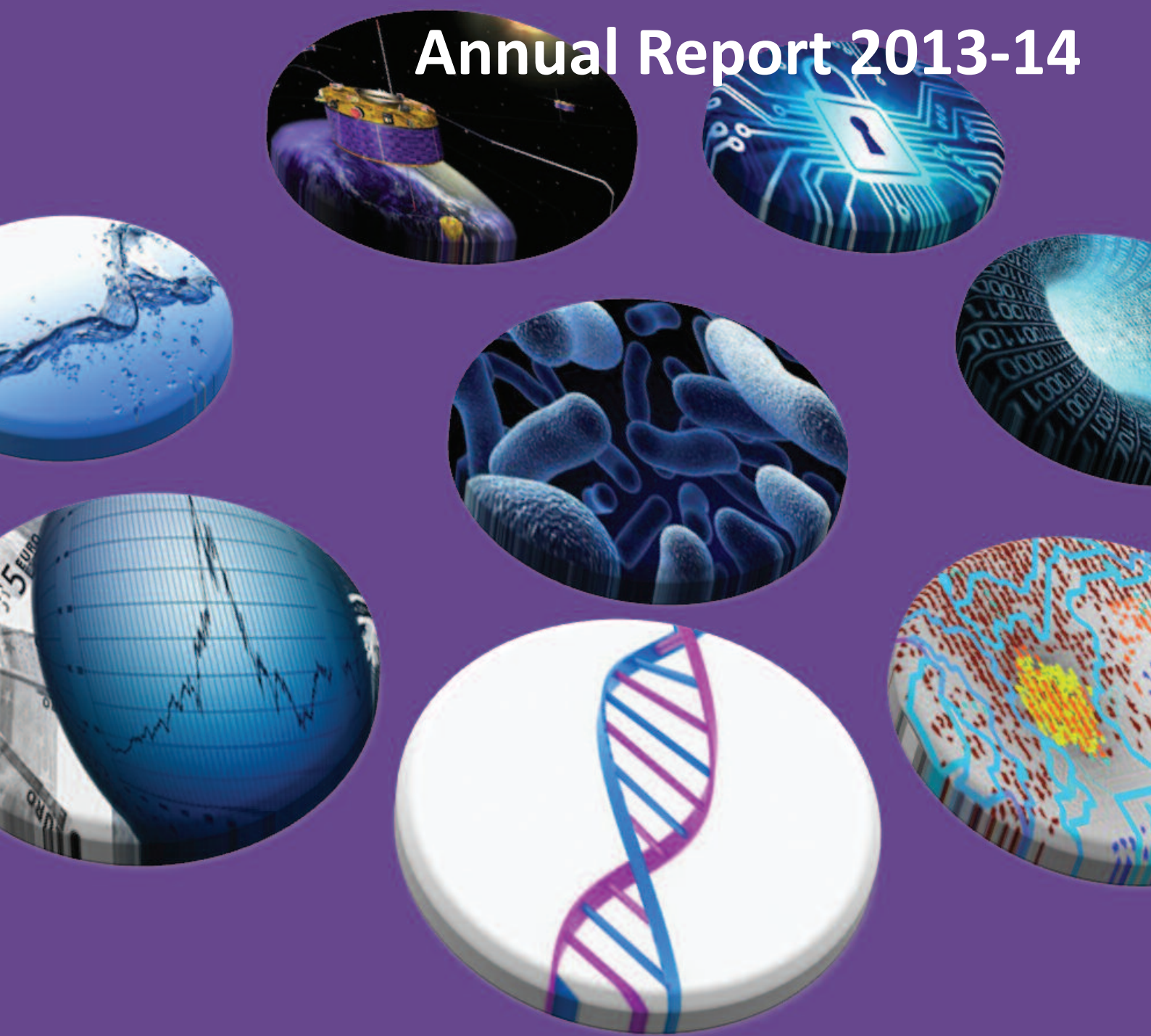


TGM | Turing Gateway to Mathematics

Annual Report 2013-14



UNIVERSITY OF
CAMBRIDGE



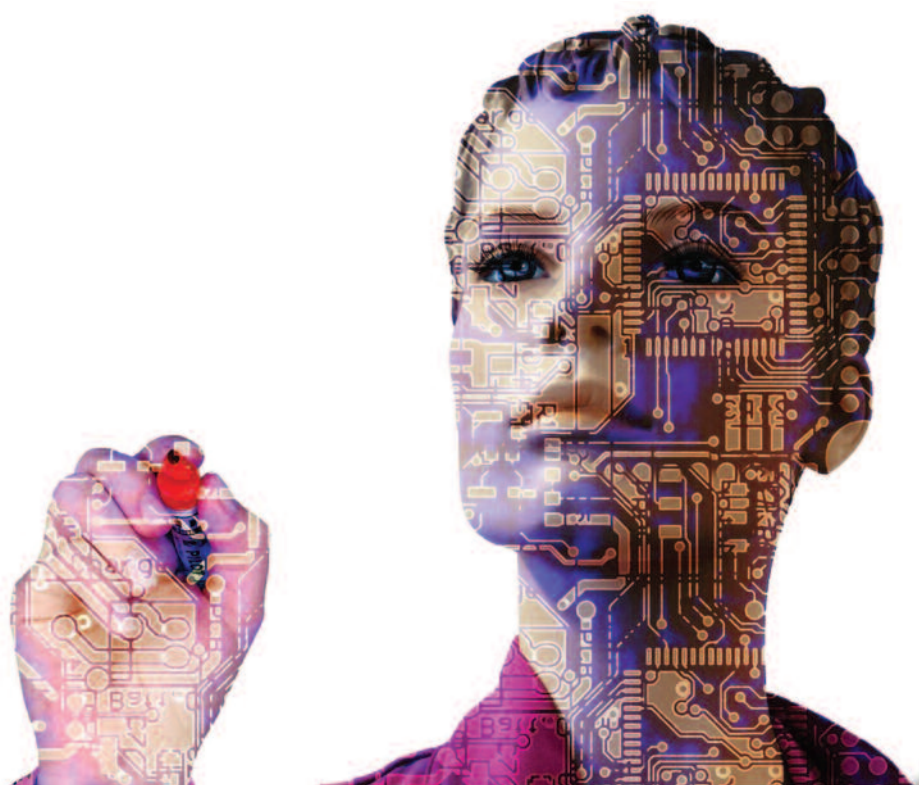
Isaac Newton Institute
for Mathematical Sciences

Overview, Aims and Objectives

The Turing Gateway to Mathematics (TGM) is an impact acceleration initiative of the Isaac Newton Institute (INI) based at the University of Cambridge. It acts as a vehicle for knowledge transfer between the mathematical sciences and potential users of mathematics, such as industry and other academic disciplines in the UK as well as internationally. It helps to bridge the gap between those engaged in frontier mathematical research and those working in more applied areas, by stimulating the interchange of knowledge and ideas between academics from different disciplines and users of modern mathematics, such as industry and policy makers.

The TGM does this by facilitating interactions and activities, such as programmes of work, consultations, workshops, research and training programmes, as well as less formal engagement for small working groups of academics and business personnel to work collectively. This enables engagement between individuals and organisations who were not previously working together and helps to achieve greater synergy and more creative and imaginative approaches.

To date, the TGM has delivered a range of activities across a variety of sectors including financial risk, quantum computing, Big Data and optimisation in space engineering. Activities vary and this flexible approach helps address targeted activity, without being proscriptive.



Mission Statement

“TGM aspires to facilitate the flow of knowledge and ideas between the mathematical sciences and potential users – in short, acting as a gateway! With activities ranging from specific projects to more extensive training and research programmes, the Gateway can help bridge the gap between academic mathematicians, business, government and other disciplines. As well as focusing on widening access to mathematics generally, the TGM can also help shorten pathways to impacts and strengthen education and training in areas where maths skills are needed”.

