“A centre of excellence is, by definition, a place where second class people may perform first class work.”

Ernest Rutherford

“A truly popular lecture cannot teach, and a lecture that truly teaches cannot be popular.”

Michael Faraday

PART I: focus on the future
Research centres are the foundation of 21st century mathematical research:

- Newton, Fields, PIMS, MSRI, DIMACS, Max Planck, IMPA, ...
- They are our membership fee into the international community

Work towards KPIs through:

- International recognition
- National leadership
- Application-informed pure research
  - Alzheimer’s: Stanford & Florida Medical Schools
  - Photonic imaging data: Stefan Hell, 2014 Chem. Nobel
- Research-informed R&D
  - Chemistry, radiology, pharmacology

2016 activities: KPIs
Selected upcoming events:

- **December 2015:** Mathematical Physics (ANZAMP), Guttmann 70th (Osborne), KozWaves 2 (Meylan)
- **February June/July:** two months of focus on Symmetries (Willis) February Optimisation SPOM 6 (Borwein)
- **November:** Effective Visualisation (EViMS3) (Borwein)
- **December:** Number Theory (NTDU 4) (Hussain)
- **December:** 39th Australasian Conference on Combinatorial Mathematics and Combinatorial Computing (Kalinowski)
- **July 2017:** 7th World Fixed Point Conference (planning, funding)

Industry, community and business engagement activities:

- **2016 Various** n.u.m.e.r.i.c. events with teachers and/or students
- **April:** Newcastle Maths Educators (NMEC II) (IMSITE, Osborne)
- **July 2017:** AMSI Optimise — and a week for practitioners

**2016 activities: events**
Mathematical foundations
Intended grant submissions:

- **Discovery grants**
  - Wadim Zudilin (Analytic Number Theory)
  - Mumtaz Hussain (Analytic Number Theory)
  - Ali Eshragh (Statistical Optimisation)
  - Bishnu Lamichhane (Computational Fluid Dynamics)
  - Mike Meylan (Wave-induced Interstitial Ice Breakup)
  - Björn Rüffer (Non-smooth Control Theory)

- **DECRAs**
  - Mumtaz Hussain

- **Laureate professorships**
  - Jon Borwein, George Willis

- **Linkage grants**
  - Yuqing Lin X2 (in Health informatics, submitted Nov 12)

All are either highly computational or ‘experimental’

**2016 activities: grants**
Impact of CARMA on New Futures by 2020

EQUITY and SOCIAL JUSTICE

- CARMA’s n.u.m.e.r.i.c. group (Newcastle University Mathematical Sciences Education Research Initiatives Collective) is part of a deep tradition in the mathematical sciences at Newcastle of care and involvement in education at all levels.

- We are invested in this tradition and are excited about the prospects of working with AMSI/BHP Billiton to ensure that women are retained in mathematics and so able to pursue STEM careers.

- CARMA attempts to reawaken research inactive academic staff.

2020 impact
Impact of CARMA on New Futures by 2020

EXCELLENCE

• Scores of ‘5’ for applied mathematics (2 of the 3 given in total) in the 2010 and 2012 ERA are emblematic of the quality of research being done within and around CARMA
• Score of ‘4’ in Statistics in 2012

This is leading to increasing student numbers in our School

• 24 Vacation Scholars in maths and stats this summer
• 2015: 21 maths RHD students (up from 12 in 2009)
Impact of CARMA on New Futures by 2020

ENGAGEMENT

The quantity of seminars/workshops/research visitors of CARMA illustrates our claim that we are highly engaged. Many CARMA members pursue active outreach activities. Most events are streamed and recorded for external audiences.

In addition, the Director with others has written 42 articles for the Conversation (attracting 1.29 million readers) and 30 articles for the Huffington Post.

Six published books generated directly by CARMA activities

2020 impact
Impact of CARMA on New Futures by 2020

INNOVATION

Throughout the mathematics research community CARMA’s name is now synonymous with innovative uses of technology in research and with excellence in all our core areas.

