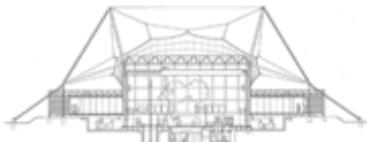


Mathematics is the new R&D

Priscilla Canizares

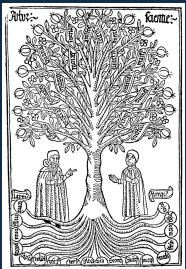


Mathematics is alive and well, but living under different names

[4]

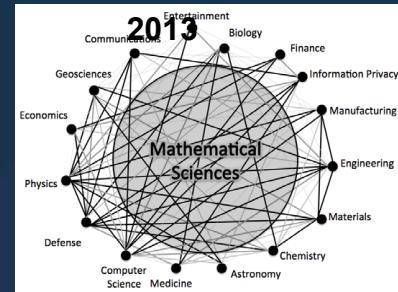
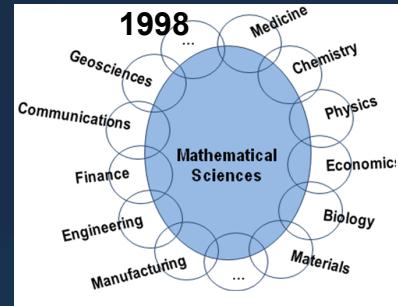


Mathematics without borders



Mathematical Sciences

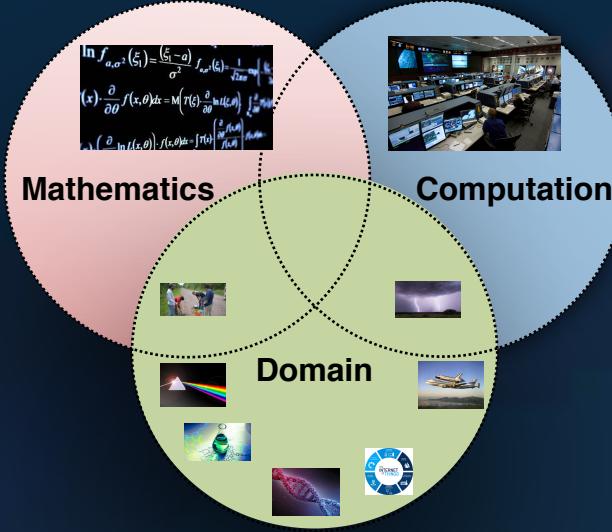
- Discovery, innovation
- Complex problems require good mathematical foundation.
- Mathematics is interdisciplinary



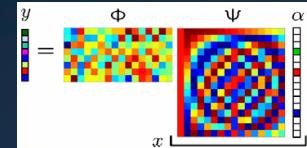
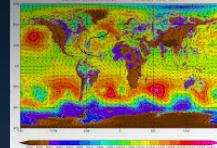
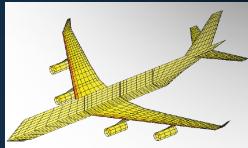
[5]

The rise of computer technology

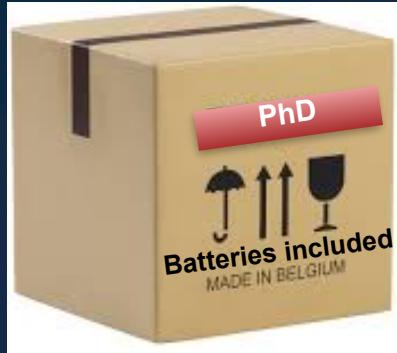
- Demand of mathematical skills
- More powerful computers
- Dependence on computer simulations & large data
- Mathematics as framework for new science



$$\begin{aligned} U &= \mu_y^2 \theta_y + \mu_x^2 \theta_x + \chi \theta_x \theta_y \\ \nabla_y \cdot (\gamma \cdot \nabla u_i E) &\\ \sum_{j \neq i, j \neq x} \alpha_{ij} \nabla \theta_j &\\ S_T = \int_{\Omega} U(I_t, \theta_x, \theta_y) dS + \lambda \int_{\Omega} dS + \mu \int_{\Omega} dV \end{aligned}$$



Academics in industry



- Science is the same
- Practical vs Fundamental problems



CV

PhD in...Physics, Biology, Chemistry, Geology, Engineering, astronomy, etc

Skills:

- Applied mathematics, problem solving, data analysis, Bayesian learning, uncertainty quantification.
- Mathematical analysis, modelling & Algorithm development

Programming:

Python, C++ (keen on learning new languages) Matlab, Mathematica, latex, SVN, GIT, GitHub, Bitbucket..