Governance

Since the last annual report, formal governance arrangements have been established and the staff resources of the TGM have increased to 2.6. The TGM Advisory Board was established with members from industry and public bodies to help advise on strategic matters, important themes and on the overall development of the TGM. The Board operates in a largely virtual way, receiving reports for comment three times per year in line with University terms and holding one face-to-face meeting in Cambridge annually.

TGM Advisory Board

Name	Organisation
Dougal Goodman	The Foundation for Science and Technology
Graham Keniston-Cooper	Investor and Entrepreneur
Peter Landrock	Cryptomathic
Natasa Milic-Frayling	Microsoft Research
Richard Pinch	Institute of Mathematics and its Applications

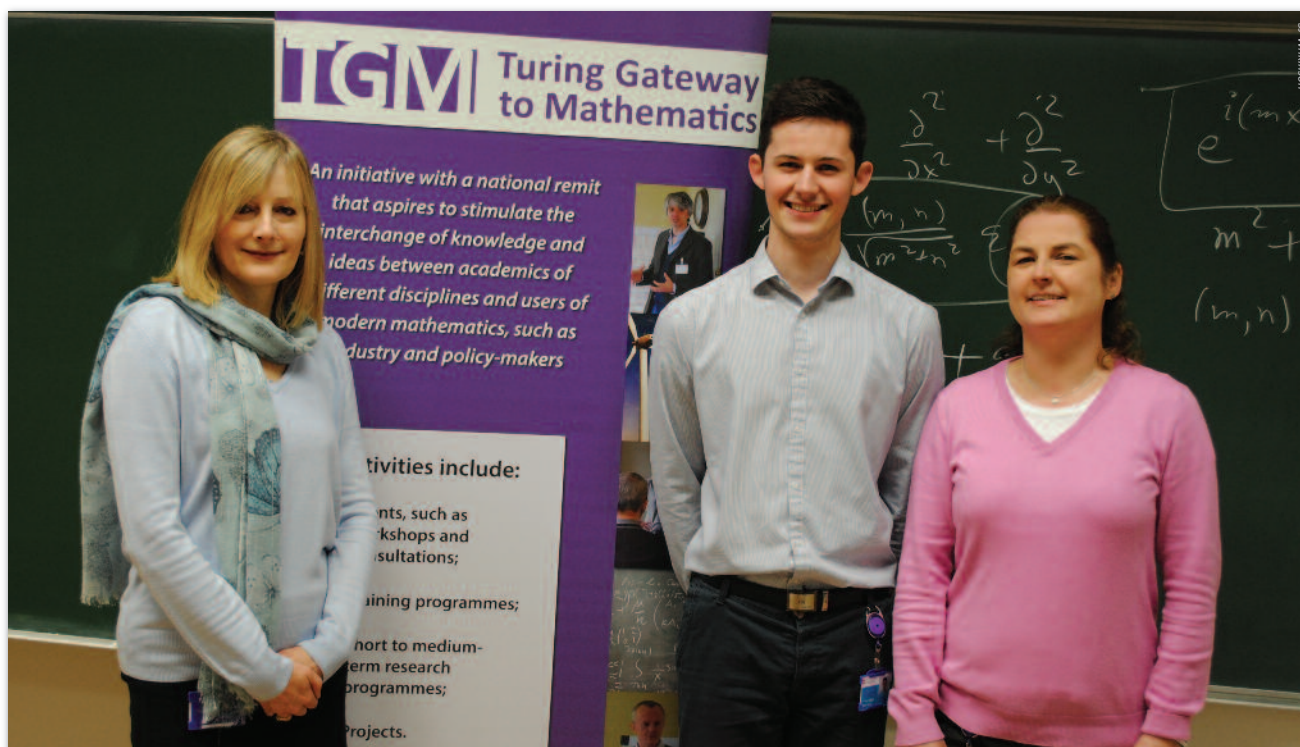
A TGM Programmes Committee was also set up to provide guidance and advice on specific scientific or research matters related to programme activities. The Committee members are all academics and operate in a virtual way via email and telephone and are responsive to ad-hoc questions and requests for guidance from the TGM.

