

The Era of Mathematics – Knowledge Exchange in the 21st Century

Professor Philip Bond BSc DEA DEA DEA FIMA FInstP GMM

Why it REALLY matters



Why does impact matter ?

- We all want to live in a fair and free society.
- We want cleaner air to breathe, to use greener energy, and to ensure that we have a planet that is habitable in 100 years time.
- We want to have healthy lives, be defended from threats and live with dignity.
- We want to communicate with a huge number of people yet maintain and control our privacy.

Why does impact matter ?

- In short, we want to have rising standards of living achieved in a sustainable way. That means doing more with fewer resources.
- It means creating new things – innovations that will enhance our lives.
- So what creates a rising standard of living ?
- and, as a nation, how is 'UK PLC' doing in this respect ?

Productivity and Standards of Living

- Paul Krugman, Nobel Prize in Economics 2008.
- ‘Productivity isn’t everything but in the long run it is almost everything’.

UK productivity shortfall with the G7 relatively stable.

Current price GDP per hour worked

US productivity was 28 % higher than the UK and 40 % higher on a per-worker basis.

French productivity was 28 % higher than the UK.

German productivity was 30 % higher than the UK.

So how do we expect to have comparable living standards ?

Productivity and Innovation

- Roughly speaking, 50 % of the increases in productivity that occur are due to two related factors : the development of innovations and the uptake of innovative technologies.
- So if we want to have a rising standard of living – and hence pay for healthcare, defence, pensions, carbon taxes, and so on – we need to become far more innovative and far more effective at driving innovation into the economy.
- UK productivity growth flatlined after 2008 and is still looking subpar.

Innovation – what it is and how to get it

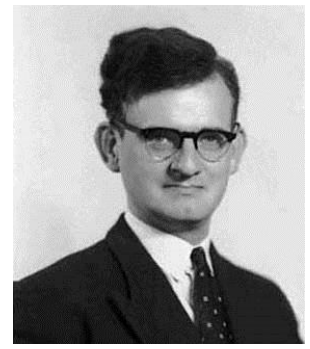
The FIVE key disciplines of Innovation ...

- (1) Focus on important needs. *‘Work on what is important, not just what is interesting – there is an infinite supply of both.’ Frank Guarnieri.*
- (2) Create value.
- (3) Innovation champions.
- (4) Form an innovation team.
- (5) Organisational alignment.

What has this got to do with us ?

- Fundamental research has its place...
- ...but impactful mathematics is innovation-orientated.
- Research = write a nice paper.
- Innovation = find a real-world need & supply a real-world solution.
- Mathematical sciences can cover the full spectrum. The Newton Gateway helps forge the connections.

An Exemplar : Sir James Lighthill



- Important needs : Worked on commercial television and communication satellites / supersonic aircraft / jet noise / ...
- Create Value : Concorde / Harrier jump jet.
- Innovation champion and teams : Example : Chair of the Special Committee on the International Decade for Natural Disaster Reduction 1990-1995.
- Organisational alignment : Created the IMA and became its first President in 1965-67.

Key Questions

As a community, how good are we at research ? At innovation ?

Do we take time to look for the big challenges and get involved ?

Do we focus enough on 'important needs' or just 'interesting stuff' ?

How much do we think about value creation ?

Do we have innovation champions ? Does our infrastructure support team work well enough ?

How did the Mathematical Sciences Stack up in the 2014 REF ?

- Impact case studies submitted

- Chemistry 152
- Physics 203
- Computer Science 280
- Aero,Mech,Chem,Manufacturing Engineering 138
- Electrical, Electronic, Metallurgy, Materials 141
- Civil and Construction 51
- General Engineering 291

- MATHEMATICAL SCIENCES 236

National spend by subject : ratios to cost

- | | | | |
|-------------|-----|--------|----|
| • Physics | 203 | £2494m | 8 |
| • Chemistry | 152 | £1049m | 14 |
| • Math. Sci | 236 | £ 354m | 66 |
- Which makes mathematicians 8 times as impactful as physicists. But you knew that, did not you ?

