The Era of Mathematics: An Independent Review of Knowledge Exchange in the Mathematical Sciences

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Annex 5. Details of Review Surveys and List of Case Studies Received

Survey details

1. *Survey on KE motivations and aspirations*

The first review survey sought evidence on the motivation, expectations and experiences of different stakeholders undertaking KE in the mathematical sciences. Information on following was gathered:

1. Basic Information
    a. Organisation Type
    b. Sector (business respondents only)
    c. Government department discipline (public sector respondents only)
    d. Academic discipline (academic researchers only)
2. Respondent Details
    a. Responder job title/group
    b. Organisation/group size
    c. Budgetary control
3. About Your Engagement with/across the Mathematical Sciences
    a. How many times (in the last 5 years) have you engaged with an academic working in the mathematical sciences, or researchers from other departments/external organisations?
    b. How do you find the industrial/academic collaborators you engage with?
    c. How easy do you find it to engage with your industrial/academics collaborators you engaged with?
    d. What motivated you to engage with your industrial/academic collaborators?
    e. When engaging with/across the mathematical sciences, what mechanisms or services do you normally access, and for each how satisfied are you that they have met with your expectations?
    f. In general, how do you qualify the success/lack of success of a KE project?

g. Do you feel that you are able to access academic support/different academic disciplines as quickly as needed?
h. In general, how would you describe your interactions with your industrial/academic partners?
i. Please indicate (if any) of the following have had an impact on your KE projects
j. If there were difficulties, what has been the missed opportunity? What has it cost you? How have you overcome these?
k. How could industrial and academic collaborators improve the way you interact with you?
l. Final comments, are there any other thoughts on KE in the mathematical sciences?

The survey was distributed publically online via the EPSRC website, the Knowledge Transfer Network website social media channels, and the Turing Gateway to Mathematics. The survey did not capture personal information.

2. Case study survey

This evidence route aimed to gather examples of current or recent KE activities within the mathematical sciences. Examples of mathematical sciences KE were sought from academic researchers, end users of mathematical sciences research and knowledge exchange professionals. Some of the examples received were collated by respondents from existing published case studies or following discussion with colleagues; others were direct responses from members of the mathematical sciences community. In total 169 submissions were received, of which 149 were complete. Examples spanned a broad range of sub-disciplines of the mathematical sciences, encompassing examples of knowledge exchange with industry, government and academia, and included examples from both within the UK and international sources. The questions posed in the survey were as follows:

1. Please describe briefly the scope of the knowledge exchange activity, including what research topics, application areas and/or sectors were involved.
2. Who was involved in the activity? This may include organisations, research groups and/or individuals.
3. Where did the original research idea come from? Select from:
    a. An academic researcher

    b. An industrial partner
    c. A governmental partner
    d. A third sector partner
    e. Emerged through a combination of these
    f. Other (please specify):
4. What was the initial motivation for the knowledge exchange activity?
5. What were each partner's goals or aspirations for the activity?
6. Please describe briefly how the initial contact between the partners was made and explain how the relationship was established, developed and maintained.
7. How was knowledge exchanged between partners and what actions or approaches were taken to facilitate this (e.g. physical meetings, virtual meetings, workshops etc.)? Please include in your answer an indication of to what extent each partner's role was as primarily a 'producer' of knowledge, a 'consumer' of knowledge or a combination of these.
8. Were any barriers encountered? If so what actions were taken to overcome these barriers and were they effective?
9. Please highlight any approaches taken which were particularly effective?
10. What were the key outcomes of the activity for each partner?
11. Overall, how would you rate the success of the activity on a scale of 1-5 (1 = This activity did not produce any positive outcomes for any of the partners, 5 = This activity produced substantial positive outcomes for all of the partners)

On 9 August 2017 a sub-group of the Review Committee met at the Medical Research Council in London to read through the case studies and generate a summary analysis for input into the review. The examples received highlighted activities in collaboration with a very wide range of partners, from government, industry and the third sector. While knowledge exchange with the general public or public engagement was within scope for the exercise there were few examples of this type of activity received. It should also be noted that relatively few examples of activities which had been less successful were received.

