Mathematics-in-Industry NZ 2015

M I
N Z

29 June - 3 July

Held at Massey University, Albany

Organised by the Centre for Mathematics in Industry, Massey University and KiwiNet

Director:	Professor Emeritus Graeme Wake FRSNZ, Massey University
Deputy Directors:	Dr Luke Fullard, Massey University A/Prof Winston Sweatman, Massey University
Administrators:	Dr Seumas McCroskery, Kiwi Innovation Network Lyn Shave, Massey University
Plenary Speaker:	Dr Maria Bruna, University of Oxford
Guest Speakers:	Hon. Ruth Richardson, Board Chair KiwiNet Dr Boris Beaumer, Chair, NZ Branch of ANZIAM Professor Shaun Hendy, FRSNZ, University of Auckland

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Welcome

The Centre for Mathematics in Industry, Massey University is delighted to welcome you to the first Mathematics-in-Industry for NZ - Study group 2015. This is a new national event established to add value to our community and our industry, as well as provide academic opportunities for all of us. I warmly acknowledge support from all our sponsors (named elsewhere in this booklet), but specially KiwiNet: an organization established to foster Industry links with Experts such as us. KiwiNet provided the administrative structure to make this event happen.

We have six exciting challenges put forward to the mathematical group from six of New Zealand's most dynamic and important companies: **Fonterra, Livestock Improvement Corp. Transpower, Eyedentify, Compac Sorting and Fisher & Paykel,** a pleasing mix of those that have taken part in similar events and those new to the study group concept. Thank you all.

We are very pleased to welcome many participants from around New Zealand and the world. One such guest is Dr Maria Bruna, from University of Oxford, England and we are delighted to have her here and look forward to her plenary talk, and contributions both formal and informal throughout the week ahead. The Study Group concept for Mathematics-in-Industry began in Oxford in the 1960s, while I was in fact there!! It has now spread around the world with tremendous success.

It is a great honor to also welcome Hon. Ruth Richardson, Chair of the KiwiNet Board, who graciously accepted the invitation to open MINZ 2015. We also look forward to the invited talk by Professor Shaun Hendy, University of Auckland.

Enjoy and happy challenge solving

Professor Emeritus Graeme Wake
Director, MINZ
June 2015

Maps

Held in the Atrium at Massey University, Albany 29 June – 3 July, 2015.

Building 7 on the Map. Free parking is Student parking areas (SP)

Challenges

Challenge 1: Eyedentify

NZ retailers lose over $2M per day from retail theft. The challenge is embodied in the question: Who is most likely to offend in my store now?

Challenge 2: Fonterra

Can we estimate the impact of various factors on the amount of foreign objects removed by the current processes in a moving stream of milk powder?

Challenge 3: Compac Sorting

The challenge is to create a calibration transform that will convert the output of different spectroscopic systems to a standardized form (space).

Challenge 4: Fisher & Paykel

Can a solution be found to obtain accurate end point to eliminate false cut offs caused by bunched cloths for a new clothes dryer product in development.

Challenge 5: Transpower

What are the causes of time error creeping positive while operating in Frequency Keeping Control mode and how might the time error creep be mitigated?

Challenge 6: Livestock Improvement Corp

Extracting data out of Milk - Generating Greater Value from Herd Test Data

MINZ- Study Group Agenda

Monday 29th June

Atrium Round room

8:00 - 8:45am	Greeting/Registration	
9:00 am – 10:20 am	**Welcome** – MINZ Director Graeme Wake	
	Opening Address	
	Hon. Ruth Richardson – Chair of KiwiNet Board	
	Dr Boris Beaumer, Chair, NZ Branch of ANZIAM	
10:20 – 10:50 am	**Morning Tea**	
10:50 – 11:00 am	What's coming up next – Graeme Wake	
	Industry presentations	
11:00 – 11:30 am	Fisher and Paykel Ltd	
11:30 – 12:00 pm	Fonterra Ltd	
12:00 – 12:30 pm	Eyedentify	
12:30 – 1:30 pm	**Lunch**	
1:30 – 2:00 pm	Compac Sorting	
2:00 – 2:30 pm	LIC	
2:30 – 3:00 pm	Transpower	
3:00 – 3:30 pm	**Afternoon Tea**	
	Initial project Meetings (Led by moderators and Industry Reps)	
3:30 – 3.40 pm	Group sorting	
3:40 – 5:00 pm	Breakout Room 1	Fisher and Paykel Ltd
	Breakout Room 2	Fonterra Ltd
	Breakout Room 3	Eyedentify
	Breakout Room 4	Compac Sorting
	Breakout Room 5	LIC
	Atrium Round room	Transpower
5.10 - 7:00 pm	Informal Reception- The Ferguson (On Campus Bar)	