High performance computing:

Parallel & distributed. Proficient in analysing big data.

Mathematical tools available vs demand

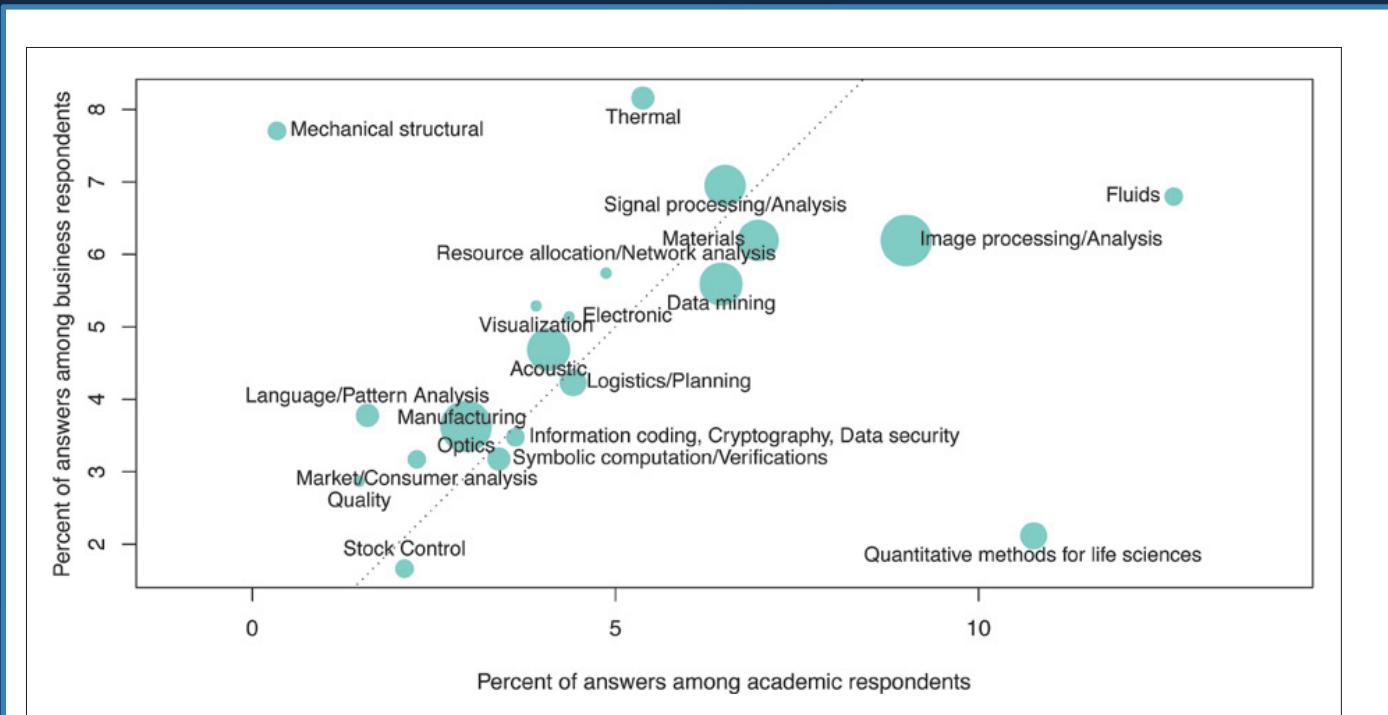


Figure 2. Main areas of competence available in academia versus major business challenges perceived by the industry. Size of the bubbles indicates total number of respondents.