List of 149 complete case studies submitted (summary scope information only; references to individuals have been removed)

1. Oil and gas sector. In particular Pentair Valves and Controls (now part of Emmerson) in Houston Texas invited us to do consultancy for them which also led to four journal papers on the topic of understanding and predicting the onset of pressure-relief valve flutter and chatter.
2. The core of my work involves transferring advanced but appropriate statistical knowledge to practitioners in neuroscience, psychology, and psychiatry, in the area of brain imaging. I develop inference procedures for magnetic resonance imaging, often directly drawn from cutting edges statistical methodological results that are out of reach of typical brain imaging researchers; this original material is not of direct use to practitioners both due to the mathematical statistical background needed to consume this work, and due to a practical

implementation details specific to human brain image data. Thus, a large portion of my work could be summarised as "value added knowledge transfer" from statistical science to neuroscience.

3. Research topic: surrogate mode building using support vector machines. - Application area: numerical simulation of engines - Sector: automotive
4. Research topic: optimisation, approximation of functions. - Application areas: computation of optical free-form surfaces (reflectors, lenses) to realize certain light distributions. - Sector: automotive.
5. Scope: develop a process-specific model for chemical mechanical planarization (CMP), a polishing procedure that is a standard technology for wafer processing in manufacturing integrated circuits. - Application area: integrated circuit manufacturing. - Sectors: manufacturing.
6. Scope: develop an automated scanning, planning and production system for the gemstone industry. - Research topics: semi-infinite optimisation. - Application area: cutting - Sector: manufacturing.
7. Reliability growth models, underpinned by statistical and probability models, were adopted by numerous aerospace companies and international standards to change how companies did reliability growth.
8. Software was developed during a collaboration between Glasgow University and Shell Global Solutions to process and analyse groundwater pollution. This collaboration focused on developing statistical tools.
9. To develop new statistical methods for disease surveillance and influenza vaccine effectiveness. The research was commissioned by the Scottish Government, through Health Protection Scotland. The modelling focused on statistics and was all in health.
10. Developing mathematical algorithms for understanding the relationship between people in large evolving networks. The application area was largely social media and a small digital marketing agency.
11. Developing a new optimisation algorithm & implementing it in an existing CFD code base. - Research topic: continuous optimisation, topology optimisation - Application area: aircraft design - Sector: aerospace
12. Maximise coverage of area of a fleet of Earth observation satellites. - Research topic: continuous optimisation. - Application area: Earth observation. - Sector: aerospace.
13. Multiobjecive Optimization Algorithms in Electronics Design Automation - Research topic: global optimisation, multiobjective optimisation, derivative-free optimisation - Application area: electronics design automation - Sector: manufacturing
14. Finding ways to control the temperature in a furnace for ceramic products in an optimal fashion by way of controlling the flame shape. - Optimal control, numerical solution of PDEs. - Application area: ceramic manufacturing - Sector: manufacturing.