Tuesday 30th June to Thursday 2nd July

Project working sessions as determined by the moderators and posted on noticeboards etc

Breakout Room 1	Fisher and Paykel Ltd Whiteware
Breakout Room 2	Fonterra Ltd
Breakout Room 3	Eyedentify
Breakout Room 4	Compac Sorting
Breakout Room 5	LIC
Atrium Round room	Transpower

Tuesday 30th June

5:15pm – 7pm	Student get-together @ The Ferguson (Pizza provided) Informal talk by Dr Maria Bruna & Prof. Graeme Wake

Wednesday 1st July

Atrium Round room

1:30 pm	"Get off the grass" Invited Talk Prof. Shaun Hendy, Univerity of Auckland
2.00 pm	"Industrial mathematics: the answer to a dilemma between academia and industry" Dr Maria Bruna, Oxford University Jr Research Fellow
3.00	**Afternoon Tea**
3.20 – 5.20 pm	Interim progress reports on the problem challenges: Moderators (20min each) Chaired by Professor Graeme Wake
6:00 pm	Informal Dinner – Massimo -Shop 246, Westfield Shopping Centre 219 Don McKinnon Drive Albany, North Shore City

Friday 3rd July

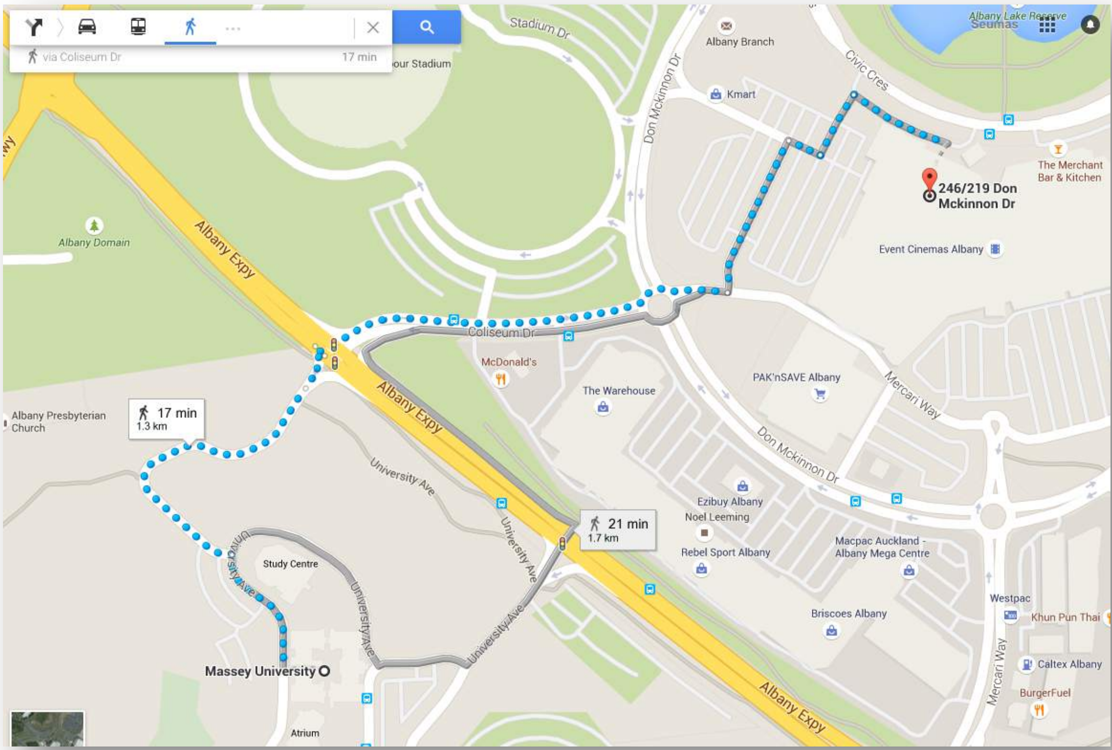
Project moderators reports on progress and recommendations followed by comments from Industrial representatives

9:00 – 9:10 am	Opening remarks by the Director Prof. Graeme Wake
9:10 – 9:30 am	Fisher and Paykel Ltd Whiteware
9:30 – 9:50 am	Fonterra Ltd
9:50 – 10:10 am	Eyedentify
10:10 – 10:50 am	**Morning Tea**
10:50 – 11:10 am	Compac Sorting
11:10 – 11:30 am	LIC
11:30 – 11:50 pm	Transpower
11:50 – 12:00 pm	Closing Remarks
12:00 – 1:00 pm	**Lunch**
1:30	Finish

Other Information

Informal Dinner

The informal MINZ dinner is being held at Massimo restaurant, which is located at Shop 246, Westfield Shopping Centre 219 Don McKinnon Drive Albany, North Shore City. It is an easy 15 min walk from the campus. There will be a shuttle bus available from the Massey University, which will depart from 5.30pm. It will leave from the front of the Atrium.