TGM Programmes Committee

Name	Organisation
Jacek Gondzio	University of Edinburgh
Des Higham	University of Strathclyde
Jane Hutton	University of Warwick
Arieh Iserles	University of Cambridge
Robert Leese	Smith Institute

Staff and Management

The Knowledge Transfer Manager has overall responsibility for managing the Turing Gateway and for developing contacts with non mathematical academics, with industry and business. This role is pivotal in identifying potential research opportunities of mutual benefit to mathematicians and industry. The Knowledge Transfer Coordinator supports diversification of the TGM and coordinates events and marketing activity with industry and businesses. The Events Assistant (0.6) provides administrative support to TGM event and marketing activities.



Activities from August 2013 to July 2014

The TGM has held regular events since its launch and below summarises what it has been doing in the past year.

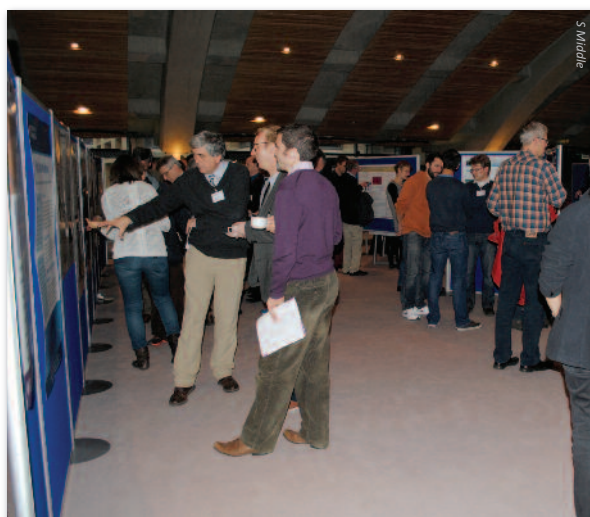
Optimisation in Space Engineering

This initiative was developed following an Isaac Newton Institute programme on *Polynomial Optimisation* and discussion with the European Space Agency (ESA) that highlighted various problems such as interplanetary trajectory optimisation, guided entry, descent, and landing trajectories. It was clear that there existed an ongoing need for technology improvements and further research in this area. The 1st UK workshop on Optimisation in Space Engineering (OSE) was held on 5–6 November 2013 in Birmingham and brought together representatives from academia and industry, leading to the formation of a national working group. The 2nd OSE workshop took place on 19–20 March 2014 in Cambridge and analysed identified challenges and real space engineering problems which were put forward for further research. The organisers are the TGM, the University of Birmingham, Airbus Defence and Space, the University of Southampton, the University of Strathclyde and the University of Bremen. Initiative activities are supported and endorsed by the European Space Agency (ESA).



Processing and Modelling of Earth Observation Data Consultation

On 4 December 2013, the TGM organised a meeting on Processing and Modelling of Earth Observation Data in consultation with the European Space Agency (ESA). A number of ideas were generated around a mathematical approach to assessing user needs for data service by developing rigorous sampling methodologies. Further analysis was discussed on ocean modelling to validate scatterometer algorithms for the measurement of wind speed and direction, synthetic aperture radar (SAR) data fusion techniques and robust automatic feature extraction to minimise costs of very manually intensive digitisation activities.



University of Cambridge Mathematical Sciences Showcase

On 29 January 2014, the TGM hosted a mathematical sciences showcase event at the INI and the Centre for Mathematical Sciences, which was attended by over 120 representatives from industry and academia. The event provided the opportunity to share and explore specific areas of research, leading to a better understanding of how mathematical sciences could impact on business and policy across a wide range of areas. Talks from leading mathematicians highlighted the role of fluid dynamics, big data analysis, the role of calibration and compressed sensing. Nearly thirty posters were exhibited across a wide range of subjects including quantum computing, image processing, mathematics of infectious diseases, mathematics outreach and the event included the opportunity for a tour of the Fluid Dynamics Laboratory.

