ENGAGING MATHS
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My Lords, Ladies and Gentlemen, my proposition – or to borrow a mathematical term – my theorem, is straightforward.

The wellbeing of our economy, and indeed our society generally, depends in large measure on the competitiveness of British industry.

Increasing our global competitiveness depends on increasing the rate at which we innovate.

And increasing the rate at which we innovate depends on mathematics. It's true for all companies, in all industrial sectors. And it's always been true.

I'm an electrical engineer. So one of my great heroes is Michael Faraday. One of the greatest experimental scientists ever, who, on 29th August 1831, discovered the means by which we now generate electricity continuously.

Without that discovery, I wouldn't have a profession. And without another discovery that he made fourteen years later, I wouldn't have a job. And none of us would have radios, televisions or mobile phones.

It was a discovery that I think is particularly revealing about the role that maths plays in innovation.

In 1845, Faraday performed a decisive experiment to show that electricity and magnetism are related to light. He suggested that the nature of that relationship is that all forms of electromagnetic energy travel in waves.

He described his idea in plain English. He had no choice. Because he was no mathematician.

Indeed, he admitted that he had only once in his life performed a mathematical operation – when he turned the handle of Babbage's calculating machine.

Faraday knew that, ultimately, the further development of his idea about the relationship between electricity, magnetism and light would depend on being able to describe that relationship mathematically.

Well, a few years later, James Clerk Maxwell did just that. With 56 pages of closely written equations. He confirmed that electricity, magnetism and light take the form of waves. He predicted that electromagnetic waves travel through space at the speed of light. And, best of all, he set out his conclusions in language which, 150 years later, is just as understandable by today's scientists, engineers and mathematicians.

Mathematics is a language which transcends national boundaries, cultures, age, scientific fields, industrial sectors – and time.

If we were to set out to design a language specifically to harness the innovative diversity in our society, it is unlikely that we could improve on maths.

Mr Faraday and Professor Maxwell. The experimental scientist and the mathematician. Which of them should I and two-and-a-half-billion other people around the world thank for beginning the innovative trail that gave us our mobile phones?

Both of them, in equal measure. They would have thought that right. Because they knew that it is hard, perhaps impossibly hard, to innovate alone.

When Faraday read Maxwell's work, he wrote:

"I was at first frightened to see such mathematical force made to bear upon the subject, and then wondered to see that the subject stood it so well."

The tonality of an innovative partnership – collaboration not competition – is so important.

Faraday and Maxwell set the standard for us all.

Rigour, communication and collaboration. All are accelerants of innovation. And all are aided by maths.

But there is a fourth accelerant, which is uniquely a property of maths.

The ability for scientists, engineers and technologists – indeed all of us – to work at higher levels of abstraction.

We engineers have always worked in the abstract, of course. How else could any of the pioneers of my profession, from Faraday onwards, have completed so many projects in one working lifetime?

Today's engineers never would complete anything if they had to master every detail. To come to terms with the increasing richness of engineering, we must work at a level of abstraction.

The development of software engineering depended on recognising that truth. In 1975, Fred Brooks, a Fellow of the Royal Academy of Engineering, wrote:

"The programmer, like the poet, works only slightly removed from pure thought-stuff. He builds his castles in the air, from air, creating by exertion of the imagination."

That was more than a quarter of a century ago, when software engineers had workstations and hardware engineers had benches. But things have changed.

Now we all have workstations. And we are all building castles in the air, from air. With breathtaking speed.

These ‘castles’ are mathematical models, of course. Then we use more maths to turn the models into tangible reality – into products – nearly as quickly.

Abstraction and cycle time are related. The higher is the level of abstraction, the shorter is the cycle time.

And, since cycles present opportunities for us to learn, every cycle drives the level of abstraction a little higher. And shortens the cycle time a little more.

Increasing abstraction and shortening cycle time. If those are the keys to innovation, then mathematicians are the locksmiths.

Ladies and gentlemen, all of us depend on the competitiveness of British industry.

Competitiveness is a function of innovation.

Innovation is a function of mathematics.

QED.