Food

The University campus has many eateries. As does the Westfield mall, 15 min walk away. Ferguson's Bar is on the Massey Campus, Building 2 on Map – see page 5.

Internet Access

Look to the white board for internet passwords.

Filming

90 seconds will be filming on Wednesday and Friday to document and advertise MINZ for years to come. Please if asked share why you came to MINZ.

Challenge Outlines

Challenge 1 – Fisher & Paykel

Moderators: Dr Luke Fullard, Massey University
A/Prof. Winston Sweatman, Massey University
Intern Moderator: Mr Matt Wilkins, Massey University

Industry Representative: James Smejlis

Background

Fisher & Paykel is developing a new dryer product that uses a thermistor in the exhaust duct of the dryer to detect the end of cycle. This is a well-used technology in the industry and the theory behind using a thermistor for end of cycle detection is well understood:

The ideal outlet temperature curve is the dark blue line in Fig 1, the temperature initially increases & then reaches a steady state. During steady state the Relative humidity (RH) of the air at the outlet is approx. 100% and the temperature does not increase as the air is absorbing as much moisture from clothes as possible. Towards the end of the cycle, as the clothes get close to completely dry, the RH drops and the outlet temp increases.

The point where the exhaust reaches < 100% RH is referred to a 'critical moisture point'. By monitoring this increase in temperature at the exhaust, the dryer can automatically stop the cycle at a preset level of dryness. If desired we can stop with a specific remaining moisture level in the clothes (between 15-2%) depending on customer needs.

Problem 1

In reality the temperature exhaust curve does not look smooth due to clothes bunching and tumbling.

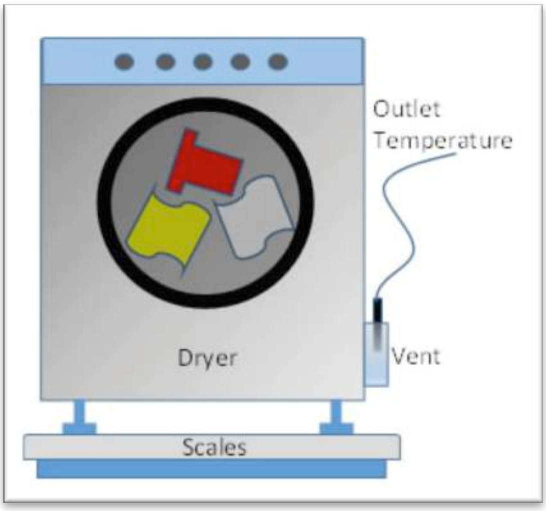
- The output temperature fluctuates around this ideal grey curve & often triggers an early stop as the outlet temp will exceed the limit and thus "false trigger" the end of cycle
- Temperatures can suddenly rise as the clothes bunch or tangle. The product will generally unbunch clothes when it reverses its tumbling direction, every 4min or 1 min depending on the pre-set cycle. Unbunching may not happen if the cycle stops early
- When this happens the customer is unhappy as there will be wet clothes still in the load

Goal

Suggest some solution to filter the data to get a more accurate end point & stop false triggers. Minimize the delay due to filtering as this may over dry the clothes.

Drier Testing

1. Select a clothes load of known "Bone-dry" weight.
2. Wash this load, spin dry then put clothes in Dryer
3. Start Dryer and record:
    a. Mass of Dryer + Clothes
    b. Temperature of Outlet Air
    c. Electrical Energy consumed
    d. Lapsed Time
4. After the clothes reach 102% of their "Bone-dry" mass, stop test.



Notes

We know that due to the physics of the system there is a maximum limit on the rate of moisture extraction of the system, but we don't put this to good use.
We have 5 end points defined for end of cycle from damp dry, extra dry, customers value this depending on what they clothes type is, i.e. damp shirts are easier to iron or may prefer extra dry towels.
We have test output data for a variety of load sizes and load types to analyse that illustrate this problem. The curve can look very different for different load types and sizes, see Fig 2 To generate our current end temperature limits we post process exhaust temperature data and apply a polynomial curve to the raw data. We don't do any filtering in real-time in the product.