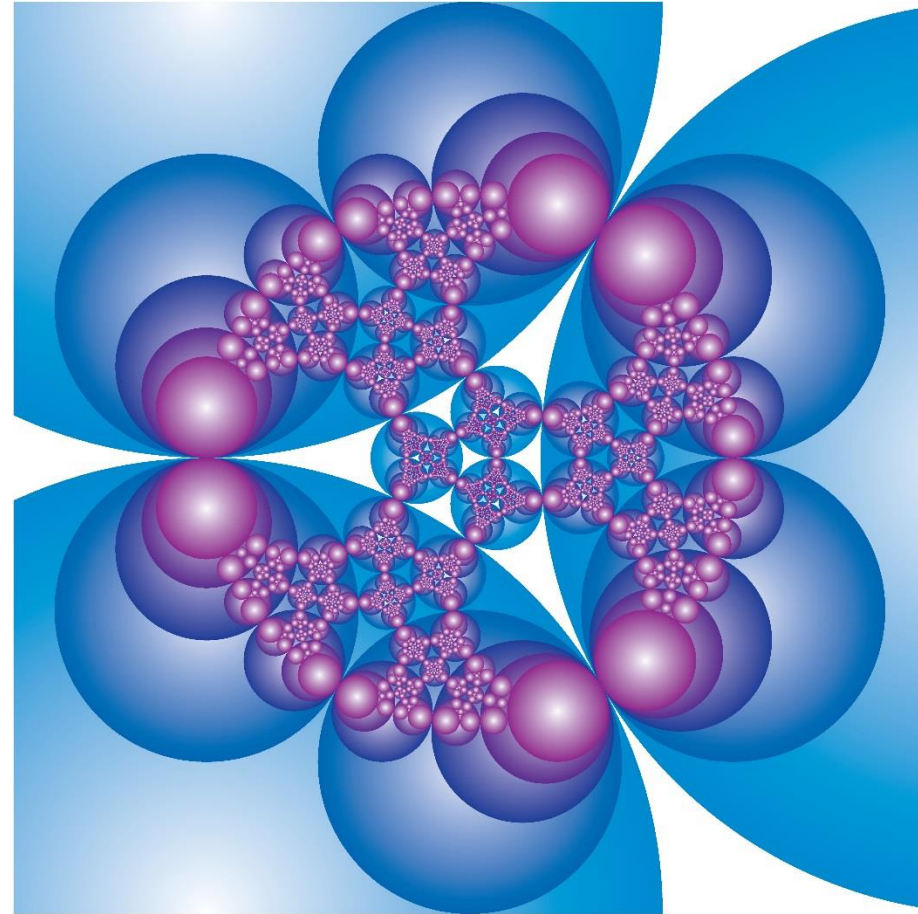
The Era of Mathematics

- We live in the Era of Mathematics.
- Virtually every new technology relies (often in a way that is 'hidden from sight') on mathematics.
- That includes 'management as a technology'.
- Demand for mathematics is increasing – see the thought pieces in the review.
- Mathematics should sit at the very heart of innovation. Making mathematics impactful is not a 'nice to have' – it is absolutely vital to achieving our core values as a society.

Some Key Challenges

- UK Research needs better alignment to industrial needs.
- **We need partnerships to make UK efforts achieve critical mass.**
- **We need adequate funding to drive innovation from mathematics into the economy.**
- **We need effective infrastructure to make this happen.**
- **We need to have the right career incentives and career structures in place.**
- **We need mathematicians willing and able to do more than write papers.**

Review of Knowledge Exchange in the Mathematical Sciences



Review of Knowledge Exchange in the Mathematical Sciences

Key questions : Is mathematics driving impact into the UK economy as it well as it could and should ? If not, what can we do to address the issue ?

- Three of the key issues that we address in the review : The need for new infrastructure, the need for new incentives, the need to engage effectively with UKRI.

Incentives

If people are to work on impactful mathematics then

People need access to 'problems to work on'.

People need more time to think and less distractions.

