted student branch of the American Institute of Aeronautics (AIAA).

AIAA is the world's largest aerospace technical society with over 200 active student branches around the world. Being a student branch, the opportunity for students to present their research in an international conference. This further opens avenues for scholarships, design competitions, and other great events put on by the AIAA. This was made possible by the efforts and recent appointment of Associate Professor Dan Zhao as an AIAA Associate Fellow.

Both domestic and visiting scholars are welcome to contact Associate Professor Zhao with your expression of interest: *www.canterbury.ac.nz/engineering/schools/mechanical/research/zhao/*

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