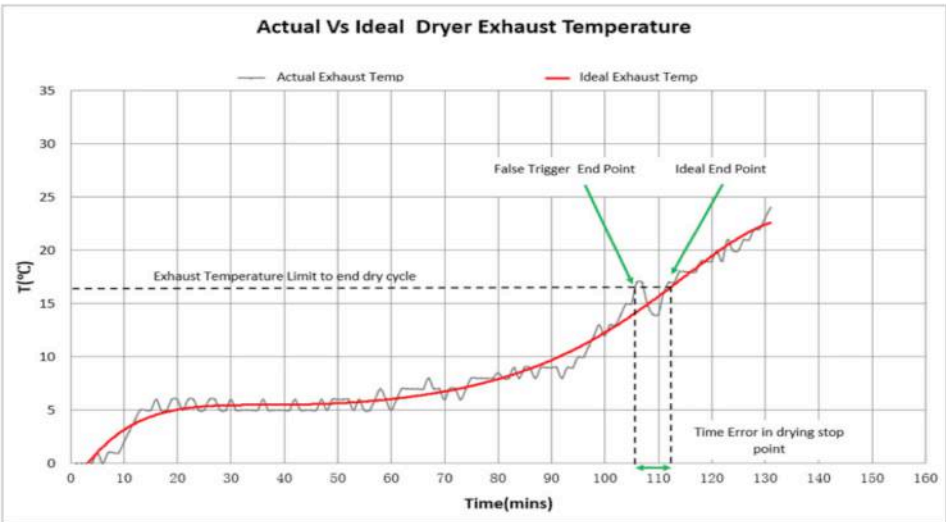


Figure 2. Ideal & Desired Exhaust Thermistor Curve

Background

To create end point limits for a new dryer product we do extensive empirical testing (see insert above) of each load type (delicate, heavy, cotton etc) and load size (1kg, 3kg, 6kg), 240+ tests, to generate a range of exhaust temperature output curves. We then compare the temperature output curves to the actual weight of the clothes as they are drying. We know the dry weight of the clothes and the wet weight at the start of the cycle.

As we can measure the change in weight (moisture removal) and the temperature output we can accurately measure during testing the exact moisture removed from the clothes. From this data we generate a limit curve that will stop the drying cycle at a specific moisture level by relating moisture remaining to output temperature. For delicate clothes of varying weights we have generated 5 curves that relate to moisture removal to temperature (sensitive data). We have mathematical simulation models for vented dryer products but these don't take account in any way for varying load types

Extension Problem

In our recent product cycle this resulted in approx. 6 months of testing to generate enough data to develop these curves, A curve is required for each load type and size
We also repeat the testing on several machines to understand machine to machine variation
After completing one of round of testing we needed to make a modification to the airflow of the product, which resulted in repeating this same testing as the increase in airflow affected the temperature curves significantly.
Back in the 1980s when we designed our last automatic dryer went through this same process!
The reason we do this extensive testing is we don't understand the fundamental relationship between the dryer design factors, e.g. heating power, drum size, airflow, heat loss, clothes moisture transfer and how that affects temperature output.
Goal

Using existing collected data to understand the fundamental design factors and their effect on temperature output. So that, in the future, we can reduce the amount of testing required to just a few key test scenarios and then be able to generate all required curves for all load types and sizes.

Challenge 2 – Fonterra

Moderators: Prof. Jim Denier, University of Auckland
Dr Haydn Cooper

Intern Moderator: Dr Amjad Ali, Massey University

Industry Representatives: Joanne Simpson
Steve Scales

Background

Fonterra Co-operative Group is the world's larger exporter of dairy products, owned by around 10,500 New Zealand dairy farmers and a leading multinational dairy company. The Fonterra Group's global supply chain stretches from Fonterra's shareholders' farms in New Zealand through to customers and consumers in more than 100 countries. Collecting around 15 billion litres of New Zealand milk each year along with around 6.5 billion litres sourced globally, Fonterra manufactures and markets over 2 million tonnes of product annually. This makes the Fonterra Group the world's leader in large-scale milk procurement, processing and management, with some of the world's best known dairy brands.

Fonterra continue to focus on our quality and food safety infrastructure, ensuring that we identify and remain ahead of emerging food safety risks. One such risk is eliminating the presence of any metal fragments that may be produced during manufacturing in our final products. Many critical control points have already been implemented to do this, including passing product through sifters and passing all product past magnets.

