Feedback from 10 years of Industrial Mathematics in Ireland

Mathematics Applications Consortium for Science and Industry, University of Limerick, Dr Sinéad Burke
MACSI founded in 2006
### 8-9th December 2016, University of Limerick

<table>
<thead>
<tr>
<th>8th December</th>
<th>9th December</th>
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<tbody>
<tr>
<td>11:00</td>
<td>09:30</td>
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<tr>
<td>Outline on SFI/ERC and IRC of Funding Opportunities for Industry-Academic Collaborations</td>
<td>Professor Dietmar Hoemberg, President of the European Consortium for Mathematics in Industry (ECMI) and Weierstrass Institute for Applied Analysis and Stochastics</td>
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<td>12:00</td>
<td>10:30</td>
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<td>Registration</td>
<td>Industrial Mathematics in Europe and Further Afield</td>
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<td>• Professor Eddie Wilson Chair in Intelligent Transport Systems, University of Bristol</td>
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<td>• Dr. Paul Dellar, University Lecturer, Oxford Centre for Industrial and Applied Mathematics (OCIAM)</td>
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<td>• Dr. Michael Wynnwy, Department of Materials Science &amp; Engineering, Royal Institute of Technology, Sweden</td>
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<td>12:30</td>
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<td>Networking Lunch</td>
<td>How the MACSI Experience has Influenced Careers Abroad</td>
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<td>• Dr. Vincent O’Regan, Research Fellow, CRM, Barcelona</td>
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<td>• Dr. Joanna Jordan, Manager, Institute for Mathematical Innovation, University of Bath</td>
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<td>• Dr. Mel Devine, Research Fellow at the Economic and Social Research Institute</td>
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<td>12:45</td>
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<td>Networking Lunch</td>
<td>MACSI Director: Professor Stephen O’Brien. Announcement of Thesis in 3 Winner and Closing Remarks</td>
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**Sponsored by**

- Science Foundation Ireland
- Analog Devices
- DELL
- Rusal
- Regeneron
- Teva
- University of Limerick
“Mathematics provides invisible solutions to visible problems”

Medical and pharmaceutical
- TEVA
- GE Healthcare
- Pfizer
- Boston Scientific
- Vistakon

Food and drink
- DIAGEO
- Manor Farm
- Rangeland Foods Limited

Materials and manufacturing
- RUSAL
- PHILIPS
- CP Cork Plastics
- Analog Devices

Finance and energy
- Bank of Ireland
- Bord Gáis Energy

Government and ICT
- Intel
- Dell
Visioning Exercise

Aim of the event?

• **Needs assessment** of Irish industry and research centers from mathematical sciences
• Discover how applied mathematical sciences can interact with **current and future** R&D needs
• Identify potential **new partners for future projects**
• Discuss appropriate **funding** mechanisms
What type of problems do we work on?

- **Data-driven knowledge generation**
  - Lacks information on physical aspects of the process
  - Accurate, robust and reliable models use both approaches
  - Parameter values difficult to estimate accurately

- **Fundamental knowledge of a process**
  - Data Modelling
  - Mathematical Modelling
Example Problems

Industry partner: Dell
Type: Multinational, with Limerick base for
  EMEA Service Parts and Logistics
  – Dell contracted MACSI to carry out 2 separate consultancy research on Forecasting Demand for Spare Parts at locations around the world
  – Analysed the datasets provided by Dell
  – Assessed the accuracy of in-house forecasting methods.
  – Developed a Poisson process model of demand that improves the accuracy of forecasts
  – **Results:** Implementation of recommendations of parameters to be used within in-house tool. IP ownership rests with Dell

Industry partner: Rusal Aughinish Alumnia
Type: Multinational, with Limerick base for extracting aluminium oxide (alumina) from bauxite (Bayer process)
  – Problem: Optimisation of bulk carrier loading & discharge at the Aughinish jetty
  – MACSI developed a queuing theory model of the shipping process, with input from an analysis of historical data
  – Implemented the model in a stochastic simulation tool
  – Analysed the results to determine optimal ship sizes, berth occupancy, and loading rates
  – **Results:** Specific recommendations for the optimal ship size and loading rates were delivered, that will yield improved berth through-put and avoid demurrage costs. “What-if” analysis of scenarios was also conducted to inform the planning of possible future capital investment
Industry: Philips
Type: Dutch-based multinational

Role of partner:

– MACSI and Philips scientists aimed to develop models to increase understanding of coffee extraction in drip filter brewing

– Philips carried out all coffee extraction experiments and measurements of material properties necessary to motivate, parametrise and validate the developed models

– Provided feedback and specific process expertise when required

– Results: MACSI developed and analysed a first experimentally-validated model of coffee extraction from a packed coffee bed. The work is described in 3 journal papers jointly published with Philips.
Reduction of Experimental Costs

Industry partner: Analog Devices
Type: Multinational semiconductor company
Reduce the need for costly experiments on polysilicon fuse components
Developed a multiphysics compartment model describing electronic, thermodynamic and fluid mechanical phenomena

Result: The model generated quantitatively accurate results, thereby reducing the amount of experimentation required

Industry partner: Printing Company:

Optimisation of the design of innovative inkjet printing technology
Developed a reduced fluid-structure interaction model and implemented in a simulation package
Using the simulation tool an optimisation algorithm for finding design parameters was developed

Result: An efficient algorithm for accurately targeting the region of design space for innovative new products, at a fraction of the computational cost of previous approaches
Your needs – now and over next 10 years…

• What are your needs?
• List them under **data** modelling & **mathematical** modelling

How do you see MACSI’s expertise fitting in to your current business model?

*Companies*

• Or do you want to consult directly with MACSI?
• Would you be interested in partnering with some of the available State funding initiatives?
• Train your staff?

*Research Centers*

• How best to work with you?
• Partner in SFI Spokes?
• Provide FI’s in your Centre?
• Horizon 2020 consortia
(Teva) has more need for mathematical models than data-driven models. Teva frequently employ external consultants as academics tend to be slower, albeit inexpensive.

What is the difference between data modelling and mathematical modelling?

MACSI should come up with models/tools that can be applied to similar problems and pro-actively introduce them to the company.

Many companies share similar goals (e.g., optimisation of manufacturing process) in working with mathematical scientists, even if located in different sectors.

…work with CFD developers to enhance the power of that software.

Root cause analysis
Predictive maintenance
Digital twinning
Scalability
Bacteria-bacteria/drug-bacteria interactions

What is the difference between data modelling and mathematical modelling?
Zimmer may prefer to train an expert internally. Such **upskilling** may take many forms with, for example, masters’ programmes and weekly classes both mentioned.

…should work with large **Research Centres** (Ireland has 12 such centres) to augment **Horizon 2020 consortia** and increase the profile of mathematics

Free up **internal resources** to carry out small “consultancy” type projects

**Post-project** support important

**Secondment model** welcomed by companies

All companies happy for work to be **published** once discussion on how data could be “hidden”
Next steps?

- Lots of opportunities arose directly from the meeting
  - 1-day “study group” workshop with J&J in January
  - Organising meetings with Ireland’s 12 large-scale research centres to discuss H2020 opportunities
  - Enhanced development of shorter scale projects
- Medium/Long term developments
  - Discussions with Science Foundation Ireland to develop funding schemes suitable for this interaction
Thank you!