15. Optimal management of a cascade of hydroelectric power stations. (Basically, pump water upstream to a power station higher up when energy is cheap, and generate energy when prices are high.) - Sector: energy, hydroelectrical engineering
16. Multiobjective optimisation of intensity-modulated radiation therapy: finding a treatment plane for a dose regime that maximises the effect on the tumour whilst minimising the effect on the surrounding tissue. - Application area: cancer treatment - Sectors: Health
17. Forecasting medical call centre demand. - Research topic: forecasting. - - Application area: Healthcare
18. A new statistical test to analyse and detect anomalous behaviour of individual molecules inside living cells. - Application area: cell biology
19. Find disease-specific patterns in mass spectrometry data of biological samples (i.e. patient blood). - Research; statistics. - Application area: medicine. - Sector: Health
20. Development of conic optimisation routines and embedding within the NAG (Numerical Algorithms Group) software package
21. Communication of Risk and Uncertainty to the general public, often through the media
22. Decision making for optimal response planning in emergency situations such as contaminant events in the environment, accidents where hazardous substances are involved, adverse - meteorological phenomena, forest fires, etc. - Application areas: emergency response - Sector: environment, forestry, fishing
23. Forecasting the structure of the Wroclaw and Lower Silesia job market; analyze the changes in population, education and the job market in the coming years. - Application area: forecasting, population dynamics - Sectors: population statistics, government
24. Optimise staffing patterns in emergency departments. - Research topic: queuing theory. - Application area: healthcare
25. Mean-variance portfolio optimisation in the insurance market. - Research topic: multiobjective continuous optimisation. - Application area: insurance.
26. Design and optimisation of computer networks. Network theory on TCP has major impact on design of internet protocols.
27. Explore novel approaches of dividing network capacity of bidirectional hybrid fibre cable networks among its users. Address the trade-off between capacity and delays. - Research topic: queuing theory, stochastic networks. - Application area: communication engineering. - Sector: leisure
28. Development of funnel plots to monitor NHS institutions for unexpected variability in mortality
29. Given a train network and a train timetable with random delays, find the optimal travel time for any given passenger. - Research topic: discrete optimisation, order statistics - Sector: transport & logistics
30. Optimisation of the emergency management system in Milan. - Research topics: forecasting, discrete-event simulation, systems dynamics, game theory, queuing theory, mathematical programming, online optimization - Application area: emergency care. - Sector: Health
31. New methods for detecting the source of human campylobacteriosis cases results in a major improvement in food safety in New Zealand
32. Statistical research, prompted by the sinking of the MV Derbyshire, to establish new standards for the design of bulk carriers.
33. Optimisation of flood defences using statistical extreme value theory
34. EU Environmental Policy and Guidance: Statistical Reasoning in Ecotoxicological Risk Assessment
35. History matching and uncertainty assessment in the oil and gas industry
36. Multiple industrial impacts of Bayes linear analysis
37. Embedded Bayesian uncertainty modelling within the UK's climate change modelling strategy
38. Statistical methods for urgent medical care call centres and sustainable transport