Mathematics for the Prediction of Financial Risk

This workshop took place on 12 March 2014 in partnership with the Statistical Laboratory at the University of Cambridge. It presented state of the art mathematical approaches and real-life examples of the issues and techniques used from insurance and banking perspectives. The event carried CPD points from the Institute and Faculty of Actuaries and included contributions from Deloitte and Barclays as well as finance experts from the University, who were on hand to offer contributions including a mini-stats surgery with a discussion and networking session.



Post Quantum Research – Identifying Future Challenges & Directions

This event took place on 8–9 May 2014 and was the result of ongoing development with GCHQ of an initiative to undertake activities to build and strengthen the future UK research community and develop effective research strategies to help build UK capacity in post-quantum computing research over the next few years. This is driven by the realistic possibility that in the medium term the power of quantum computation will have the potential to compromise cyber security systems. This event was attended by over fifty participants and successfully identified future challenges and directions for post-quantum cyber-security research leading to the generation of ideas for developing UK research and teaching in the area.

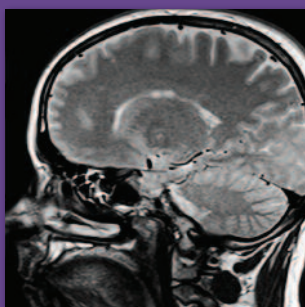
Open for Business

The Isaac Newton Institute sponsors *Open for Business* events as a part of the continuing goal of bringing academic researchers in the mathematical sciences together with industrial, commercial and government organisations and individuals. These activities are delivered by the TGM and provide opportunities, at senior level, for cross-fertilisation between the business-facing activities of users from industry and the public sector, and the research focus of the Institute. A number of events were hosted over the past year:

Polynomial Optimisation

8 August 2013

Delegates were able to interact with international research leaders with expertise in the modelling and solution of hard discrete and non-linear optimisation problems.



Mathematics of Applied and Medical Imaging

11 February 2014

This was part of a one week follow-up meeting on Inverse Problems and aimed to disseminate the recent developments in the mathematical problems associated with such problems in medical imaging and provided an interface between academia and users of the technologies.

Metagenomics - Insights from Mathematical, Statistical & Computational Research

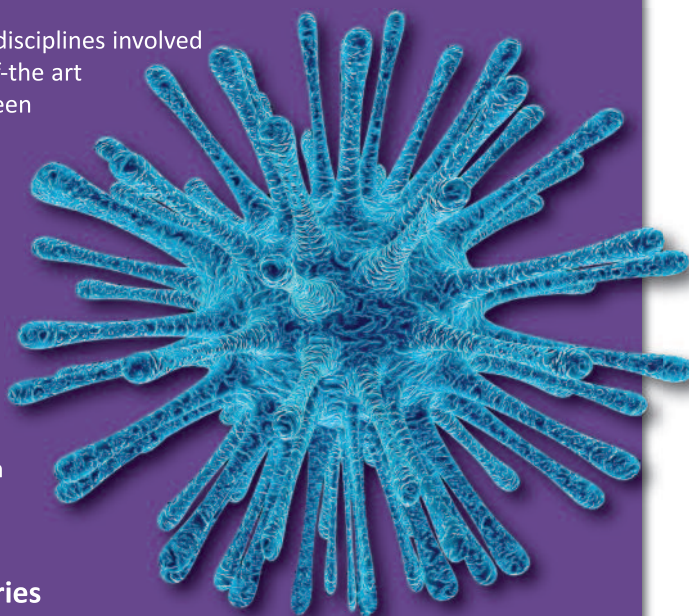
14 April 2014

This brought together leading expertise in the multiple disciplines involved in metagenomics, helping to highlight the latest state-of-the art models and methods and facilitating engagement between representatives from industry and academic experts.

Infectious Disease Dynamics: Mathematical Modelling for Public Health

5 June 2014

This well attended workshop successfully highlighted fundamental problems inherent in modelling specific diseases and their public health impact. It brought together mathematicians, statisticians, epidemiologists, biologists and ecologists as well as policy makers, health managers, NGOs, funding agencies and industry.



