

# MASSEY UNIVERSITY

## 2011 ANNUAL REPORT TO THE UNIVERSITY

### RESEARCH CENTRE: CENTRE FOR MATHEMATICS-IN -INDUSTRY

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<http://www.mathsinindustry.co.nz>

(A dedicated website)



**The main contributors in 2011 ...**



**Graeme Wake**



**Robert McKibbin**



**Winston Sweatman**



**Barry McDonald**



**Howard Edwards**

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# 1. Objectives of the Research Centre

## Mission Statement

The Centre will develop and apply modern industrial mathematics concepts and techniques, emphasise the interdisciplinary nature of such applications, provide support for the mathematical modelling needs of the College of Sciences and the University, and promote the use of mathematical techniques through research and collaboration with industry and the community at large.

## **Comments**

The Centre for Mathematics in Industry (CMI) was formed in September 2002. The main focus for the first 4 years was the preparation for hosting ANZIAM Mathematics-in-Industry Study Groups (MISG's) which were held in Auckland in 2004, 2005 and 2006. Professor Graeme Wake was appointed as a (part-time) Adjunct Professor of Industrial Mathematics from March 2003, and was Director of the MISG's during 2004–2006. After this the MISG's returned to Australia (University of Wollongong) 2007–2009, and RMIT University 2010–2012. These events encompass applications of mathematics, statistics and decision science to the physical, engineering and biological sciences, bio-engineering and finance. The emphasis is on devising practical models and obtaining useful solutions for industrial problems using modern quantitative methods. Computational and informatics techniques provide a solid basis for the methods used. The availability of local expertise and new powerful computing facilities at Albany are distinct advantages. The meetings are self-funded, mainly through industry fees for problem presentation, though substantial support in 2004–2006 also came from NZ's Foundation of Research Science and Technology (FRST).

The activities of the CMI and MISG fit nicely with Massey University's intentions to link with NZ industry, to provide access by the industrial community to sophisticated quantitative expertise, techniques and problem-solving, and the CMI also fits with NZ's goal and efforts to make a transition to a knowledge-based economy. There is also "spin-off" to research activities which have an industrial focus within other disciplines, purely from the links the CMI would make with industrial organisations. A list of activities is given at the Centre's webpages: <http://www.mathsinindustry.co.nz>. A crucial aspect of running the (ANZIAM) MISG is for each location to use the opportunity of planting a long-lasting local footprint which continues after the MISG moves elsewhere. This was established here in 2006, with FRST-funded one-off, one-to-one, in-house, industry-specific workshops under the Foundation's TIF-expert scheme. This scheme was launched in late 2006 and began to gain traction in 2007–2008. This is ongoing as a significant activity of the CMI albeit it now client-funded. More on this will be found below.

## 2. Research Outputs – See Appendix 2

## 3. Activities and Achievements

During 2011 there were several major projects undertaken as described below..

- **Mathematics-in-Industry Study Group: ANZIAM**

Three MISGs (2010–2012) have now been held at RMIT in Melbourne, with substantial involvement in planning from Massey University and NZ. Five members of the CMI attended in 2011. Professor Wake, Drs Sweatman and McDonald all were moderators for problems from the NZ Steel industry (Wake, Sweatman) and from Transpower Ltd (McDonald). Two PhD

students attended (Syaza Abdul Latif, Albany; and Luke Fullard, Palmerston North) as did 2011 RSNZ Teacher Fellow (Kerri Spooner). **See photo below for the NZ Steel working group.**



In 2013 MISG will move again and will be organised and directed from QUT University, Brisbane; the CMI has been asked to assist with the obtaining of problems from NZ (three of the four industry problems in 2011 were from NZ). In addition, Professor Wake served as a member of the MISG Science Advisory Board in 2011–12.

- **Thailand/Malaysian/Brazil developments.**

Arising out of the visits from 2004 onwards to Thailand by Professors McKibbin and Wake and to Malaysia in 2009 by Professor Wake, these two members visited in 2011 as follows:

Thailand – Wake was an invited speaker at the Royal Jubilee Congress at Pattaya in April;

- McKibbin was invited to KMITL in Bangkok to run a trial workshop in Industrial Mathematics.

N.B. Another conference focussing on Industrial Mathematics will be held in Pattaya in July 2012 and Professor Wake is to be a lead invited speaker.

Malaysia – Wake was appointed as a Visiting Professor at the Universiti Teknologi Malaysia, Johor Bahru, and in April was a lead moderator and speaker at the First Malaysian Mathematics-in-Industry Study Group. Arising out of this initiative, it has just (February 2012) been announced that "the UTM Centre has been established with hopeful official opening next October and a budget of ½ million pounds from Oxford."