39. Statistical modelling for digital marketing
40. Control of epidemics in the aquaculture industry of England and Wales, using stochastic epidemic models
41. Informing clinical policy on epilepsy treatment
42. Fast binary decision algorithms to enable real time diagnosis of in-flight faults in Unmanned Aerial Vehicles
43. Optimisation of public transport systems. - The evidence provided considers a multitude of knowledge exchange activities during the years (approx.) 1990-2011. - Research topics: discrete and combinatorial optimisation. - Application area: public transport.
44. Supply-chain management for fast-moving consumer goods, across different products and countries. - Research topic: forecasting. - Application area: supply-chain management. - Sector: manufacturing consumer goods.
45. Improving air traffic control, especially runway scheduling, - Research topic: discrete optimisation, scheduling. - Application area: air traffic control. - Sector: transportation
46. Calibrating a measurement system that provides information on the physical configuration of an excavator system. - Research topic: parameter estimation. - Application area: manufacturing.
47. Optimising container freight shipments. - Research topics: optimisation modelling, linear and discrete optimisation. - Application areas: sea shipment - Sector: transportation.
48. Numerical matrix analysis into commercial and open source software
49. Optimising container shipment, taking into account ship fuel consumption and shipment cost of empty containers. - Research topics: nonlinear network flow optimisation - Application area: shipment industry - Sectors: transport
50. Novel Statistical Methods for Optimising Production of Disc Brake Pads
51. Tactical asset allocation for currency reserve of a central bank. - Research topic: multiobjective stochastic optimisation. - Application area: portfolio optimisation. - Sector: finance.
52. Optimal decision making in the mining industry: determine the maximum expected valuation of an extraction project (and corresponding decisions) in the presence of economic and geological uncertainty. - Research topics: multicriteria decision analysis, geology, economics - Application area: mining - Sector: energy
53. Estimating porosity and permeability of oil reservoirs. - Research topic: stochastic methods in global optimisation. - Sector: energy
54. Modelling and assessment of ageing and maintenance efficiency of complex repairable systems. - Research topics: Monte Carlo simulation; frequentist and Bayesian statistics. - Application area: reliability engineering - Sector: energy
55. Production planning in nation-wide electricity generation. - Research topic: nonlinear non-smooth optimisation. - Application area: electricity production planning - Sector: energy
56. Decision support for strategic financial investment portfolio selection, especially for sovereign wealth funds. - Research topic: continuous optimisation, multicriteria decision-analysis. - Application area: wealth fund management, investment portfolio selection. - Sector: finance
57. Development of algorithms for the evacuation of people from buildings.
58. Mathematical modelling of environmental processes; work with external agencies and regulatory bodies
59. Research conducted at the School of Mathematics at Cardiff University has engineered radical, lifesaving, improvements to UK healthcare systems. New mathematical models, accounting for the complexity and diversity of the health system, have been created and applied in a variety of contexts to markedly enhance the efficiency and effectiveness of a wide range of healthcare services - at policy, commissioning and operational levels.
60. Improving Clinical Trials by Innovative Statistical Design - Statistics - Public Health and Health Services - Applied Economics
61. Improving Met Office weather forecasting accuracy - Pure Mathematics, Applied Mathematics, Numerical and Computational Mathematics
62. Electricity Capacity Assessment Study and Capacity Mechanism, i.e. official study of risk in GB of electricity generating capacity shortfalls and operation of the market for additional capacity to mitigate risk. - Applied probability and statistics.
63. Scheduling, combinatorial optimisation.
64. Resource management; allocating medical resources to optimise patient flow, bed availability, and staff availability. - Goal programming, multicriteria optimisation, discrete event simulation, queueing theory. - Healthcare.
65. Spatial-temporal infectious disease (meningococcal meningitis) modelling including temporary immunity. - Control of infectious diseases, medicine, healthcare, public health.
66. Stabilizing a non-affine control system via time-scale separation. - Optimal non-affine control laws for aircraft control. - Application area: aircraft manufacturing.
67. X-ray tomography for airport security. Improved imaging techniques for scanning at airports.
68. Oilfield Reservoir Souring Research and Development. A predictive model for when an oilfield is going to start misbehaving
69. Preventing Blood Clots in Children undergoing Kidney Dialysis
70. Faster Fault Tracking for National Grid Gas using statistical process control
71. Keeping Track of Nuclear Fuel in Reprocessing
72. Using Targeted Projection Pursuit to Improve Social Care Call Centre Operational Effectiveness
73. Enhancing competitive advantage at Pratt & Whitney using Design for Variation (i.e. using emulator framework to improve the industrial design process)
74. Shape analysis in 3D motion sensing (at a commercial motion analysis company) and in fingerprint analysis
75. Novel statistical methods for drawing inferences on the performance of an individual patient. The methods have become the standard way of analysing single-patient studies in neuropsychology and are widely used by clinicians to compare individual patients with normative data.
76. Statistical research undertaken at Sheffield has resulted in the provision of internationally-agreed calibration curves for radiocarbon dating that offer greater accuracy and higher resolution, and which (for the first time) span the full range of timelines over which radiocarbon dating is feasible.

