This article reports on a pilot ‘Magic of Mechanics’ event that took place on 6th January 2005. The Mathematics Education Centre at Loughborough University ran the event for students from Burleigh Community College, Loughborough. The primary aim of the event was to introduce the students to mechanics and to generate within them an interest in the subject.

Background on Mechanics in Schools

There is growing concern at the decline in the number of students studying mechanics at A-level standard and the consequences of this for relevant undergraduate courses. This decline is in part due to the implementation of Curriculum 2000 [1], but also the subsequent changes in A-level mathematics in September 2004 [2], [3]. Figures on the uptake and availability of the applied modules that students can study at A-level, e.g. Mechanics, Statistics, Decision & Discrete, were put forward in a paper entitled “Mechanics Teaching in Schools: Implications for Undergraduate Engineering Courses” [4]. There it was shown that the availability and uptake of Statistics was greater than that of Mechanics. For example, 5% of schools did not offer any modules in Mechanics, whereas only 1.25% did not offer any Statistics modules. In addition, changes to A-level mathematics effective from September 2004 reduced the number of applied modules students are required to study and led to the expectation that, in the future, there will be even fewer students who have studied several mechanics modules entering higher education programmes. In response to this situation the Mathematics Education Centre at Loughborough University organised and ran a ‘Magic of Mechanics’ morning aimed at introducing mechanics to college students.

Liaison with Local Schools and Colleges

Over a number of years, the Mathematics Education Centre (MEC) at Loughborough University has developed good working relationships with mathematics staff at a number of local schools and colleges. Discussions with the teachers at one of these colleges led to the University hosting a morning for college students to carry out mechanics experiments. The rationale was that such an event would enhance the relationship between the college and the University. It would encourage widening participation, as the college recruits students from a wide variety of backgrounds. It would encourage students to consider studying a mechanics module as part of their A-level mathematics course; and for those students who decided not to proceed with mechanics the event would allow them an insight into the application of mathematics in everyday life.

Preparation for the ‘Magic of Mechanics’ morning

At preliminary meetings it was decided that the event would target year 11 students, (i.e. students in their GCSE year of study) as these students would shortly be making decisions about which A/AS level courses to study. It was hoped that the morning’s experience would encourage them to choose to study mathematics and would give them an insight into what might be involved in the study of a mechanics module. The session was to be entitled the ‘Magic of Mechanics’.

The Mathematics Education Centre staff were familiar with the work of Professor Mike Savage of the University of Leeds, who in the 1980s developed a book [5] which included mechanics worksheets for use in schools/colleges.
Staff were also aware of experimental equipment, “the Leeds Mechanics Kit” manufactured by Unilever and an accompanying teachers' guide [6]. It was decided that the University would purchase the mechanics kit to use as the basis of the magic of mechanics event.

Staff familiarised themselves with the equipment within the mechanics kit and selected four experiments to be carried out by the students. The students were to be divided into 4 groups and each group would do each of the 4 experiments. However, in order to make it more interesting for the students, when they moved to a new experiment they would be asked to continue from where the previous group left off, rather than repeating what had gone before. The staff who were to oversee each experiment were responsible for preparing appropriate worksheets for the experiment. It was decided that the data from two of the experiments would be best collected by use of camcorders, linked to computers (Fig 1). This would also mean that the mechanics kit, from the 1980s, was being used in conjunction with current technology to once again interest and inspire students.

Twenty students were invited to take part in the ‘Magic of Mechanics’ morning. A preliminary meeting was held at the college in order to introduce participating students to some of the concepts to be covered in the experiments – in particular forces and friction.

Professor Savage was invited to attend the ‘Magic of Mechanics’ morning to speak to the students and share with them his enthusiasm for mechanics.

**The ‘Magic of Mechanics’ morning**

Sixteen students and three of their teachers attended the morning session. After a brief welcome and introduction the students started the experiments. The experiments were carried out in the Mathematics Learning Support Centre and in an adjacent lecture room at the University. After 25 minutes on their first experiment, the groups moved round to a second experiment. (Details of all the experiments carried out are described in the next section.) During a coffee break Professor Savage gave a presentation to the students. He spoke about the history of mechanics, the usefulness of the subject and reasons for studying it. Finally he carried out some mechanics demonstrations (Fig 2).

**The Experiments**

Four experiments were selected to expose the students to different aspects of mechanics.

i) **Motion in a Vertical Circle** (Looping the loop)

This experiment used cars and a track to investigate what happens when cars are released from different heights and travel along a track with one or two loops (Fig 3).