Brazil – Wake was an invited speaker and panellist at the "International Conference on Mathematical Modelling in Industry" in Sao Paulo, Brazil in December. This was a precursor to a national launch of a Brazilian-wide Initiative in Industrial Mathematics, Professor Wake is to be involved in this.

- **Contracts**

Three major external contracts were undertaken through the Centre in 2011, in addition to a few very small ones. The major ones completed were:

- (a) **Environment Protection Agency** Enquiry into the proposed site of the Wiri Men's Prison in South Auckland, adjacent to the existing Wiri Oil Storage Terminal. It

- involved formulating and assessing the safety risk involved and the giving of (oral and written) evidence as to the safety aspects. The prison is going ahead with the substantial protection mechanisms we recommended. (Personnel: Wake, Dr Howards Edwards of IIMS, and an externally contracted technical writer. Funding \$40,000.)
- (b) **Fonterra Cooperative Group Limited.** Development of mathematical models to describe the passage of powder bins/hoppers. This was a six-month project which finished in December. (Personnel: Wake; Professor Clive Davies, Palmerston North; and two PhD research students as funded research assistants: Arno Leist from IIMS Albany, and Luke Fullard from IFS, PN. Funding \$60,000).
- (c) **Dennis King Law, Solicitors, New Plymouth.** Evaluation and preparation of expert witness material relating to safety procedures within an Engineering Contracting Company. (Personnel: Dr Howard Edwards, IIMS Albany; Wake. Funding \$2,000.).
- **RSNZ Secondary School Teachers' Fellow**  
We were delighted to accept the placement of Ms Kerri Spooner (a Mathematics Teacher from nearby Long Bay College) as a RSNZ Teachers Fellow in the Centre for July–December 2011. Her project was to investigate, and participate in, activities of, or those linked with, the Centre. The local contact with the North Shore Schools is especially welcome. She was attached to the contracts in (b), (c) above.



Mathematics teacher Kerri Spooner decodes a mathematical formula on a painting by mathematician-artist Peter James Smith, at Massey's Institute of Information and Mathematical Sciences where she has been a Royal Society of New Zealand Teachers' Fellow.

#### 4. The Future – Opportunities, Risks and Directions

- The Centre is an active participant in the ICT Auckland cluster group and the Director gave occasional promotional talks at their monthly meetings. We play a full role in the regular meetings of the Innovation Team based at the e-Centre. Long-term, the Centre could have a more permanent presence there but this is not feasible at present.

#### 5. Work in progress

- The need for a marketing plan is still clear, so as to reach out further to Industry. We have a dedicated website <http://www.mathsinindustry.co.nz> and have work in hand to produce further publicity material.
- This might eventually lead to the Centre developing into a stand-alone Centre within the College of Sciences. But this is still to be realised.

- Members of the Centre have supported the submission of a theme in the area of Industrial Mathematics and Statistics to the national group that is evaluating the specifics of a new Centre of Research of Research Excellence from 2014. At the time of writing indications are that this may succeed. Professor McKibbin led the way on this.

## 6. Staffing

- The Centre, being a “Level One” Centre, has no dedicated staffing *per se*; the current part-time Director has put the work of the CMI as a primary objective for his activity.
- The following Institute staff members clearly have a strong interest in the activities of the Centre and have made major contributions to the Centre in 2011. These contributions are mentioned elsewhere in this report. This is strongly acknowledged:  
 Professor Robert McKibbin, Professor of Applied Mathematics  
 Dr Winston Sweatman, Senior Lecturer in Mathematics  
 Dr Barry McDonald, Senior Lecturer in Statistics  
 Dr Howard Edwards, Senior Lecturer in Statistics.
- Professor Graeme Wake ceases his paid employment with Massey University on 30 June 2012 and therefore this is his final annual report. He then becomes an Emeritus Professor of Massey University and a full-time Research Company Director. A new Director should be appointed from 1 July 2012. The outgoing Director thanks the Institute, Research Management Services, and University at large, for their support

## 7. Financial

- As at 31 December 2011, the Centre account PR 40313 had a credit balance of approximately \$829.
- External contracts mentioned above grossed approximately \$102,000 in 2011. This money was distributed to research providers and used for legitimate activities related to the work of the University, mostly Professional Time and Overheads, and Conference Travel.