Water Waves Theories and the Marine Industries

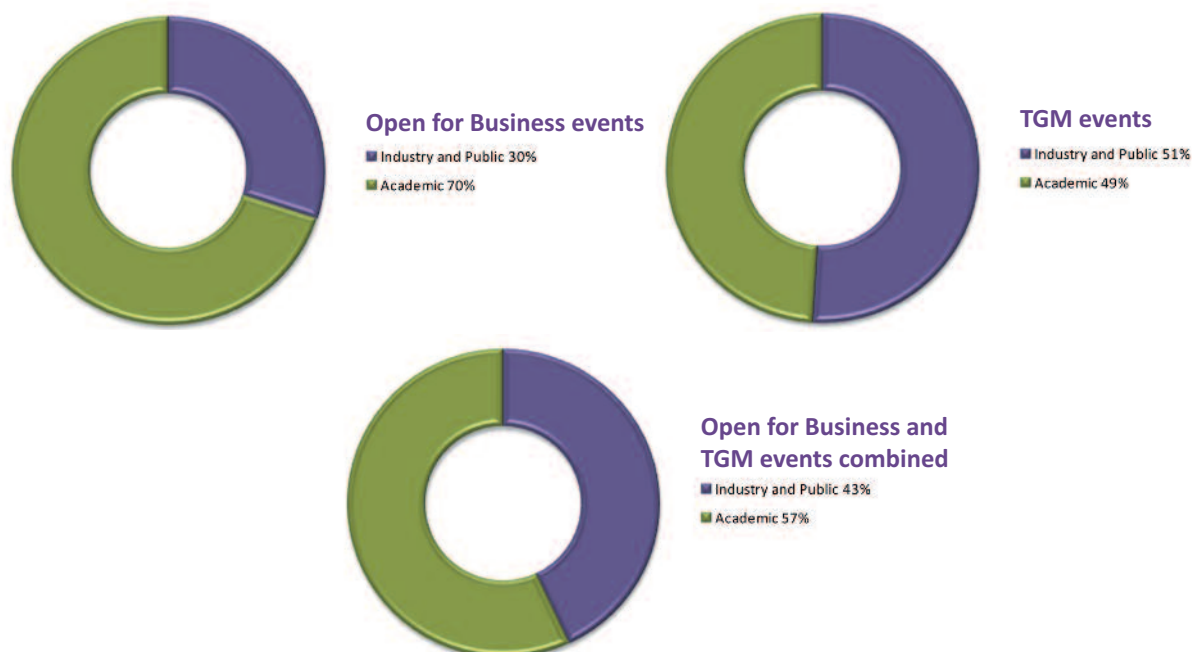
30 July 2014

This event highlighted how the theory of water waves can impact on technology developments and deployment within offshore renewable energy, oceanic vehicles, shipping and offshore oil and gas exploration. It was structured to enable the formation of new relationships and to assist in identifying the common challenges with the greatest potential for research, knowledge transfer, public policy and commercial impact.



Participation

Following its launch, the TGM has established itself as an effective vehicle for the delivery of knowledge transfer from the mathematical sciences. From August 2013 to July 2014, 525 participants have attended the 14 events that the TGM has coordinated. The focus has been to facilitate links between academics and industry and this has been achieved by ensuring a good spread of attendance from both disciplines. The pie charts below show attendance at TGM delivered events divided by affiliation.



Future Development

The TGM aims to respond in a speedy and focused way to new ideas and approaches, but recognises the need for a targeted and continuous approach to the delivery of longer term knowledge exchange activities in the mathematical sciences. In appreciation of this, a series of thematic knowledge exchange programmes are being developed, which are designed to stimulate and support research activities and include workshops, consultations and project meetings. These include Mathematics for Financial Services, Mathematics for Biology and Healthcare Systems, Mathematics for the Space and Security Sectors, Mathematics for the Environment and Energy, and Mathematics of Big Data.