MIDAS (Masters in Data Analytics and Science)
• a new Masters programme being planned

2020 impact
INTEGRITY

Especially with ECRs we make sure that appropriate professional conduct is discussed frequently

- as is the culture of research

We are highly engaged in the “Reproducible Computational Science” community

- Two fully-funded week-long workshops (2012, 2014) at the Institute for Computational and Experimental Research Mathematics ICERM (Brown University)

2020 impact
Impact of CARMA on New Futures by 2020

SUSTAINABILITY

Cyber-security, cryptography, reproducible computational science, informatics and education of a mathematically-enabled population underpin sustainable enterprises and all are CARMA research focuses

2020 impact
PART II: CARMA’s strengths
"A research policy does not consist of programs, but of hiring high-quality scientists. When you hire someone good, you've made your research policy for the next 20 years."

Chief CNRS advisor Vincent Courtillot

• CARMA members
  40 members, 10 student members, 9 external members

• CARMA research

• CARMA support

• CARMA visitors
  Over 100 international visitors

• CARMA events
  Over 750 events 2009-2015

• CARMA research groups

• CARMA workshops
  24 conferences and meetings, 11 short-course lecture series

• CARMA collaboration

• CARMA technical

• CARMA facilities
  Over 500 hours of ACE support per year

CARMA
Our past 12 months

- Four 2016 ARC Discovery Grants (of UoN’s 15)
  - Jon Borwein and Jeff Hogan, Murray Elder, Chris Kellett, Mirka Miller

- 2 Fellowships and one Distinguished Scholar (Jon Borwein)

- National distinguished teaching award (Peter Howley)

- Five RHD prizes and awards

- “Test of Time” award, Super Computing 2015 (David Bailey)

- Schools poster competition produced international winners

- Administrative Staff Award (FSCIT) (Juliane Turner)

Recent successes
- **Experimental mathematics**
  - Jon Borwein, Wadim Zudilin, Ohad Giladi, Paul Vrbik, James Wan
- **Discrete mathematics and graph theory**
  - Mirka Miller, Joe Ryan, Thomas Kalinowski, Judy-anne Osborn, Ali Eshragh, Richard Brent
- **MAFFIA (financial mathematics)**
  - Jon Borwein, David Bailey, Amir Salehipour, Ali Eshragh
- **n.u.m.e.r.i.c.**
  - Judy-anne Osborn, Peter Howley, Malcolm Roberts, Elena Prieto
- **Number theory**
  - Wadim Zudilin, Michael Coons, Jon Borwein, Richard Brent, Mumtaz Hussain
- **Applied functional analysis and optimisation**
  - Jon Borwein, Brailey Sims, Jeff Hogan, Bishnu Lamichhane, Mike Meylan
- **Symmetry Groups aka The Group Group**
  - George Willis, Murray Elder, Colin Reed, David Robertson
- **Control, Optimisation and Operations research**
  - Chris Kellett, Björn Rüffer, Masoud Talebian, Thomas Kalinowski, Jon Borwein, new professor

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**Research groups**
2013: **Blue Gene** 2,000 rack-day computation

2014: Mike Meylan in *Nature*

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**THE AUSTRALIAN BUSINESS REVIEW**

Supercomputer cracks 'impossible' calculation

Jennifer Foreshew
Technology Reporter
Sydney

HUMAN ingenuity and awesome computing power have combined to deliver an algorithm that can identify potential weaknesses in computer system hardware and software.

The BlueGene/P supercomputer system, used for IBM's benchmarking tests and quality control, was used by experts to conquer a calculation thought to be unachievable.

"It was believed to be impossible until not very long ago that we would ever know the billionth decimal digit of pi," said Newcastle University laureate professor Jon Borwein.

Professor Borwein, a world-famous mathematical expert, said the computer time spent on the work was equivalent to the time that went into creating a computer-generated movie such as Toy Story 3. "My estimate is that it may be by a factor of three the largest single computation done for any mathematical object ever," he said.

