Mathematics in Industry
Past, Present and Future

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December 2016

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The past 50 years

N.B. Industry = Any activity of social or economic value

1. *IMPACT OF COMPUTERS*
2. *SPREAD OF APPLICATIONS TO NEW FIELDS*
3. *EVOLUTION OF THE INDUSTRIAL MATHEMATICIAN*

- *Works with 'applied scientist to set up model*
- *Has a toolbox of mathematical and computational methods.*

Milestones

- 1966 Report by Royal Society of London
- 1968 First Study Group with Industry (L.Fox, A.B.Tayler) in Oxford
- 1974 Maths Clinic started in Claremont USA
- 1985 Foundation of European Consortium for Maths and Industry

- 1985 First Australian Study Group
- 1985 First US workshop on Mathematical Problems in Industry
- 1989 First UK Study Group outside Oxford
- 1997 First Canadian Industrial Problem-solving Workshop
- 1998 First ESGI in Denmark (first outside the UK)
- 2000 Chinese Workshop on Industrial Applications
- 2004 First Maths in Industry Study Group in South Africa
- 2011 First Malaysian Maths in Industry Study Group
- 2016 First ESGI in Cyprus!

Study Groups are now held regularly in at least 14 countries and have been held in at least 26 different countries

Evolution of the Industrial Stimulus

Year	Problem Category
1968-80	Interdisciplinary modelling of physical processes, mostly deterministic **Differential Equations**
	Formulation and validation of **Algorithms**
1980 to date	Problems with **codes/algorithms**
1980's	More stochastic problems, stimulated by **Finance**
	More ill-posed/inverse problems **(Parameter Identification)**
2000	Beginning of dominance of discrete problems, **Networks**, **Data**, **Multi-scaling**
2010	**Social Science** modelling
	Environmental modelling, **Agriculture**

How to include students

Train to think on their feet, interact with non-mathematicians, have an open mind .... via

- Modelling classes/ Case studies
- Modelling weeks
- Study Groups
- Industrial Projects - from 6weeks to 3 years

e.g. MSc in Mathematical Modelling and Scientific Computing.

INFOMM Doctoral Training

https://www.maths.ox.ac.uk/study-here/postgraduate-study/industrially-focused-mathematical-modelling-epsrc-cdt

Why is Maths-in-Industry thriving?

1. Industrial research is always interdisciplinary
2. Growing pressure on academics to make their research more relevant (IMPACT).
3. Burgeoning student demand for courses that lead to jobs.
4. Intellectual benefits to academics – many areas of maths have been stimulated by industrial problems. E.g.

Some academic areas stimulated

- The pantograph equation (Transport)
- Violent impact in liquids (Shipbuilding)
- Singularly perturbed systems (Energy)
- Auction Modelling (Government)
- Complex Ray Theory (Defence)
- Free Boundary Problems (Manufacturing)
- Inverse Problems (Various)

5. Benefits for Industry

- Modelling leads to understanding
- Feasibility studies to assess new processes
- New and improved simulations
- Recruitment of students
- SMEs can obtain expertise

The Future

- International networking: Started in 1984 but has grown fast recently
- Communications networks and databases, e.g.
  - Maths in Industry Information Service (www.maths-in-industry.org/)
  - ECMI (www.ecmiindmath.org/)
  - EU Maths In (www.eu-maths-in.eu)
  - APCMfI (http://apcmfi.org/)
  - MI-NET COST network (https://mi-network.org/)

All these are vital to avoid duplication of effort

Finally:

- Plugging the gap between TRL 3 and 7

  Technical Readiness Level 1,2 – academic research

  TRL 8,9 – deployment of results

- Bilateral funding is essential to maintain stability under economic fluctuations and provide administrative support.
- Need for Hubs which provide necessary underpinning and can develop expertise in TRL 3-7. (eg Smith Institute in UK)

All this is vital if the industrial mathematics community is to maximise its creativity and provide educational inspiration.