Problem

Can we estimate the impact of various factors on the amount of metal picked up by magnets in a moving stream of milk powder?
Factors that will influence the ability of the magnets to work include:

- flow rates and profile of the powder;
- pipeline orientation;
- the magnet itself - strength, design (spherical or bar), distance from the powder, spatial magnetic field and permeability;
- how magnetised the material is (most equipment used in processing is 304 or 316 Stainless Steel);
- the distribution of the metal fragments within the powder flow (including their size and orientation); and
- how often the magnets are inspected and cleaned.

From the workshop we would like a model to be produced, taking into account a number of the above factors, that will provide us with an estimate of the amount (or likelihood) of metal being detected by the magnets and the limitations of this detection method. Specific questions we would like to explore are:

- How efficient are magnets for detecting metal? (e.g. 10% of all metal contamination in the size range 0.5-1mm is removed by the magnets, or is it 50%?)
- What is the probability of detecting metal of different sizes?
- How do we express the success of magnets at removing metal?
- How often should the magnets be checked? If we have a piece of metal on the magnet, what is the likelihood that it will be "pushed-off" by another piece?
- Are two magnets better than one?

We have some information available in regards to flow rates and volumes, current magnet strengths and placements and pipeline orientation. However, we are happy for the Study Group to address this problem from a "clean slate" prospective and provide recommendations.

Challenge 3 – Eyedentify

Moderators:	Dr Barry McDonald, Massey University
	Dr Golbon Zakeru, University of Auckland
Intern Moderator:	Ms Lisa Hall, University of Canterbury
Industry Representatives:	Phil Thomson
	J'aime Laurenson

Background

The true cost of crime to society is staggering. In NZ, retailers lose over $2M per day from retail theft. But retail crime is a global problem that affects all retailers and law enforcement.

Eyedentify works with retailers and Police, connecting people with information to prevent crime. By providing a cloud-based software platform that simplifies the crime reporting process, Eyedentify aggregates information across all retailers, providing smart data to our customers to enable actionable intelligence and analytics to prevent crime.

Eyedentify is already operational and working with retailers and Police across New Zealand and is being trialled in Australia. Eyedentify works with major retailers including Countdown, Briscoes, and Rebel Sport in New Zealand, and is engaging in trials with Woolworths, Queensland Police, and the National Retail Association in Australia. Our customers have expressed a strong desire for the information/data collected to be turned into actionable intelligence.
While there have been some attempts in crime prediction previously, these have primarily been based on analysing Police data. In contrast, the Eyedentify dataset is mainly industry-driven – therefore we capture a huge amount of data that would not typically be included in the traditional Police dataset.

The problem faced by Eyedentify, retailers, and Police, is if this significant amount of previously unknown data is collected, how can it be turned into meaningful information and used to prevent crime?

In order to deliver this insight to our customers, we want to build an algorithm that will take a series of data points (including both Eyedentify data and some external data) as inputs and provide a real-time, customised list of the most likely offenders and their estimated likelihood of offending. Our proposed challenge is to apply mathematics and statistics to build such an algorithm, creating a real-time high risk offender rating. This would likely be based on a combination of weighted variables that factor to the unique characteristics of each of our user types, giving stores up to date information on which offenders are most likely to commit an offence in their store at that given time.

The outcome is embodied in the question:
WHO IS MOST LIKELY TO OFFEND IN MY STORE NOW?

CHALLENGE OVERVIEW

This question can be broken into three core components. Each of these components will have their own hypotheses that need to be tested by focusing on a variety of data points. These components are summarised in below:

1. Who is most likely…
   This component requires a focus on Offender behaviour, including their incident history, preferences for particular products, vehicle links, geographic areas of operation, and associations with others.

   It is important to note that although we capture personal attributes of a person (e.g. name, gender, ethnicity), these attributes will not be used as inputs into the algorithm. The behaviour-based focus of the algorithm will ensure that the insights are not discriminatory in any way (reducing common racial profiling).

2. In my store…
   This component ensures that the list of most likely offenders is tailored to a particular store. Therefore the focus will be on building a store profile to understand both its susceptibility to retail crime, as well as its likelihood of being a target.

   This will require analysing factors such as store incident history, location (e.g. proximity to other high-theft stores, proximity to motorway on-ramps, etc.), and product types.

3. Now
   This component embodies the real-time requirement for the algorithm. It involves analysing incident patterns based on time of day, day of the week, seasonal patterns and weather, and real-time information such as an offender's vehicle being in the area (through use of Licence Plate Recognition).

Note that there is some overlap between the three components. For example, a 'Hot Product' can be linked to all three components – i.e. offenders with an apparent preference for those products, stores that sell that type of product, and seasonal trends for that product type.

How is our solution innovative or different?