The work would have taken about 1500 years on a single CPU, but it took just a few months of super-computing time. The project was done in conjunction with the Lawrence Berkeley National Laboratory and IBM Australia.
A plethora of resources

- Extensive research support experience
  - technical and administrative
- Strong, customised web presence
  - e.g. Mahler, D Borwein, DocServer archives
  - event and conference websites
- Events and conference management systems
- Local HPC supplemented by UON grid
- Remote collaboration expertise
- Web development expertise
  - interactive web apps for research projects

A strong backbone
Conferences and meetings run by CARMA (or very closely related)

(Uptcoming meetings are at the top, with past ones below.)

Past Meetings

2015 events

Conference websites
Featured visualisation projects

- Walking on Real Numbers
- EViMS conferences
- NSF Visualisation Challenge
- “Complex Beauties” Calendar
- Pi Concert, Digital Maitland
- Connecting with the modern humanities
A Random Walk with Pi

BY SAMUEL ARBESMAN 06.12.12 12:12 PM

Wired

3.14

Huffington Post

Science Foundation International Science & Engineering Visualization Challenge

INTERNATIONAL SCIENCE & ENGINEERING VISUALIZATION CHALLENGE

SCIENCE AND ENGINEERING’S MOST POWERFUL STATEMENTS ARE NOT MADE FROM WORDS ALONE

Wired UK August 2013

NSF Vis Challenge

Wired UK

David H. Bailey and Jonathan M. Borwein also wrote a post that day. They later told us that our project was featured on the front page of The Huffington Post and was tweeted by many people. Three days later we won the competition, and our GigaPan picture was written in Japanese. It turns out that our work had already reached the first position both in the ranking of new entries and in the ranking of most popular entries.

We decided to submit our picture of the walk on 3.14 to the National Science Foundation (NSF) Visualization Challenge. Our picture was one of the ten finalists in the Illustration category. In January 2013 the picture of 3.14 appeared on the front page of The Huffington Post, and the readers must guess what the image is. Several people who did not see the picture before. This made the GigaPan picture even more popular, reaching more than 20,000 views (at one moment it has been seen more than 50,000 times). The GigaPan administrators decided to write an article about our Success Story.

In April 2013 David Bailey and Jon Borwein wrote an article for the Huffington Post regarding the project. Another article appeared on Wired UK. The Wired Uk article has also been covered in other major media outlets.
Financial mathematics at CARMA

- MAFFIA: Mathematicians Against Fraudulent Financial and Investment Advice
- Interactive on-line financial modelling tools
  - Backtest Overfitting
  - “Tenure-maker”
- Collaborations with UoN Business School
  - *Mathematical Aspects of Behavioural Economics and Finance* co-organised conference
- Workshop on *Optimization, Nonlinear Analysis, Randomness & Risk*

Financial Maths
Pseudo-Mathematics and Financial Charlatanism: The Effects of Backtest Overfitting on Out-of-Sample Performance

David H. Bailey, Jonathan M. Borwein, Marcos López de Prado, and Qiji Jim Zhu

Another thing I must point out is that you cannot

ScienceDaily
Your source for the latest research news

Should you trust your financial advisor? Pseudo-mathematics and financial charlatanism

Date: April 10, 2014
Source: American Mathematical Society
Summary: Your financial advisor calls you up and asks if you want to join an investment scheme. Drawing on their expertise, he feels confident that the scheme is a sure winner. After all, according to some pretty impressive financial models, the average investor has never made a loss. His computer has been programmed with the most advanced algorithms, and the profit potential is almost limitless. His scheme is backed by the best mathematical minds on the planet. Should you invest?

Computer Models Often Use Unsound Math, Researchers Say

by Siddhi Khoban
April 11, 2014 — 9:10 PM EDT

When use of pseudo-maths adds up to fraud

by Stephen Foley
Interactive financial tools
New KPIs to be met:

- establish a National Research Centre for Mathematics
  - in partnership with AMSI, externally funded
- host 8 international conferences each year
- increase competitive external research funding by 25%
- increase PhD student numbers by 50%
- publish 25% more papers in leading international journals
Thank you!

CARMA PRC v2016.0

Background image: 3D render of random walk visualisation