# CEID Research Symposium 2022

## Thursday 7th July

**G-Block Rotokauri Campus**
**Wintec Te Pukenga**
**Hamilton, New Zealand**

Wintec | Te Pūkenga

Edited by: Dr. Praneel Chand

# CEID Research Symposium 2022

Kia ora koutou and welcome. This booklet contains the abstracts presented at the 2022 CEID Research Symposium. This event has been revived after a lapse of several years. Research in CEID encompasses a variety of disciplines such as:

- Engineering education
- Electrical engineering
- Mechanical engineering
- Civil engineering

Applied research and cross-disciplinary research is encouraged in CEID. Technology and innovation is one of the major themes (e.g. sports engineering, biomedical, electrical power, materials, robotics and automation). In addition to this, sustainability and environmental issues are important to CEID research. This is reflected in the symposium abstracts.

The aim of the symposium is to promote the sharing of research ideas and progress in a "friendly" environment. It also informs the Research Leader, Team Manager, and Centre/Group Director of research progress within the centre. It is anticipated that researchers will expand their abstracts into conference/journal papers in due course.

## Symposium and Review Committee

- Dr. Mohammad Al-Rawi (Engineering Education, Mechanical Engineering)
- Dr. Paul Ewart (Mechanical Engineering)
- Dr. Praneel Chand (Chair and Editor, Electrical Engineering, Engineering Education, Civil Engineering)

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# Programme

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|---|---|
| 9.00 am | Welcome and Introduction |
| 9.10 am | Engineering Education: A Continuous Improvement and Evaluation in Engineering Education – Sarla Kumari |
| 9.30 am | Engineering Education: Applying the Reciprocal Peer Coaching Model for Successful Learner Outcomes in Engineering Education – Jai Khanna |
| 9.50 am | Civil Engineering: Helical motions and hydraulics of river channel confluences – a review – Liam Aghazadegan |
| 10.10 am | Electrical Engineering: Scalability enhanced new communication architecture for irrigation point controllers – Thilanga Ariyarathna |
| 10.30 am | Morning Tea |
| 11.00 am | Mechanical Engineering: Did you just Cough? Visualization of Vapor Diffusion in an Office using CFD – Mohammad Al-Rawi |
| 11.20 am | Electrical Engineering: Introducing Vision Based Methods for Sorting Used Parts – Praneel Chand |
| 11.40 am | Electrical Engineering: Power Distribution Economics Modelling – Bhujanga Chakrabarti |
| 12.00 am | Mechanical Engineering: What makes a good polo mallet? - vibrational characteristics using a cantilevered visco-elastic beam model – Ken Louie |
| 12.20 pm | Lunch |
| 1.00 pm | Informal Research Discussions |
| 2.00 pm | Conclusion |

# A Continuous Improvement and Evaluation in Engineering Education

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During the 2020 segment of the COVID-19 pandemic, the use of digital education required - and achieved - significant improvement. Universities, colleges, schools, and researchers are now all very much involved in the online learning process. In the area of engineering education research, all conferences worldwide have been affected, with face-to-face conferences being replaced by online versions. Online tools proved indispensable for the continuation of all teaching and research processes across 2020 and continue to be so in future. The requirement that all teaching and research outcomes be delivered virtually provided educators and researchers with an opportunity to leap on to the learning curve of these formerly unfamiliar or niche technologies.

This research aims to support the process of continuous improvement and growth in online digital education and industry based-projects engagements by providing data and analysis of the deployment and effectiveness of online learning tools, such as video content, online discussion forums and live online classes in the delivery of a CAD course.

In this research we collect and report on data on new technology uptake and deployment including: the use of the online video content in teaching, online industrial projects engagements, group discussion and new approaches to teach CAD software-based classes online using the cloud and live online classes. We monitor students' online interactions during tasks assigned in online sessions and examine the level of student-student interactions and student-content engagement with the online material.

Online teaching does have its own attractions. We don't have to worry about rooms, equipment issues (excluding Internet and computer resources) and it is safe option to avoid COVID transmission. We have noticed that the drawbacks of online teaching such as requirements of whiteboards and Zoom issues could be overcome with better software.

This research identified that student performance is enhanced in online delivery compared to face-to-face delivery, as students responded better to Statistics as it was easy to teach online for the most part; however online teaching presented challenges for Engineering Calculations and Materials.

# Applying the Reciprocal Peer Coaching Model for Successful Learner Outcomes in Engineering Education

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Teaching and learning should always be considered with a kaizen (continuous improvement) approach, investigating authentic and modern pedagogies to empower learning in teachers/kaimahi and students/tauira. The future of academia relies strongly on educational sustainability and competency in the ākonga, which must be applied through innovative teaching pedagogies and a student-centred learning model. Therefore, this research project offers coaching tools into teachers' professional development plans to achieve successful learner outcomes. The usefulness and impact of proper coaching practices from primary to tertiary education is significant, coaching allows teachers to develop themselves further and continue to gain professional and technological attributes for a successful career in education. This study presents the Reciprocating Peer Coaching (RPC) model. Th objective is to achieve the deliverability of peer-assisted coaching model to improve teaching and learning between the kaimahi and the ākonga, to perform reflective practice, refine current classroom strategies, share resources, and build on new teaching pedagogies.

