Newton’s Mechanics: Who Needs It?

This question challenged delegates at a symposium, held at the Møller Centre, Cambridge, in July 2008. They were faced with a growing problem arising at the school-university interface, a problem affecting schools and universities, industry and the Government’s STEM agenda:

Newtonian mechanics plays a vital role in preparing students at 16-19 for physics, engineering and applied mathematics at university but each year more students arrive with little or no experience of it.

But just how vital is the role of Newtonian mechanics? Is there a decline in access and take-up at 16-19? If so, what impact does that have and what can be done about it?

The symposium brought together physicists, engineers and applied mathematicians, participants from schools, colleges, universities, and from business and industry to examine the problem and find solutions. Over the course of two days delegates heard evidence and opinion from experts in education and industry; they considered reports from universities on the impact of the decline of pre-university mechanics on students starting degree courses; they discussed data from examining bodies on the take-up of mechanics as part of A level Mathematics. Their key findings can be summed up:

• There has been a significant decline in the take-up of mechanics at 16-19 following curriculum changes in 2004. Students in 30-40% of schools and colleges now have minimal access to mechanics modules (at most one).

• Urgent action is now needed to increase access to and uptake of Newton’s mechanics at ages 16-19.

It was agreed that the action needed was not for universities to take alone; it could not be taken by schools and colleges alone. Action was needed across the transition.

University representatives argued that sixth formers should have access to at least two modules of mechanics. Schools and colleges were equally insistent that if university departments want students with a mechanics background they should specify, in their prospectuses and offers, how many mechanics modules are expected for their degree courses. Nothing would happen, though, unless both sides acted together. So complementary, balancing recommendations were made, proposing realistic action to be taken now – action for schools and colleges to take, and action for universities to take.
This was characteristic of the outcomes of the symposium, of the planning which had led to it and of the report on what took place. A steering group representing schools, colleges and universities had planned the symposium and ensured participation from a range of viewpoints. Compilation and editing of the report, published January 2009, has similarly been a joint responsibility. The report summary below highlights its key recommendations. They propose practical measures which can be implemented immediately if support can be found to match the energy and enthusiasm of the symposium speakers and delegates.

Summary of the Report,

*Newton's Mechanics: Who Needs It?*

The importance of Newton's mechanics

The symposium was set in context by the personal views of speakers with a concern for the UK's contribution to science and engineering. Sir Peter Williams spoke of the importance of Newton's mechanics to the UK economy. Dawn Ohlson of Thales Aerospace, outlined its place in a career in mathematics and engineering. Sir David Wallace stressed its importance as the foundation on which so much later development in science and engineering was built.

Key recommendation 1: Careers

Universities and employers should build upon links with schools and colleges to emphasize that degrees which develop mathematical modelling and problem-solving skills, based on a foundation of Newtonian mechanics, can lead to stimulating and rewarding careers.

The mechanics curriculum in decline

Against a broad outline of A/AS level Mathematics development over the last fifty years, a detailed examination of the effect of recent AS/A level Mathematics curriculum changes in schools and colleges was presented and discussed. Recent research shows that:

- students have limited access to mechanics modules (at most one) in 30-40% of schools and colleges;
- the impact of 2004 curriculum changes has led to a significant decline in the take up of mechanics modules as part of A level Mathematics.

Key recommendation 2: Student information

Schools and colleges should ensure that students intending to study physics or engineering in Higher Education know that:

(i) the content of mechanics units within AS/A level Mathematics provides important background knowledge for such university courses; and
(ii) studying mechanics is an excellent way to develop mathematical modelling and problem-solving skills.

Key recommendation 3: Teacher training

Courses and resources in mechanics should be provided:

(i) within initial teacher training for all secondary mathematics and physics teachers; and
(ii) for continuing professional development of practising mathematics and physics teachers.

The impact on Higher Education of the decline in mechanics studied at A level

A common picture of a growing problem is emerging from studies in university departments of engineering and physics in the UK and across Europe, the situation being more acute in the UK.

Key recommendation 4: Universities’ expectations

University departments of physics, engineering and mathematics should specify how much mechanics they would like prospective students to have studied.

Enhancing the take-up of Newtonian mechanics at ages 16-19

Action being taken to make further mathematics tuition available to all students is encouraging. There are initiatives at work in universities. The introduction of the Engineering Diploma also has the potential to improve students’ knowledge of mechanics.

Key recommendation 5: Access

Schools and colleges offering A level Mathematics should provide access to tuition in both Mechanics 1 and Mechanics 2, either as part of A level Mathematics or as part of AS/A level Further Mathematics.

Schools and colleges that cannot provide such tuition directly should collaborate with other local schools and colleges, or with external providers, to ensure their students can access tuition.

Discussion groups took place after the input from the speakers and fed into the key findings and recommendations related to each of the themes above. In four groups over two sessions the groups considered the questions:

What constitutes an adequate preparation in Newtonian mechanics for students entering Higher Education in engineering, physics and applied mathematics?

How can teachers and students be supported in studying Newtonian mechanics, both at school/college and university levels?

What recommendations can we make to improve new undergraduates’ mathematical modelling and problem-solving skills?
The discussions also covered review and comment on demonstrations and resources in use and under development.

**Key recommendation 6: Resources**

Funding should be made available to create innovative and inspirational mechanics resources and integrate them into the teaching and learning of mechanics on both sides of the school/college – university interface.

The emphasis of these resources should be to help develop students' modelling and problem-solving skills.

**Taking action**

The report, *Newton's Mechanics: Who Needs It?* is aimed at those in universities with responsibility for admissions in mathematics and science-based subjects, particularly physics and engineering, and wherever mathematical modelling and problem-solving are key skills. It is further aimed at those in schools with a responsibility for giving students access to studying mechanics and further mathematics. It aims to influence those involved with the design and content of mathematics, physics and engineering curricula at this level, and all those who wish to inspire young people with the excitement, skills and opportunities which Newton's mechanics opens up for them.

As the report hits the desks of policy makers and leading figures in education, science and industry, may it inspire them too. Can we together apply our problem-solving skills to find a solution to the mechanics problem at the transition to university?

The report, *Newton's Mechanics: Who Needs It?* (shown above) is available online at [www.mathstore.ac.uk/mechanicsreport/](http://www.mathstore.ac.uk/mechanicsreport/) or for a print copy contact Janet Nuttall:

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