77. Researchers in the Epidemiology Group at the University of Warwick have an international reputation for high-quality mathematical modelling of human infectious diseases, with particular emphasis on population heterogeneity and variability. Such formulations and insights are an important component of predictive modelling performed by Public Health England (PHE), and are helping to shape national policy for a range of vaccine-preventable infections.
78. Methodology for election exit-poll design and analysis
79. The biasing effect of selection of data due to consent procedures or selective reporting, and its consequences for the validity of conclusions and reliability of results in medical and legal situations. This has resulted in NICE guidelines, reporting guidelines in the biomedical literature, and impact as an expert witness in legal cases.
80. Production of statistical reporting methodology for the Human Fertility and Embryology Authority website, informing public of effectiveness of fertility treatments
81. Collaborations with mathematicians at other institutions on topics of common interest, mostly combinatorics.
82. The knowledge exchange was centred on the theoretical, computational and experimental fluid dynamics of flows past/around aeroplane wings and engines. The main research topic concerned the onset of turbulence, in particular: (i) the receptivity process; (ii) the nonlinear breakdown stage; (iii) the 3D PSE approach. - The main application area was around the reduction of drag on aeroplane wings. Reduction to noise and geometries other than wings (e.g. formula 1 cars, engine nacelles) were also applicable. - Sectors involved were: (i) aerospace; (i) defence; (iii) Formula 1
83. Multi-level modelling methodology used throughout social sciences, particularly to inform educational policy. Greater understanding of statistical problems of league tables influencing educational research hits the national press. Department for Education / OECD / etc changes policies accordingly.
84. Reversible jump Markov chain Monte Carlo methodology is used in multiple areas to carry out statistical inference
85. Information theory is joining up with multinational companies through the CDT in Communications at the University of Bristol
86. Recommender system theory being put into practice
87. Statistical and operations research into multiple industries through the CDT at Lancaster University
88. Supply of high performance revised simplex method techniques for linear programming and provision of advice on the same. Sectors involved are software for animal feed, pet food and human food formulation, and data science.
89. Multi-Period Sales Districting
90. Development of optimization software for managing oil and gas wells and their gathering pipeline networks. - Required development of nonlinear optimization software capable of dealing with derivative discontinuities that result from multiphase flow of oil gas and water in pipes.
91. Research and industrial applications of modern interior point methods - for very large scale optimization.
92. Introduction of designs for first-in-human clinical trials which should obtain more precise information from the same resources without compromising the safety of participants. - Research area: Design of Experiments, which is part of Statistics. - Application area: pharmaceutical industry.
93. Mixed integer programming models for the design of aircraft cockpits
94. Hierarchical Bayesian models to monitor and report on covert and illegal processes, which cannot be monitored using standard statistical methods. - Application area: monitoring illegal ivory trade. - Sector: economics, trade, wildlife protection.
95. Mathematical optimisation. Mathematical modelling and new algorithmic optimisation tools in convex optimisation. - - Application area: pricing and valuation problems in finance. - Sector: finance
96. Predictive analytics, credit scoring, novel credit scoring scorecards. - Application area: finance, consumer credit, retail banking. - Sector: finance
97. Rostering, timetabling, integer programming, heuristics. - Application area: workforce planning.
98. Statistical imputation, decision-making under uncertainty. - Application area: forecasting wind energy generation, energy options switching. - Sector: energy.
99. Nonlinear optimisation, multiobjective optimisation, high-performance optimisation algorithms. - Application areas: space engineering, spacecraft design. - Sector: space.
100. Random fields, spatial distribution statistics for scintillated laser beam profile, photonics, mathematics, probability and statistics
101. Development and application of design of experiments methods for the pharmaceutical industry
102. Using the Public Sector Scorecard to measure the effectiveness of interventions to address child obesity. - Performance measurement; strategy development; balanced scorecard.
103. The project is one in Operational Research. Specifically, it focuses on the following research topics: - Discrete optimization - Statistical methods, including survival analysis - Computer simulation - Heuristic methods - Cutting and packing
104. This project falls under the remit of Operational Research. Specifically it uses ideas from: - Simulation - Statistical analysis
105. I was involved in a project for applying optimization algorithms in a construction site. - Research topics: routing, stochastic optimization - Research Area: Operational research. - Industrial Sector: Construction
106. I have been involved in projects with major UK airports and developed simulation and analytical models to address their problems.
107. Our KE activities focused on data integration across the construction supply chain, in particular telematics.
108. Industrial Inverse Problems Sandpits, University of Leeds, 2007-2012.
109. Quantifying Uncertainty in Inverse Problems, 25-27 April 2016, Novosibirsk, Russia.
110. Statistical analysis, sensible estimation, with Universities Superannuation Scheme - Statistical analysis, evaluation of data quality, expert witness in litigation regarding performance of hip joint replacements. Work on an article on accuracy of diagnosis of a condition (adverse reaction to metal debris) has begun. - Statistical analysis, evaluation of data quality, expert witness in life expectancy estimates. Research on methods of estimating life expectancy for complex situations on going. Systematic review of mortality rates after spinal cord injury ongoing. - Chain event graphs and missing data in clinical trials, link with obesity trials.