[2]

Mathematics in industry – vital in a knowledge-based economy

Figure 4.1.2. Direct jobs in mathematical science occupation employment as a percentage of all jobs in that sector, 2010

Top 20 sectors

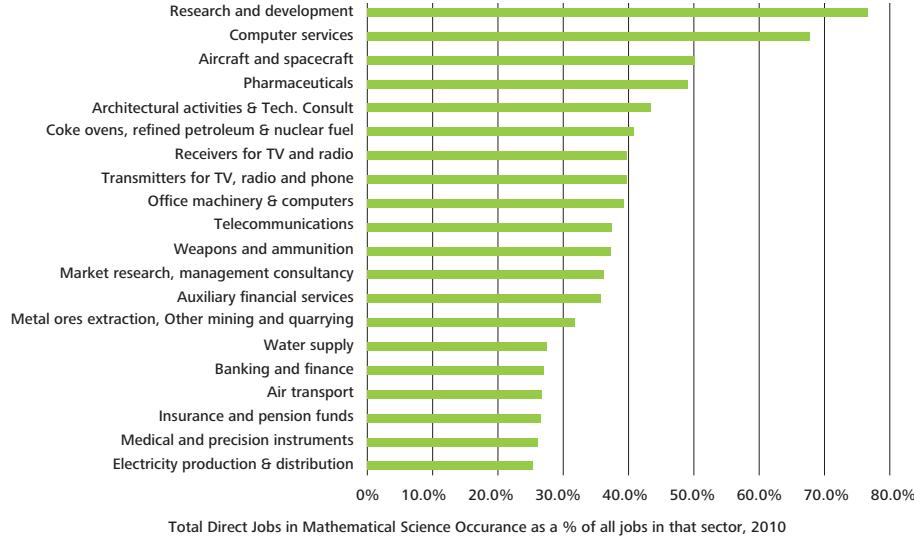
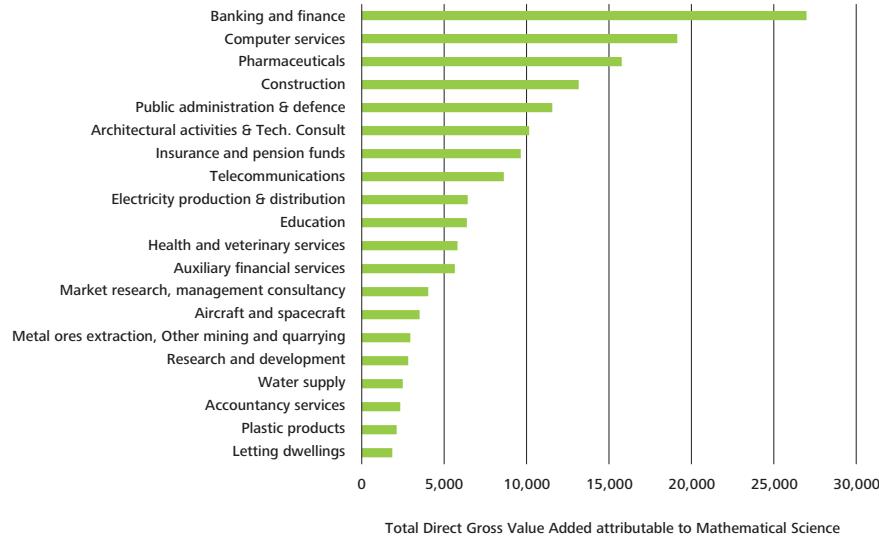


Figure 4.2.1. Top 20 sectors for direct mathematical science GVA in the UK, 2010, £m

Top 20 sectors



Source: Deloitte using ONS data

[3]

Contribution mathematics is significant in UK economy

Source: Deloitte using ONS data

Schlumberger Cambridge Research



World's
leading provider
of technology
for reservoir characterisation,
drilling, production,
and processing to
the oil and gas
industry.

Schlumberger Fact sheet

- Research comprises from engineering problems to fundamental research of natural phenomena.

- Employs around 4500 scientists and engineers in more than 60 R&D centres world wide,
- Has five major laboratories in the UK.
- Schlumberger Cambridge Research has about 120 scientists.

- Collaboration with Universities: Southampton, Cambridge, Oxford and Edinburgh
- Main funding EPSRC (master and PhD students)
- Patented technology and establishment of spinout companies.