Five different cars were used and students were asked to calculate a minimum height of release to enable each car to loop the loop once or twice. The results were compared with the minimum height of release predicted by theory.
ii) Bouncing Balls

This experiment used balls of different materials to investigate what happened to the rebound height when the balls were released from different drop heights.

Students used a camcorder, connected to a computer, to capture and measure the rebound height of a ball when dropped onto a given surface. In addition to using different balls, the balls were dropped onto different surfaces, e.g. carpet, wood.

iii) Motion in a Horizontal Circle

This experiment used a motor and turntable to investigate motion in a horizontal circle.

Firstly, coins were placed at different points on a turntable and the speed of the turntable was increased until the coins slid off. Then a coin was placed on a banked attachment of the turntable and the speed of the turntable was increased until the coin slid up the banked attachment. The experiment was repeated for different coins and for different banking angles. Finally, a bob at the end of a piece of string was rotated with constant angular speed. The angle between the string and the vertical was captured and measured, using a camcorder attached to a computer, for various speeds of the motor. Different bobs were used and comparisons made.

iv) Friction

This experiment used blocks, weights and variable inclines to investigate friction.

Students first investigated the relationship between the weight of a block and the weight required to make it move (Fig 4). The block was then placed on a plane and the inclination of the plane was gradually increased until the block just began to slide. Finally, blocks of different shapes and sizes were used to investigate whether a block would topple or slide first as the angle of incline was gradually increased.

Feedback

i) Student Feedback

Fifteen of the sixteen students who attended the event completed feedback forms. The feedback indicates that the students were generally very positive about the morning. Fig 5 summarises the responses to general questions about the course.

From the feedback it became clear that the one aspect that the students had appreciated the most was being able to participate in the experiments. It also suggested that the students felt that there had not been sufficient time to spend on each experiment and that they would have liked more time to do this.

ii) Staff Feedback

MEC staff and teachers held a feedback meeting a few weeks after the mechanics morning. Overall, they were very pleased with the success of the event. The students worked hard throughout the morning and the format of the morning worked well. It was felt that there was a very high standard of oral presentation provided by the students during the final plenary session.

(a) Beneficial Features to be retained

- It was decided that there is much benefit to be gained from retaining the general talk by Professor Savage. If this were not possible, it was suggested that an alternative speaker be found.
- The format of four experiments with students rotating round them should be retained, as it introduced the students to a variety of mechanics problems.
• Using camcorders and computers for data capture was very helpful and brought the kit up-to-date.
• The preliminary meeting at the school/college was thought to be important in order to prepare students for the event.
• The target audience, of year 11 students, was appropriate. The event could also be offered to year 10 students (summer term), or year 12 students.
• Providing the students with a certificate of attendance and some publicity material was well received.

(b) Suggested Changes for Future Magic of Mechanics Events
• Extend the morning event to a full day event, if possible.
• Ensure that the students have summary sheets to take home as reminders of the salient points.
• For an all day event, increase the times allowed for presentations to enable questions to be asked and answers given.
• Show students how to use the camcorders and equipment in order that they can use the technology themselves to capture data.
• Revise the friction experiment equipment as it is currently unreliable.
• To reduce costs, request that students bring their own packed lunch.
• Provide a non-compulsory follow-up activity, in the form of an open-ended activity, which students could do at home. Students would write up their findings and submit these, with a prize being awarded.

Implementation of mechanics events at other universities/colleges

Each university and school/college will find that they need to work out practicalities for their own institutions. However, there are a number of general guidelines that may assist in this process, in addition to the specific features outlined in the staff feedback section:

• The cost of the first event is high, as the equipment needs to be purchased and preparations made. There may be financial help available for this through local widening participation schemes or from funding schemes for gifted and talented students. Transport costs may deter some schools/colleges from participating and financial help may need to be provided for this. However it is recommend that the schools/colleges pay for supply teachers to cover for participating teachers.

Concluding Remarks

Awareness of the issues surrounding students (lack of) knowledge of mechanics is becoming more widespread, and was discussed by participants at a Higher Education Academy Subject Centre workshop entitled ‘Reinvigorating mechanics teaching in science and engineering – current issues, challenges, and resources’ in March 2005.

This article has described a trial event that was held as an attempt to promote both awareness of and interest in mechanics with a group of able school students. Feedback from both students and staff indicates that the event was successful in doing this and it is hoped that the event could be run for other schools.
References