111. Interaction with the energy company ITPower Ltd in Bristol and the research company Offshore Wave Energy Ltd (OWEL) in Cornwall. They are involved with developing floating wave energy extraction devices and they sought our advice on mathematical modelling and analysis of the devices.
112. The overarching research topic in uncertainty quantification and risk management. The knowledge exchange sectors that have been involved are varied and include engineering (aerospace, automotive, manufacturing, energy), finance, management, psychology.
113. I had a student supported through the TKN, working on a CASE award with Arup. The research focused on mathematical models for natural ventilation of building developed through the use of laboratory experiments.
114. Turing created a theoretical model of a machine capable of fast computations. The model comes from mathematical logic. Its purpose was to make a step towards answering another pure mathematical problem from number theory (Hilbert's tenth problem). On another continent, the US Army became involved in the project of building a machine for high speed calculations involving warfare activities - EDVAC. The mathematician von Neumann (who was in touch with Turing) is invited to collaborate on the project. Due to a public release of the ideas in the project, industry was greatly supported in building computers, which have transformed human life.
115. I am involved with the development of Predictive Policing with Providence Police Department, PredPol (the market leader in predictive police software). Research includes dynamical systems, partial differential equations and data assimilation that has been on going over a number of years at the University of Surrey. The key aim of the work is to help Police forces carry out resource management effectively and efficiently.
116. Applications of Topological Data Analysis to Computer Vision
117. STOR-i CDT has currently over 30 PhD projects jointly funded and co-supervised with industry. This applies over all sectors and multinationals to SMEs.
118. The birth and growth of topological data analysis. - The core pure research topic is in Algebraic Topology, and specifically, the development of Persistence Homology in support of Topological Data Analysis. Contributing areas of pure mathematics include group theory, discrete Morse theory, matroid theory, and category theory. - Application areas are extremely diverse. Core sectors involved have been Academia, US military complex, and private industry.
119. Topological quantum computing; takes advantage of the topology of certain quasi-particles called anyons to propose much more stable quantum computers. The idea was taken up by Microsoft's station Q and they are currently working on making this feasible. - The research topics spanned includes quantum computing, topology and group theory. The applications of quantum computing are multifarious and include: encryption, genomics and applications in astronomy, healthcare and finance.
120. Heilbronn Institute for Mathematical Research. An academic partnership, initially with Bristol University, to study problems of interest to Government in discrete mathematics, quantum information and data science.
121. A project to develop additional capability in post-quantum cryptographic research in the UK. The development of quantum computation is leading to the need for high-calibre expertise in the UK for strategic advice and qualified staff for government (NCSC) and standards bodies, and to help to grow an "eco-system" of qualified and capable practitioners for business and industry. The mathematical underpinnings of proposed systems need to be assessed so that specific costing and security advice can be derived. The areas of mathematics involved are quantum information and algorithms, cryptography and specific areas such as lattice theory, coding theory and combinatorics.
122. Knowledge exchange from pure mathematics (Tropical Geometry) through to Economics and Auction Design/pricing models for indivisible goods. - The effected sectors are academia, government, and private industry (the banking industry).
123. Dynamic pricing of delivery time slots for grocery shopping with Ocado. Involved modelling of customer choice behaviour, and optimisation of dynamic pricing with anticipation of implications on vehicle routing costs.
124. This knowledge transfer concerns the application of group theory to the design of experiments for stronger results of statistical trial. The knowledge transfer is from academia to European health governance, and to big pharmaceuticals. - In this example, we will mostly expose mechanisms where knowledge transfer has failed for various reasons.
125. The application of scientific techniques to a broad range of security related subjects. This includes mathematics, physics, chemistry and engineering
126. In the InFoMM CDT, all students do two 10-week mini-projects as part of their first year of training. These mini-projects all involve working on company challenges. Research spans modelling, data and scientific computation.
127. We have been collaborating with Oxford InFomm on applications of Mathematics to fusion plasma problems. I have been involved in exploring novel parallelization techniques in scientific computing.
128. From the academic field of Fractal Geometry to the industry of data compression/image compression.
129. Amec Foster Wheeler is a multinational engineering company. The Department of Mathematical Sciences at Bath has had a long term interaction with Amec Foster Wheeler, including a number of jointly funded PhD projects. In particular, collaboration has been with the ANSWERS® Software Service within the company that provides technical consulting and develops state of the art software for the nuclear industry including reactor physics, criticality and shielding applications.
130. DNV GL are a multi-national risk analysis company, working across a wide range of sectors. They first began working with the Department of Mathematical Sciences in 2013 through jointly funding a project, through the University's Impact Acceleration Account, to investigate new approaches to risk assessment.
131. BT is the UK's national telecommunications company, with a track record of investment in University research over decades, and involving leading institutions in the UK, USA and China. Their links with Bath have in the past primarily been via short-term placements for students on our Masters course in Modern Applications of Mathematics.
132. The UK Met Office provides weather and climate services across the UK and the world. Building on existing collaborations with the department, members of their climate statistics (partnered on the EU-funded EUSTACE project) and space weather groups attended SAMBa's 3rd ITT. The climate statistics group brought problems that concerned the historical measurement of ice in Polar Regions, something that requires complex statistical modelling.