## 8. Miscellaneous

- Professor Wake was external examiner for a PhD thesis from RMIT University, Melbourne (on the feasibility of farming of kangaroos) .
- Dr Winston Sweatman was external examiner for two PhD’s related to CMI areas; at the Universities of Canterbury (Mechanical Engineering: Medical Engineering Modelling) and Auckland (Statistics: Wind Power Modelling).
- Dr Barry McDonald was an Examiner for the PhD thesis: Gang Xie “Further developments of two point process models for fine scale time series”. Jan–Feb 2011.

*G. Wake*

*Anthony C Norris*

.....  
**Professor Graeme Wake FRSNZ DSc**

.....  
**Professor Tony Norris**

*Director, Centre for Mathematics in Industry*

*Head of IIMS*

20 March 2012



## Appendix 1 – Research Objectives

### Aims

The Centre for Mathematics in Industry aims to

- provide an environment for the development and application of modern industrial mathematics concepts and techniques;
- become a recognized collaborative research and consulting centre for the mathematics needs of industry in the widest sense;
- encourage students to undertake postgraduate study in applied mathematics, mathematical modelling and industrial applications;
- become a recognized key centre of expertise, and thereby attract post-graduate, post-doctoral and visiting researchers;
- facilitate regular industrial mathematics seminars, workshops, etc;
- develop a strong position with respect to funding applications, either in its own right or as a partner in collaborative research;
- develop its own research funding-based staff.

## Appendix 2: Research Outputs: Publications & Reports

- **Wake GC:**

### Publications

Subcharoen T, van Brunt B & **Wake GC** “Aysmmetric cell division in a size-structured growth model” Journal Differential and Integral Equations” Vol **24** (7-8) August 2011, pp787-799.

Derfel G, van\_Brunt B & **Wake GC** “A Cell Growth Model Revisited Journal Functional Differential Equations. Published by the University Centre of Judea and Samaria, Israel, Vol **18**, 2012.(in press)

Kiataramakul C, **Wake GC**, Ben-Tal A & Lenbury, Y” Optimal Nutritional Intake for Fetal Growth” Mathematical Biosciences and Engineering, Vol **8(3)**, July, 2011. <http://hdl.handle.net/10179/2437>

van-Brunt B & **Wake GC**. "A Mellin Transform Solution to a Second Order Pantograph Equation with Linear Dispersion in a Cell Growth Model" 2011. The European J of Applied Mathematics. (2011), vol. 22, pp. 151–168.doi:10.1017/S0956792510000367.

**Wake GC**, Pleasants AB, Vickers MH, Sheppard AM, Gluckman PD. “The application of a model of glucose and insulin dynamics to explain an observed effect of leptin administration in reversal of developmental programming”. Mathematical Biosciences 229 (2011) 109–114.

**Wake GC**. Industrial Mathematics - on the Crest of a wave” IMAsia Newsletter, January 2011, Issue No. 1 pp 16-7: (Also translated into Korean).

**W.L. Sweatman, G.C. Wake**, H. Cooper (2011) “Using influence diagrams as a tool for decision making”, Proceedings of the 2010 Mathematics and Statistics in Industry Study Group, MISG-2010, ANZIAM Journal, 52, M147-M170.

<http://anziamj.austms.org.au/ojs/index.php/ANZIAMJ/article/view/3572>

Presentations at Conferences without Proceedings, Invited Lectures  
and other Seminars/Lectures/Talks (not mentioned elsewhere)

**Wake GC.** Modelling of optimal maternal nutrition for fetal growth, ANZIAM Conference Adelaide, January 2011.

**Wake GC** “Counting the Elements: Earth, Air, Water, Fire and Life”: Invited public Professorial lecture, May 2011.

**Wake GC.** “Calculus from the past and at a distance”, Royal Golden Jubilee Congress, Invited talk, Pattaya, Thailand, April 2011.

**Wake GC:** “You are what your mother ate” International Conference of Industrial and Applied Mathematics, Vancouver, Canada July 2011.

**Wake GC.** “Non-local Calculus: from the past and at a distance”, Invited seminar, Victoria University of Wellington, April 2011.

**Wake GC** “Mathematics in Medicine-a healthy start to life”, Invited talk to the NZMS Mathematics Colloquium, Auckland, December 2011 (ANZIAM Speaker).

• **McKibbin R:**

Publications

**McKibbin, R.**, Hale, N., Style, R.W. and Walters, N. Convection and heat transfer in layered sloping warm-water aquifers. *Journal of Porous Media*, Vol. 14, Part 4, pp. 329-343, 2011.