Over the coming year, the TGM will develop this thematic work in partnership with stakeholders and progress with its aspiration to play a key national role in mathematical knowledge exchange.



Accounts (August 2013 to July 2014)

	2012/2013 ¹ £'000	2013/2014 £'000
Income		
University of Cambridge Funding ²	69	70
University of Cambridge Funding for OfB ³	6	6
Carried Forward ⁴	0	52
Donations ⁵	0	10
Total Income	75	138
Expenditure		
Staff Costs	16	58
Travel and Subsistence	1	2
Event Expenditure	0	17
OfB Event Expenditure ⁶	1	8
Marketing and Documentation	0	3
Overheads and Administration ⁷	0	1
Total Expenditure	18	89
Surplus / (Deficit)	57	49

Notes to the Accounts

[1] The TGM was launched in March 2013. The first column refers only to the 7-month period January to July 2013.

[2] This amount is provided by the University of Cambridge's Higher Education Innovation Funding stream.

[3] The TGM delivers *Open for Business* (OfB) events on behalf of the Isaac Newton Institute, so these are itemised as separate income.

[4] £51,900 was carried forward from 2013 to 2014.

[5] Two donations were received, one as a contribution towards an event, the other philanthropic.

[6] The TGM delivers *Open for Business* (OfB) events on behalf of the Isaac Newton Institute, so these are itemised as separate expenditure.

[7] To date, the TGM has been supported by the Isaac Newton Institute in its early development stage, with free use of seminar/AV facilities for events, administration and human resources.

Grants and Funding

Initially the TGM has been funded by the University of Cambridge through the Higher Education Innovation Funding stream. This funding covers the human resource costs, but there is currently no budget for TGM activities. Therefore all TGM projects require independent funding, for example through other public or government sources, industrial sponsorship and participant registration fees.

The TGM will continue to pursue longer term financial support in order to underpin operational costs and funding for activities.

Activity in 2014–15



NC3Rs/POEMS Network Maths Study Group

In September 2014, the TGM helped to organise the annual study group that was hosted at the INI and the Centre for Mathematical Sciences, to connect mathematicians and biomedical scientists.

Post-Quantum Research - Addressing Future Challenges and Directions

This workshop on 18–19 September 2014 took forward ideas generated in the first event which was held in May 2014.

Techniques for Data Linkage and Anonymisation

With support from the Economic and Social Research Council (ESRC), the TGM held a workshop on 23 October 2014 that gained input from nearly 90 key stakeholders, with expertise in specific application domains, such as educationalists, official statisticians, medical researchers, commercial organisations and epidemiologists.

Maths and Public Policy

The TGM is delivering a programme of work and associated events on behalf of the Engineering and Physical Sciences Research Council (EPSRC), to raise the profile of the mathematical sciences and its importance to the public policy area. A launch event took place in December 2014, and will be followed by 2 further events, one on *Cities and Infrastructure* on 11 March 2015, with the second on *Health and Society* on 24 March 2015.

Coping with Big Data - an Analytics and Computational Perspective

This half day workshop on 7 January 2015, was the first day of a UCL Workshop on the Theory of Big Data. It brought together leading expertise in the areas of Big Data methodology, analytics and computation and provided an insight into the latest approaches and techniques needed to cope with this rapidly developing and important area.



The Role of Inverse Problems & Optimisation in Uncertainty Quantification

The TGM is part of a partnership with the Knowledge Transfer Network of Innovate UK, the Smith Institute, the International Centre for Mathematical Science (ICMS) and the Isaac Newton Institute for Mathematical Sciences (INI) that is delivering this two day event on 17–18 June 2015. The workshop will focus on new developments in (i) optimisation and inverse problems theory for uncertainty quantification and (ii) system optimisation in the presence of uncertainty. It will be hosted by the ICMS in Edinburgh.

Design & Analysis of Experiments

This Open for Business workshop will take place as part of an INI follow up week in July 2015 and will focus on experiments in healthcare and associated design challenges.

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