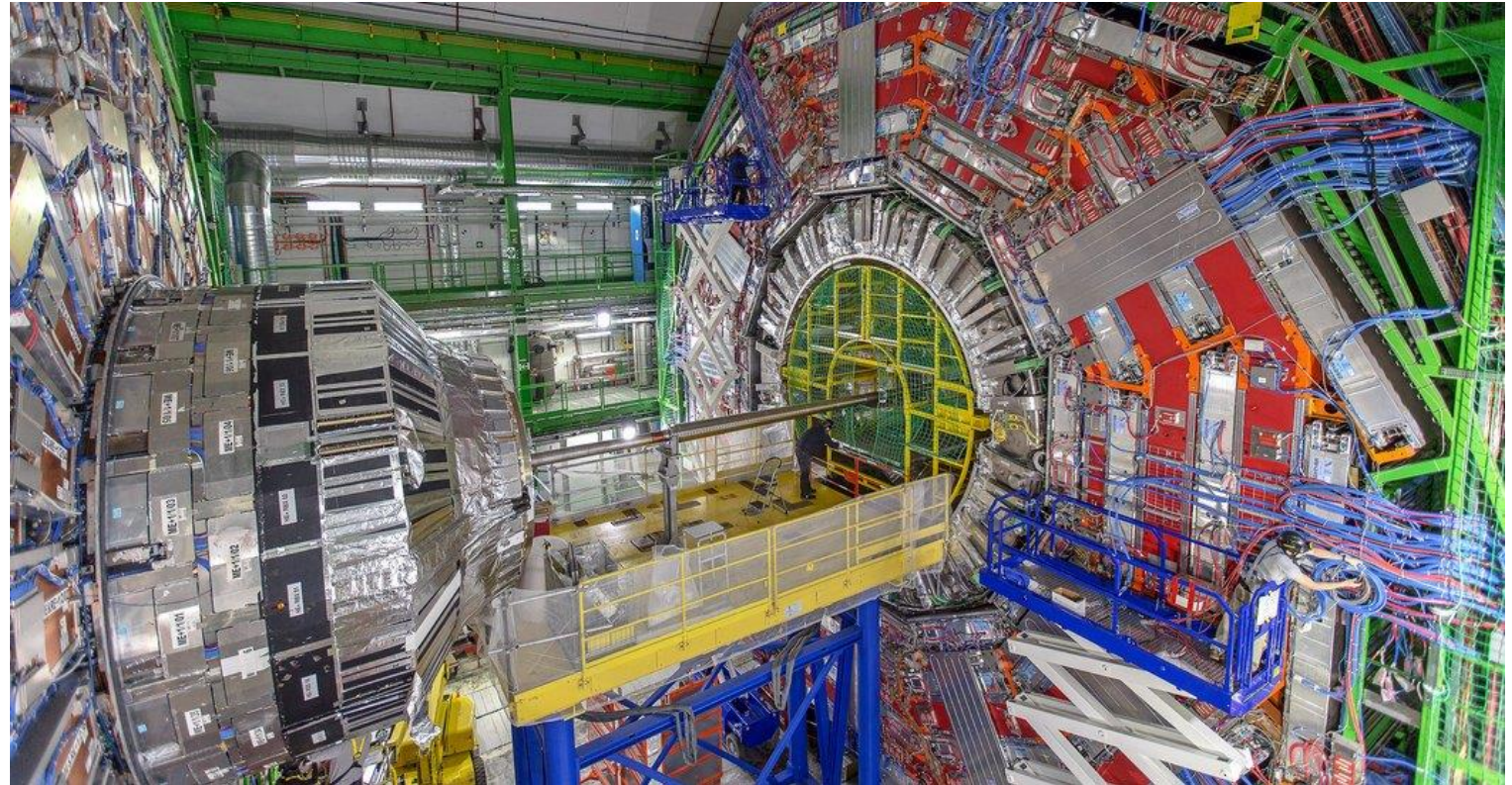
People need to have a better career if they make that choice.

We need more PhDs.

Strong incentives should be put in place for cross-disciplinary work between the mathematical sciences and other disciplines.

Infrastructure

- Here is infrastructure to a physicist ...



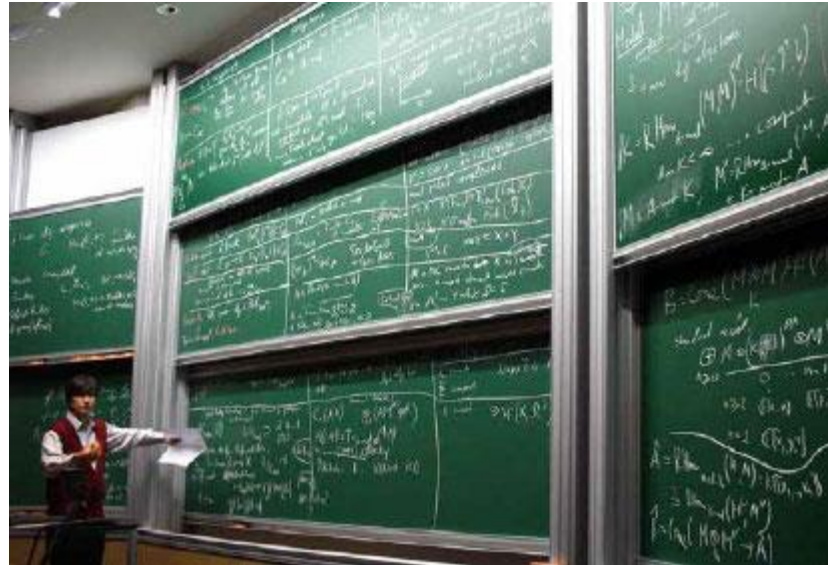
Infrastructure

- Here is infrastructure for a biologist



What does 'mathematics infrastructure' look like ?

- Here is what people often think of as infrastructure for mathematics



- This is NOT the key infrastructure of mathematics !

What is infrastructure for mathematics ?

- Infrastructure for mathematics takes many forms – the majority are intended to do three things usefully
- (1) Enable people to network.
- (2) Have a place that people can physically meet in addition to ‘virtual’ institutes.
- (3) Create an environment conducive to research.

Infrastructure should support research and, crucially, innovation.

The Newton Gateway

Mathematical Infrastructure that works

- Networking – as opposed to working in ‘silos’ ?
- Networking with industry, the service sector, with government.
- Cross-disciplinary engagement.
- As a community we need to better engage with the Industrial Strategy challenge fund or Global Challenges fund.