While there have been some attempts in crime prediction previously, these have primarily been based on analysing Police data. In contrast, the Eyedentify dataset is mainly industry-driven – therefore we capture a huge amount of data that would not typically be included in the traditional Police dataset. In addition to the unique nature of our dataset, the industry focus of our platform represents an opportunity to increase collaboration across the community to help solve what is a community problem.

Challenge 4 – Compac Sorting Limited

Moderators: Dr Boris Baeumer, University of Otago
Dr Steve Taylor, University of Auckland
Intern Moderator: Mr Ruanui Nicholson, University of Auckland

Industry Representatives: Scott Rusby
Scott Walbran
Jamie Heather
Dr Kate O'Byrne

Background

In this project we aim to create a calibration transform that will convert the output of different spectroscopic systems to a standardized form (space). This means that signals from different spectroscopes, probing the same object will be transformed to approximately the same value in the standardized space.

Each system is made up of a 256 diode spectrometer coupled with a unique opto-mechanical system consisting of various mirrors, lenses and light sources. Subtle variations in each system result in each system "seeing" the same thing slightly differently, hence producing different signal for the same object.

Note that variations in signals between different spectroscopes may originate from both electro-optical differences between the devices as well as variations in pose of the object under inspection. As each object is probed multiple times in different (semi-random) positions, the same spectrometer may produce a different set of signals for different acquisitions of the same object.

For this project large sample sets from multiple real world systems looking at the same objects will be provided.

Challenge 5 – Livestock Improvement Corp.

Moderators: Dr Howards Edwards, Massey University
Dr Cathy Hassell-Sweatman, AUT

Intern Moderator: Ms Karen McCulluch, Massey University

Industry Representative: Vladimir Obolonkin

Background

Livestock Improvement Corporation is a leading New Zealand Agritechnology company driving farm productivity and profitability improvements through its commitment to research and innovation. As a farmer owned co-operative, it's our vision to improve the prosperity and productivity of our farmers. LICs goal is to empower farmers with the genetics and information needed to produce superior livestock, information to improve livestock performance, and the hardware and systems that will improve on farm productivity and decision making.

LIC is the biggest provider of *Herd Testing* (HT) in New Zealand. We conduct the service for 72% of all New Zealand dairy farmers. Herd testing is the process by which dairy farmers estimate the productive output of individual cows in their herds. LIC's staff visit each farm 2-4 times a year to collect milk samples and deliver them to LIC laboratories. Well over 20 million individual milk samples, collected from approximately 3.5 million cows, are analysed on LIC's MilkoScan™ FTIR milk analysers every year. The subsequent data set includes the main production trait measurements like milk yield, fat, protein and lactose content, as well as somatic cell count (SCC) and some corresponding metadata.

The primary purpose for herd testing is to provide dairy farmers with information they require to make culling and replacement stock selection decisions. The HT data also contributes to the 'industry good' *National Animal Evaluation* system for dairy sire evaluation, developed and operated by LIC on behalf of New Zealand dairy farmers. LIC on the other hand uses the data for the analysis of the dairy cow population in order to assist farmers with on farm selection decisions, as well as the evaluation of LIC's own sires in its sire proving scheme. LIC also use the HT data in wide range of R&D projects in the fields of genomics, farm management and farm automation.

LIC considers itself an heir of the very first herd test service provider in NZ and recently celebrated its 100–year anniversary of this core service. About a billion raw HT records collected over the last 50+ years are stored in LIC's databases waiting for keen researchers.

In essence the challenge is developing a methodology for sensible multivariate analyses of the raw HT data. Specifically we see the following three areas for improvement:

- *Data Quality Control*

  We need to learn how to differentiate "technical" outliers from "biological" ones. Delineation of these outliers will reduce data loss in our resulting analysis and enrich our data with biologically important variations, thus allowing more specific analytical methods. This is our primary reason for promoting this challenge
- *Analytical Process Control*

  Current methods to account for outliers are limited to removal using statistically derived cut-offs. We require a method to detect and analyse these outliers in real time, which determines the cause of each outlier and accounts for it appropriately.
- *New 'Big Data' Analytics*

  We want to uncover the potential of using these massive data flows to develop new analytical methods to uncover undetected variation and lift the power of our selection models.

We have data as described above and access to serious computational facilities. LIC can also provide experts in the field of herd testing and animal breeding who understand the underlying business need. These experienced applied scientists and business managers that believe in power of science are available to clarify the problem.

