

MATHEMATICAL SCIENCES RESEARCH – Leading the Way to UK Economic Growth



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Working in partnership with the Council for the Mathematical Sciences (CMS), the Engineering and Physical Sciences Research Council (EPSRC) commissioned a study which has shown that 10 per cent of jobs and 16 per cent of Gross Value Added (GVA) to the UK economy stems from mathematical sciences research.

The report, by Deloitte, was the first of its kind, and reflects the excellence of the UK mathematics research base, that has generated a range of impressive and far-reaching impacts.

The fruits of mathematical research affect the daily lives of everyone in the UK, for example:

- Smart-phones which use mathematical techniques to maximise the amount of information that can be transmitted
- Weather forecasting is based on complex mathematical models
- The latest Hollywood blockbusters take advantage of the mathematics behind software for 3D modelling to showcase cutting-edge special effects
- Elite athletes at the 2012 Olympic Games used tools based on sophisticated mathematics to maximise their performance.

It is not just contemporary mathematics research that has an impact. Research from the past century has paved the way



for technology used in a range of activities, goods and services, such as mobile telecommunications and medical devices.

ECONOMIC IMPACT

The report estimated the contribution of mathematics to the UK economy in 2010 to be 2.8 million in employment terms (around 10 per cent of all jobs in the UK) and £208 billion in terms of GVA contribution (around 16 per cent of total UK GVA).

In addition to these direct impacts, mathematical research activities have influence across the supply chain (indirect effects) and also affect household spending (induced effects). There are also wider impacts and benefits generated by organisations using the research.

Productivity (as measured by GVA per worker) is significantly higher in mathematical science occupations compared to the UK average, and as such the direct GVA impact of mathematics in 2010 is

proportionately higher than the share of employment (16 per cent versus 10 per cent).

The direct contribution of mathematics is highest in research-dependent industries such as computer services, aerospace and pharmaceuticals. Mathematics plays a key role in tackling the modern-day challenge of cybersecurity,

CONTRIBUTION OF MATHEMATICAL SCIENCES

- 10% of UK jobs, 16% of UK GVA
- Productivity of mathematical science occupations is double the UK average
- UK maths accounts for:
 - 4% of world maths researchers
 - 6% of mathematical articles
 - 11% of mathematical citations
 - 14% of highly-cited articles.



Professor Frank Kelly
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... personalised healthcare ...

ensuring that the UK is a safe place to do business and that we all benefit from a secure and resilient cyberspace. It is part of the 'big data revolution' with the development of massive databases and energy-efficient computing – both key areas highlighted by the government for excellence and contribution to economic growth – resulting in the need for new tools from the mathematical sciences.

UK manufacturing sectors such as aerospace, the second largest in the world, benefits from a highly-skilled home-grown workforce, superior manufacturing processes and sophisticated quality management systems – all made possible by research and training in mathematics.

High levels of employment associated with mathematics include sectors such as public administration and defence, architectural activities and technical consulting, construction and education. Mathematical science occupations include not only professional mathematicians and statisticians, but also engineers, physical scientists, IT professionals, social scientists, finance professionals, medical practitioners, administrators and senior managers.



HOW MATHEMATICS CONTRIBUTES TO THE UK ECONOMY AND SOCIETY

Through its contribution to the development of a skilled workforce, the production of high-end, value products and the development of quality processes, mathematics enables us to:

- Make sense of data and better understand the world by building the 'information infrastructure' upon which myriad businesses and individuals rely, and supply the tools and techniques to analyse and interpret large datasets
- Safeguard society by modelling the impacts of natural disasters, testing drugs and contributing to national security
- Create robust forecasts to address uncertainty and allow for better planning and optimising processes to increase efficiency.

The generation and application of maths drives economic growth and develops prosperity.

UK LIFE SCIENCES SECTOR

Without mathematics, the UK life sciences sector would not be in as strong a position to contribute to economic growth. It provides the expertise for the development of personalised healthcare and pharmaceuticals, as well as many medical technologies.

In the pharmaceutical industry, statisticians are involved in the design of clinical trials and also work across all areas of R&D, from the initial

A DEFINITION OF MATHEMATICAL SCIENCES RESEARCH

For the purposes of this study mathematical sciences research was defined as high-end research in mathematics carried out in academic institutions, research centres, the private sector, government and by individuals that adds to the store of accumulated mathematical knowledge.

Mathematical sciences occupations were therefore those which either entail maths or which directly require mathematics-derived tools and techniques.

identification of medicines to product manufacture. In 2010 R&D expenditure amounted to £4.6 billion – 29 per cent of all UK R&D spend and the greatest in Europe.

Britain is a leading location for running the complex and often multinational studies needed to develop new medicines. The industry makes a substantial contribution to the British economy in terms of both income and employment, and has generated a trade surplus for the past 13 years. Exports exceeded imports by over £5 billion in 2011. The Government has identified the pharmaceutical sector as one of the industries to pull the UK out of the current recession.

WEATHER FORECASTING

Mathematics continues to play a role in weather forecasting and modelling. The cost of not predicting changes in the physical world can be

immense. Natural disasters have cost the global economy over £100 billion in 2011 – the costliest in over 300 years of the insurance industry. With the effects of climate change becoming clearer, through extreme weather events, the demand for robust forecasts is greater than ever.

Around 2,000 mathematicians are employed by the UK Met Office to analyse and evaluate vast amounts of atmospheric information.

The UK is regarded in the meteorological industry as a talent hub with many institutions choosing to locate research facilities in the UK to take advantage of the high-quality workforce.

Mathematical sciences underpin our 21st century technology, economy and society, and as such are vital for the prosperity of the UK and its position in the world economy.

THE TIMING OF ECONOMIC IMPACT

The study took into account the contribution of both contemporary research and past mathematics research since the full economic impact of a given piece of research may not be felt immediately.

A classic example is the Radon Transformation in topography, first introduced by mathematician Johann Radon in 1917. This research provided the mathematical basis for non-invasive imaging technology used in CAT scans and barcode scanners introduced over 50 years after Radon's breakthrough. Clearly, research performed nearly a century ago continues to benefit the UK economy and society today.