The RPC model implements transfer of learnings and make the ako approach among the teachers to deliver the best practices. The RPC model directly links ākonga-centred approaches and Te Tiriti based practices by supporting and benefiting the students with cultural dimensions. The goal of the project is to allocate a coach for every teaching professional (coachee) per semester, which can be reciprocated in the following semester. The progress of the project is currently developing the plan to organise a session where all academics can participate and partner with their coaches. The initial results demonstrate positive acceptance and feedback from the kaimahi, where they have stated that this collaborative exercise builds an opportunity to create and define new teaching and learning tools to achieve successful and equitable outcomes for the ākonga. The projection of completion of the project is to include the RPC model into teaching or moderation plans for the kaimahi from 2023. The project also going to include the qualitative analysis, which collects data through survey/questionnaires with the kaimahi and ākonga from different courses to ensure there is an effect of RPC through evaluation/reflection exercises, this would establish consistency and continuous growth in the teaching and learning space.

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# Helical Motions and Hydraulics of River Channel Confluences – A Review

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River confluences are locations where strong mixing occurs, which is often formed with the development of shear layers and helical motions. This review describes some recent trends in confluence hydrodynamics, focusing on conditions within mixing processes, shear layer and helical motion. It is well established that significant changes in hydrodynamics and bed morphology occur at the confluence, where tributaries meet river channel, and the effort to better understand such dynamic environment has led to multiple studies through detailed laboratory experiments and computational models. The measurement techniques allow researchers to measure velocity and sediment transport under controlled flow conditions. River channel confluences studies have been growing, and many experimental studies have been carried out in the range of different confluence planforms and angles. However, there have not been any systematic review articles to study the hydrodynamics of confluences to summaries the advancement in this area.

The impact of discharge ratio and junction angle on confluence hydrodynamics is discussed, with attention being paid to mixing flow, shear layer and helical motion. The key research challenges of the hydrodynamics of vegetated channels are highlighted.

# Scalability Enhanced New Communication Architecture for Irrigation Point Controllers

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With the advancement of ICT (information and communication technology), IoT (internet of things) concepts are gaining popularity due to their wide industrial applications and transforming lifestyle. IoT helps manufacturing companies reduce costs by improving efficiency and revolutionizing business processes. IoT innovations are applied in various fields such as smart homes, health care, factory automation, irrigation systems and remote sensing applications. Considering the depth of investment, extended visibility beyond the proof-of-concept (PoC) stage is crucial in IoT systems.

According to the IoT Signals report by Microsoft [1], one-third of the IoT projects fail at the PoC stage, and the root cause for most of the failures (32% of them) is the cost of scaling. Diversity of the technology is the greatest challenge for IoT scalability. It is essential to choose suitable technologies and the correct architecture at a very early stage for long term visibility of the system. This presentation proposes a new star topology-based hardware architecture to enhance scalability in IoT systems. The new architecture is used to develop a proof-of-concept smart irrigation system to verify the operation and integration of diverse hardware platforms. In this research, we have considered various IoT aspects, including high-level hardware architecture, communication protocols, and portable software layer to enhance the scalability of an IOT system, which are major contributing factors for scalability.

The system is currently under development for a proof of concept prototype for an irrigation point controller. An irrigation point controller is a self-sustained unit powered by solar that can be used to control solenoid valves for sprinklers and that enables collecting data. Introducing scalable architecture enables a new node to be integrated conveniently without complicated configurations and no technical expertise required. Radio transceivers are introduced for two way communication between the central node, and client notes and LoRa (long-range) modules are proposed for long-distance communication. The software layer is developed on top of this hardware infrastructure, and suitable communication protocols are under investigation.

References:

[1] “Iot signals, summary of research learnings 2019,” Microsoft, Tech. Rep ., 2019.

[2] A. Gupta, R. Christie, and P. R. Manjula, “Scalability in internet of things : Features , techniques and research challenges,” 2017.

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# Did you just Cough? Visualization of Vapor Diffusion in an Office using CFD

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New Zealand and many countries gained heightened awareness of indoor air quality (IAQ) issues [1], and increased investment, according to the World Health Organization (WHO) guidelines, to improve their IAQ and reduce air pollution in commercial and residential buildings. Additionally, some countries have introduced new standards for indoor environments, such as the New Zealand "healthy homes" standard. At the same time, COVID-19 pandemic forced many people to spend much more time in indoor spaces, due to stay-at-home, or lockdown orders by governments. This increased attention on other aspects of indoor environmental quality, such as occupants' satisfaction with thermal comfort parameters, presents an additional parameter for research and in the development of standards. From a medical perspectives, infectious respiratory diseases, such as influenza or COVID-19, are transmitted by airborne droplets. In this work, we assess a Polyester Filter and UV light (PFUV) dehumidifier device (as prototyped in [2]) performance in an office with two occupants (one uninfected and the other one infected with a disease with airborne transmission using computational fluid dynamics (CFD) approach. Two positions for locating the PFUV dehumidifier in an office with a scenario in which one person is exhaling infected air and the other occupant must inhale and exhale from the shared air. The CFD model illustrated the best position of the device to distribute the air velocity contours. Further, based on the CFD model which was validated via the IAQ and comfort kit (Testo 400) thermal comfort analysis showed that the room is slightly cold.