Challenge 6 – Transpower

Moderators:	Dr Gerrard Liddell, University of Otago
	Dr Richard Brown, Massey University
Inten Moderator	Dr Stefanie Hittmeyer, University of Auckland
Industry Representatives:	Nabil Adam

TRANSPOWER

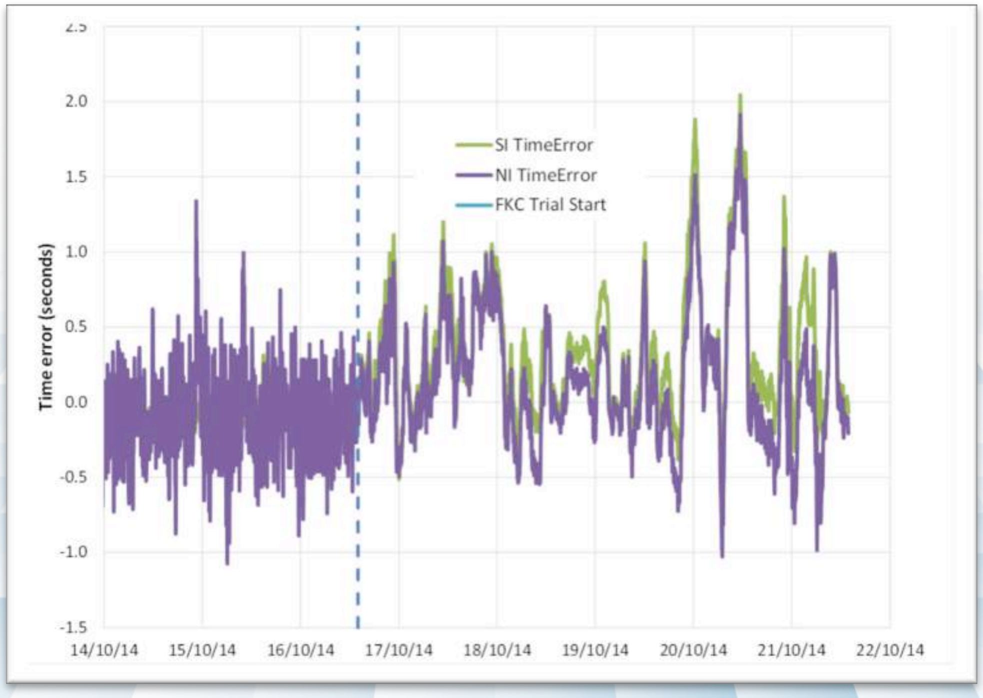
Background

Transpower is New Zealand's electricity system operator. One of our functions is to dispatch generation to meet load. Any imbalance between load and generation causes a variation in the system frequency away from its nominal 50 Hz. Frequency deviations from 50 Hz are integrated into a measure called 'time error'. Time error is in effect the amount in seconds that an electric clock connected to the system would drift.

The system operator is mandated to manage frequency and time error within set limitations.

When Transpower commissioned Pole 3, the new inter-island HVDC link, in 2014 it upgraded the control systems and introduced a Frequency Keeping Control (FKC) mode of operation, which linked the two islands' frequency. However, turning on this controller had some unexpected impact on the pattern of time error drift, presenting new challenges for the system co-ordinators to manage it.

With FKC in operation the time error has a seemingly randomly occurring positive bias. The time error will frequently ramp up at a significant rate, as illustrated below (NI = North Island, SI = South Island):



This rapid ramp in time error prompts a reset by the system co-ordinators to take corrective action with extra dispatches, which are both time consuming and costly. The time error ramp up happens seemingly randomly, exhibited some days more than others, and the times in which it occurs do not have an obvious association to a particular time of day, load pattern or generation mix. We seek a better understanding of the dynamics of what causes this and how it can be mitigated.

The FKC control system balances the frequency of the two islands, and does not have any control related to time error. The issue observed with time error may be an interaction between the FKC control system and other phenomena on the power system. It may be the interaction with certain loads, the pattern of load changes throughout the day, certain generation, something inherent in the FKC control system, a combination of all or something different entirely.

Transpower is submitting this challenge to the Mathematics in Industry New Zealand event to answer this question:

What are the causes of time error creeping positive while operating in Frequency Keeping Control mode and how might the time error creep be mitigated?
To assist in answering this question we will provide relevant data (lots of it!), control system schemas, and an expert in the subject.