**McKibbin, R.**, Fowkes, N., Florio, B. and Horowitz, F.G. Geothermal data analysis and optimization (Proceedings of the 2010 Mathematics and Statistics in Industry Study Group, MISG 2010, held at RMIT, Melbourne, Australia, 27-31 January 2010), *The ANZIAM Journal (E)*, Vol. 52, pp. M1-M35, 2011.

Ali, A., **McKibbin, R. and Sweatman, W.L.** On simplified modelling of pollution transport in stratified groundwater aquifers. *Proceedings of the IIMS Postgraduate Conference 2011*, Massey University, Auckland, NZ.

Presentations at Conferences without Proceedings, Invited Lectures  
and other Seminars/Lectures/Talks

(Presenter is underlined)

**McKibbin, R.** Mathematical modelling of aerosol transport: Effect of dispersion coefficients on predicted ground deposits. IIMS Seminar, Albany, 18 May 2011.

**McKibbin, R.** What is industrial mathematics? (a) Thermodynamics of a chicken barn. (b) Simple mathematical modelling of a tsunami. Seminar, King Mongkut's University of Technology North Bangkok, Thailand, June 2011. (*Invited Lecture*)

Ali, A., **McKibbin, R. and Sweatman, W.L.** Simplified mathematical models for tracer transport in layered aquifer systems (*Poster presentation: Modelling pollution transport in stratified groundwater aquifers*). Presented at IUGG 2011, Symposium HW08: Tracer hydrology as a tool in heterogeneous systems. Melbourne, Australia, July 2011.

**McKibbin, R.** The role of dispersion in ashfall models. Presented at IUGG 2011, Symposium V09: Transport and deposition of pyroclasts in plumes. Melbourne, Australia, July 2011.



**McKibbin, R.** Mathematical modelling of volcanic eruption plumes. Presented at the 2011 NZ Mathematical Society Colloquium, Auckland, NZ, December 2011.

## **Sweatman WL:**

### Publications

**W.L. Sweatman, G.C. Wake, H. Cooper** (2011) “Using influence diagrams as a tool for decision making”, Proceedings of the 2010 Mathematics and Statistics in Industry Study Group, MISG-2010, ANZIAM Journal, 52, M147-M170.

<http://anziamj.austms.org.au/ojs/index.php/ANZIAMJ/article/view/3572>

**W.L. Sweatman, G.C. Wake, H. Cooper** (2011) “Influence diagrams to support decision making”, Equation-free summary, supplementary file to the Preface to the Proceedings of the Mathematics in Industry Study Group 2010, ANZIAM Journal, 52.

<http://anziamj.austms.org.au/ojs/index.php/ANZIAMJ/article/downloadSuppFile/3359/731>

G.C. Hocking, **W.L. Sweatman**, A.D. Fitt and C. Breward (2011) “Deformations during jet-stripping in the galvanizing process”, Journal of Engineering Mathematics 70:297–306. DOI 10.1007/s10665-010-9394-8

### Presentations at Conferences without Proceedings, and other Seminars/Lectures/Talks

**W.L. Sweatman**, H. Cooper, P. Kilby and **G.C. Wake** (2011) “Influence diagrams to aid decision making”, New Zealand Mathematical Society Colloquium 2011, University of Auckland, NZ, 6- 8 December, 2011 (poster presentation)

**W.L. Sweatman** (2011) “Dynamics of some few-body problems with symmetry”, New Zealand Mathematical Society Colloquium 2011, University of Auckland, NZ, Wednesday, 7 December, 2011

**W.L. Sweatman** (2011) “Symmetrical few-body systems and the collinear four-body problem”, Mini-symposium MS97: “Symmetric Few-body Dynamics”, ICIAM 2011 Applied Mathematics Conference, Vancouver, Canada, 18 July, 2011

**W.L. Sweatman** (2011) “Full ionisation in encounters between binary stars”, ICIAM 2011 Applied Mathematics Conference, Vancouver, Canada, 18-22 July, 2011 (poster presentation)

A. Ali, **R.McKibbin** and **W.L.Sweatman** (2011) “Simplified mathematical models for tracer transport in layered aquifer systems (*Poster presentation: Modelling pollution transport in stratified groundwater aquifers*)”, IUGG 2011 (International Union of Geodesy and Geophysics General Assembly), Symposium HW08: Tracer hydrology as a tool in heterogeneous systems, Melbourne, Australia, 4 July, 2011 (poster presentation)

**W.L. Sweatman** (2011) “Four-body systems with symmetrical configurations”, ANZIAM 2011 Applied Mathematics Conference, Glenelg, South Australia, Thursday, 3 February, 2011.