Main research projects:

- Automation and control: automated drilling operation to reduce personal and environmental risks.
- Sensing: Ensuring the safety and efficiency of oil and gas operations and preventing leakages

Sensing, Automation & Control



Worker and environment safety in oil fields has utmost priority because it deals with dangerous operations in remote locations



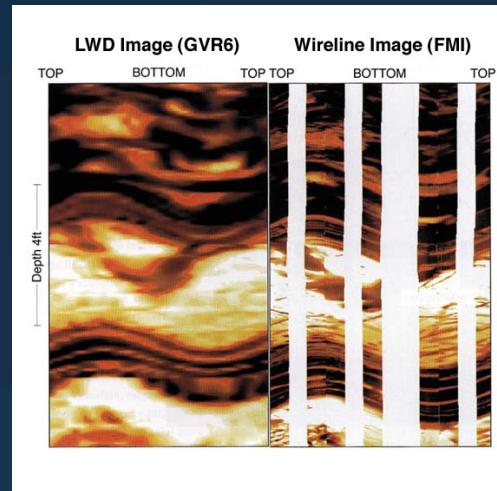
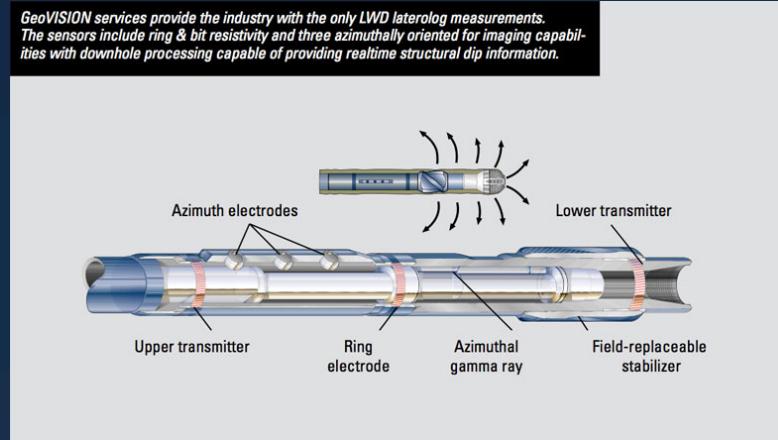
Internet of Things platforms. Eliminate the need for workers to go to hazardous locations.

Improve Decision Making, Production and Maintenance Planning, Optimisation, Availability and Safety

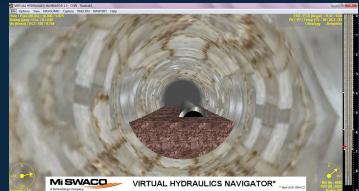
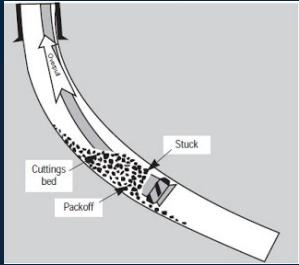
Sensing

Sensors, providing both real-time analysis and post-acquisition processing.

- Based on sampling technologies
- Real-time detection and estimation of overpressured formations

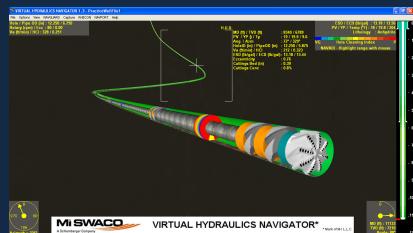


Automate drilling process



Understanding mechanisms + data

Which are the control parameters, which
are the constraints and what is the goal

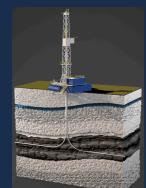


Mathematical model

1. Numerical simulations,
2. Validation of the model with data
3. Adapt the model

Improve, optimise & control the process using online data

Hydrodynamics,
chemical kinetics,
geology, differential
equations, stochastic
analysis, uncertainty
quantification,
Learning algorithms
....



Thank you for your attention!

References

- [1] Philip Bond (2018): **The Era of Mathematics**. An Independent Review of Knowledge Exchange in the Mathematical Sciences.
- [2] European Science Foundation. **Mathematics and Industry** (2010).
- [3] Deloitte. **Measuring the Economic Benefits of Mathematical Science Research in the UK** (2013).
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- [5] The National Academy of Sciences. **The Mathematical Sciences in 2025** (2013) .
- [6] <https://epsrc.ukri.org/newsevents/multimedia/business-engagement-schlumberger/>
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