Attendees

As at 13 June 2015

Name		Job Position	Organisation
Adam	Nabil		Transpower NZ Ltd
Ali	Amjad	Lecturer	Massey University
Ardekani	Iman	Student	University of Auckland
Babylon	Andrea	PhD student	Massey University, Albany
Baeumer	Boris	Senior Lecturer	University of Otago
Begg	Ronald	Researcher	Researcher
Behzadi	Golnar	PhD Student	University of Auckland
Bilton	Penelope	PhD student	Massey University
Brown	Richard	Lecturer	Massey University, Palmerston North
Bruna	Maria	Research Fellow	Oxford University
Cater	John	Senior Lecturer	University of Auckland
Cheon	Pascal	Applied Maths Hons Student	University of Auckland
Chiu	Tsz Lun	Student	Auckland University of Technology
Choi	Ho Chang	Student	Univerity of Canterbury
Chopovda	Valerie	Postgraduate student	Massey University
Choudhary	Renu	Lecturer	Auckland University of Technology
Chung	Hyuck	Lecturer	Auckland University of Technology
Cooper	Haydn	Data Scientist	
Creaser	Jennifer	Research Fellow	University of Auckland
Denier	Jim	Senior Lecturer	University of Auckland
Deylami	Hanif Mohaddes	Professor	Unitec Institute of Technology
Dillon	Owen	PhD Student	The University of Auckland
Do	Tan	Maths PhD student	The University of Auckland
Downward	Tony	Lecturer	The University of Auckland
Edwards	Howard	Senior Lecturer	Massey University
Ferede	Tilahun	PhD Student	Hawassa University

Fullard	Luke	Lecturer	Massey University
Gong	Jianhua	Senior Lecturer	United Arab Emirates University
Gravatt	Michael	PhD Candidate	The University of Auckland
Gul	Saima	Student	Massey University
Gulley	Anton	PhD student	University of Auckland
Hall	Lisa	Masters student	University of Canterbury
Harwood	Kieran	Student	Auckland University of Technology
Hassell-Sweatman	Catherine	Research Fellow	Massey University and Liggins Institute
Heather	Jamie		Compac
Hendy	Toby	Student	University of Canterbury
Hermez	Laith	Product Development Engineer	Fisher and Paykel Healthcare
Hiscott	Gordon	PhD student	University of Otago
Hittmeyer	Stefanie	Research Fellow	University of Auckland
Irani	Amir	PhD Student	Massey University
Jing	Qi	Student	Auckland University of Technology
Jorgensen	Murray	Consultant	Consulting Statistician and Mathematician
Kent	Stephen		Fisher&Paykel
Kim	Jeong-Hoon	Professor	Yonsei University
King	Steve	Westlake Boys High School	Secondary School Maths Teacher
Kuang	Jie	Student	Univerity of Canterbury
Kueh	Celia	Postdoctoral Researcher	Massey University
Kuhra	Khadija Tul	Student	
Lau	June	Student	University of Auckland
Laurenson	J'aime		Eyedentify
Lee	Tet Chuan	Doctoral Candidate (Engineering Science)	University of Auckland
Liddell	Gerrard	Lecturer	University of Otago
Lin	Catherine	Mathematics Teacher	Diocesan School for Girls

Liu	Xudong	Student	Auckland University of Technology
Lo	Andy Chun Yip	Student	University of Auckland
Marsanasco	Ana	Lecturer	Auckland University of Technology
McCroskery	Seumas	Innovation Manager	KiwiNet
McCulloch	Karen	Student	Massey University
McDonald	Barry	Senior Lecturer Math and Stats	Massey University
McMahon	Liam	PhD Student	University of Waikato
Nicholson	Ruanui	PhD student	University of Auckland
Oak	Devendra	Student	Auckland University of Technology
O'Brien	Lynette	Student	Massey University
O'Byrne	Dr Kate		Compac
Obolonkin	Vladimir		Livestock Improvement Corp
Parshotam	Aroon	Research Fellow	The University of Waikato
Pawley	Matthew	Lecturer	Massey University
Pritchard	Geoffrey	Senior Lecturer	University of Auckland
Promrak	Jairaj	Student	Mahidol University
Rohl	Elliot	Student	Auckland University of Technology
Rusby	Scott		Compac
Sakhaee	Neda	PhD Student	University of Auckland
Scales	Steve		Fonterra
Sharma	Rajinder	Lecturer	College of Applied Sciences , Sohar, Oman
Sharp	Annette Sharp	PhD Student	Auckland University of Technology
Shen	Amy	Mathematics teacher	Massey High School
Simpson	Joanne		Fonterra
Sweatman	Winston	Associate Professor	Massey University
Taboada	Karla	Information scientist	Inland Revenue
Taylor	Steve	Senior Lecturer	University of Auckland
Thomson	Phil		Eyedentify
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Wilkins	Matt	Student	IFS Massey
Williams	Zoe	Student	University of Canterbury
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