## **McDonald B:**

### Publication

Whiten, W., **McDonald, B. W.**, & Drovandi, C. (2011, September 11). Taxonomic analysis of marine phytoplankton. *ANZIAM Journal*, 52, M119-M146.

Presentation at Conference without Proceedings

**McDonald, B. W.** (2011, August 28). Correlated Winds and the Risk of Extreme Power Fluctuations. In *New Zealand Statistical Association Conference 2011* (pp. 25). University of Auckland: NZSA 2011 Conference Committee.

**Edwards, HP:**Publications

Summerhayes RJ, Morgan GG, **Edwards HP**, Lincoln D, Earnest A, Rahman B, Beard JR. Exposure to Trihalomethanes in Drinking Water and Small-for-gestational-age Births *Epidemiology* 23(1):15-22, 2012

Summerhayes RJ, Morgan GG, Lincoln D, **Edwards HP**, Earnest A, Rahman MB, Byleveld P, Cowie CT, Beard JR. Spatio-temporal variation in trihalomethanes in New South Wales. *Water Research* 45(17):5715-5726, Nov 2011.

**Appendix 3:****Research:****Wake, GC:**

- Continued as a Principal Investigator in the National Research Centre for Growth and Development, (a CoRE) based in the Liggins Institute, Auckland Medical School. Won a major contract 0.35 FTE for 2012-14.
- Continued as an Associate-Investigator in the Riddet (Food) CoRE. Minimal activity in 2011.
- Appointed as a Research Science Investigator in Epigen, an International Company (with hubs in Singapore (Head Office), Southampton and Auckland) dealing with Theoretical and Applied aspects of Developmental Epigenetics.

**McKibbin, R:**

- Period of sabbatical leave at Kanazawa University (29 January – 14 March 2011) working with Japanese collaborators on modelling dispersion caused by wind in forest canopies.
- Continued work (some in collaboration with PG students, other with international collaborators) on mathematical modelling of airborne particle and droplet transport, dispersive transport of pollutants in porous media (aquifers), thermal convection in porous media, volcanic eruption plumes.

**McDonald, B:**Workshop Moderation

6- 11 February 2011 Moderator for the problem “Allowing for ‘worst case’ wind farms correlations in delivering secure power system operations in New Zealand” presented by Transpower. (With Whiten, B. and Bedford, R)

Research grant collaboration

von Hurst, P., Conlon C., Coad J., Stonehouse W., Camargo C., Hollis B., McDonald B., Eyles D., Grant, C. "Vitamin D deficiency risk and respiratory/allergy diseases in NZ 1-4 year-olds" HRC Grant 11/655 for \$149,883 approved from 1 July 2011

#### Consultancy

Data Mining of Accident Data; - Preparation of Five Industry Related Reports of CU Claims Data. \$3,600.00. Undertaken for SCION, 1 Jan–31 April 2011. (Resulted in production of five unpublished reports by Hide S., Ashby L., McDonald, B.)

Other research collaborations

- With Professor S Finau *et al.* on "Health Literacy and Pacific Peoples"
- With P Watson on Maternal nutrition and infant outcome
- With A-Prof P Lineham *et al.* on organising committee for the New Zealand Church Life Survey

#### **Edwards, HP:**

- Associate Investigator in Epigen, based in the Liggins Institute, Auckland Medical School, 2011–2013.

### **Appendix 4: Post-Graduate Supervision**

#### **Wake, GC:**

Kiataramakul Chanakarn. Completed PhD in April 2011 at Mahidol University, Thailand. Located at Massey University 2010-11: funded through NRCGD. Fetal growth: Graduated July 2011.

- Abdul Latif, Nurul Syaza. Second-year PhD international student. Enrolment confirmed August 2011. "Biocontrol Modelling" in collaboration with Plant and Food Research Ltd.
- Wang, Leiyan: Master of Applied Statistics; Joint with **Dr Barry McDonald**. Funded through NRCGD. From July 2011. Fetal growth.
- Eraki, Manara. 700-level (160.783) Project in Applied Functional Analysis. Completed in November 2011. Grade B+.

#### **McKibbin, R:**

- Amjad Ali: Mathematical modelling of tracer transport in groundwater aquifers. Mathematics PhD student; funded by Pakistan HEC (with **Sweatman WL**). From January 2010.
- Andrea Babylon: Models for sedimentation in a reservoir. Honours Project student. From July 2011.

#### **McDonald, B:**

- PhD student Norazlina Ismail. (Rainfall modelling: Co-supervisor Paul Cowpertwait)
- Masterate student Mark Wohlers (on Sensory evaluation threshold models)
- Masterate student Leiyan Wang (with Professor Graeme Wake)