References:
[1] World Health Organisation, 2021 Update of WHO Global Air Quality Guidelines. Retrieved from. https://www.euro.who.int/en/health-topics/environment-and-health/air-quality/activities/update-of-who-global-air-quality-guidelines
[2] Al-Rawi, M., Lazonby, A. & Smith, C. (2022). Prototyping a low-cost residential air quality device using ultraviolet germicidal irradiation (UVGI) light. HardwareX, 11, e00251. https://doi.org/10.1016/j.ohx.2021.e00251

# Introducing Vision Based Methods for Sorting Used Parts

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This presentation introduces the development of vision-based methods for identifying objects in a sorting task. It addresses the issue of economic and environmental sustainability. By attempting to identify and sort items, parts can be recycled/reused thus reducing waste. Automated handling of materials can also improve safety in the COVID-19 pandemic environment.

For example, some electrical courses rely on hardware components such as resistors, capacitors, inductors, voltage regulators, and diodes for circuit construction. After practical work, components are often discarded instead of being reused. Sorting small parts can be tedious and this could be achieved using an automated sorting system . Initial investigation into detecting and recognising small electrical components has been presented in [1].

The proposed solution will utilise a Niryo Ned Robot Arm and Conveyor System for moving parts [2]. A Matlab based AI algorithm will use a Logitech webcam to identify parts in the workspace. After recognising parts and their locations, commands will be sent to the Niryo robotic system to sort the parts. Currently, the Niryo Robotic System has been procured and basic movement of the robotic arm using Matlab has been developed. Two possible solutions for part identification are proposed. One solution has been tested in a sample workspace – a multiple object workspace scenario.

Basic communication between the Niryo Robotic System and Matlab has been achieved. Initial testing of part identification suggests the that the multiple object workspace scenario can achieve adequate results. Next steps in the project will involve the development of Matlab scripts files based on ROS to send movement commands to the robotic system. Following this, the part identification will be re-tested and applied to move parts. This is anticipated to take the remainder of the year.

References:
[1] R. Kumar, S. Kumar, S. Lal and P. Chand. “Object Detection and Recognition for a Pick and Place Robot,” in *Proceedings of IEEE Asia-Pacific World Congress on Computer Science and Engineering*, Nadi, Fiji, 2014: IEEE, pp. 1-7, doi: 10.1109/APWCCSE.2014.7053853.
[2] Niryo. “Ned User Manual.” Niryo. https://docs.niryo.com/product/ned/v4.0.0/en/index.html.

# Review of Modelling and Measuring Market Power in Electricity Markets

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Market power is defined as the ability for producers to alter profitably prices away from the competitive price levels by restricting output below competitive level (withholding) for a sustained period (Financially by bidding high or physically by curtailing output). This can happen due to market concentration and transmission congestion. The effects of exercising market power are the transfer of wealth from customers to suppliers, and dead weight loss to society in terms of inefficient dispatch.

The electricity market is changing quite fast as are the relevant rules and regulations. Exercising market power always brings extra burden in terms of excess prices for the power consumers. The analysis of the electricity market should provide a tractable analysis in which the Cournot model is the most suitable for electricity market application. This presentation provides a review of various mathematical models and bidding methods for market power. It also examines the potential for improvement in detection and mitigation.

The modelling of market power and general metrics for detecting and monitoring market power are discussed. We are now going through the market monitoring units of individual markets such as, New Zealand, Australia, and a few Independent System Operators (ISO) in the US to know and understand their practices at this point of time. The knowledge in modelling will be used for the monitoring and mitigation of market power in different power markets. Simulation to be conducted for case studies and results will be presented.

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# What Makes a Good Polo Mallet? -Vibrational Characteristics Using a Cantilevered Visco-Elastic Beam Model

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The shafts of most traditional polo mallets are made from the trunks of the rattan cane plant. This plant is in serious decline due to habitat loss and pest damage. Some attempts have been made recently to replace the shaft of the traditional wooden mallet with human constructed materials. However, elite players comment that these modern mallets lack the “playability” and “feel” of the traditional mallets. Moreover, there is concern that use of modern composite materials could lead to more injury amongst the players’ horses as they are sometimes struck on the stroke wind-up or follow-through.

In this research, we make an initial enquiry into the vibrational characteristics of the traditional mallet shaft. This is done by modelling the shaft as a cantilevered visco-elastic beam and then representing this as a spring-damper-mass system. The oscillation frequency and decay parameters of this simplified system are compared with experimental data and this allows determination of the visco-elastic constant of the shaft without the mallet head. Good agreement with experimental data for oscillation frequency and decay is obtained when heads of different masses are then fixed to the same shaft.

It is hoped that a sound theoretical understanding of the shaft’s mechanical properties in determining its vibrational characteristics will lead to improved design of artificial shafts. This should also result in better player acceptance of these shafts and improved animal welfare.