133. University of Bath has established a new University Research Institute called the Bath Institute for Mathematical Innovation (Bath IMI). Bath IMI aims to do three things: nurture more cross-disciplinary projects within the University involving mathematics and statistics, provide a more coherent framework for carrying out projects for, and funded by, external partners, and to promote research-related activities involving mathematics and statistics, for example funding more academic visitors.
134. I am a Co-director of the CDT in Industrial mathematics and therefore activity involved in a variety of KE activities. Most of these relate to identifying, nurturing and supporting collaborative efforts between academic mathematicians and a large spectrum of industry sectors. The CDT research topics extend from classical applied mathematics (fluids/solids/differential equations, asymptotics etc.) to numerical analysis (linear algebra, optimization, etc.) as well as rapidly growing activity in data analytics. The wide variety of sectors are represented by 60 companies, each of whom is actively involved in KE through networking meetings, contributing training courses, proposing and supporting small projects (10 week projects) and longer term 3 year research projects.
135. Direct collaboration with industry through PhD and postdoctoral projects
136. Academic collaboration with a Biologist colleague into pigment patterning in embryogenesis.
137. Research Topics: mathematical and statistical modelling. - Sector: raw materials processing.
138. Crack detection in Non-destructive evaluation. - Energy, defence sectors - Continuum mechanics
139. Seismic, and ground vibration, defence structures and metamaterials. The deflection of waves and control of wave motion. - Applications to defence, civil and mechanical engineering, manufacturing.
140. Guided waves in pipes and structures aimed at non-destructive evaluation - Energy, manufacturing - Continuum Mechanics
141. An ongoing collaboration between a Mechanical Engineer (MIT), a Naval Engineer (NTUA) and myself, a mathematician (Dundee) on the modelling and prediction of Rogue Waves. This brings state of the art kinetic and microlocal techniques to bear on an applied problem, making use of measured wave statistics and empirical knowledge on the modelling of various ocean processes. Applying the mathematical theory to equations that are correctly scaled, both in terms of dimensional analysis and estimation of parameters, proved crucial in obtaining results that seem to successfully model rogue waves.
142. It was a collaboration between experimental stem cell biologists and me. I was performing the mathematical analysis and mathematical modelling for the experiments undertaken by collaborators. The experiments measured cell lineages (clone sizes) of stem cells in mouse oesophageal epithelium, disrupted by mutations. The experimental data by the biologists was not conclusive on its own, but through my mathematical input, hypotheses could be validated and important conclusions about stem cell dynamics in adult tissues and tumours could be drawn. The mathematical methods used were stochastic modelling, dynamic systems, and Bayesian analysis. The experimental methods were predominantly in-vivo cell lineage tracing with inducible genetic labels
143. The field in general is 'big-data'. Most projects are concerned with mathematically grounded methods for network structured data. The hoped output is better technology for clients on a web interface (page or app). The knowledge exchange part of the research project takes from 3 to 9 months.
144. I have been working with biologists on trying to extract useful diagnostic information from cardiovascular data collected with high sampling frequency (e.g. 1000Hz) over hours or days. Of particular interest is the early detection of disease or infection, particularly sepsis.
145. Bright Club - stand-up comedy about research. Topics: modelling sand ripples, evolutionary biology. Various venues including the Edinburgh Fringe, the Green Man Festival.
146. A dance and music performance inspired by icosahedral symmetry and related talks, involving a choreographer, dancers, composer, mathematician and biologist. The performance was open to the general public.
147. Three-year Knowledge Transfer Partnership (KTP) project. Use of statistical methods (Gaussian process emulators) for approximating computationally expensive computer models used in flood risk modelling.
148. Mathematical Biology. Mathematical Modelling of Epidemics - KE with UK JCVI (the Joint Committee on Vaccination and Immunisation) - Areas: Safety and cost-effectiveness of vaccines; predictions, strategy development and analysis for ongoing outbreaks (e.g. 2001 Foot-and-Mouth outbreak, 2009 H1N1 influenza outbreak); strategies for Low and Middle-Income Countries (LMICs) where statistical challenges of sparse data are greater including real-time policy advice and predictive modelling (e.g. for the Ebola emergency); models to underpin decision making for ongoing eradication campaigns in LMICs
149. A formal collaboration agreement with INSERM, the major French heath research organisation for knowledge transfer, cooperation and collaboration in the area of cancer research and chronotherapy. Key areas of KT include: multi-scale physiologically-based modelling for personalized therapeutics; multidimensional time series analyses and forecast systems; modelling, data analysis and bioinformatics techniques for biological understanding of cancer and circadian processes. A collaboration with Philips on building an environment for a health body clock has emerged from this.