Clocks as a learning tool
[slideshow presentation]

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Clocks as a Learning Tool

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Optical Engineering & Design Education Research Groups
Loughborough University
Project Background

Laser Made Clock

- Undergraduate Project
- Utilises only Laser Cutting

Benefits of the Technology

- Design Freedoms
- Design for Manufacture
- Design for Assembly
- Fast Manufacturing
- CAD
- Quick Design Iterations

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Current Resources

• The production of engaging resources and projects has not kept up with the rapid adoption of CAD/CAM in schools
• Laser cutters are currently used to produce key fobs and book ends, not products with engineering content

Horology Project

• Requires appreciation of modern School environment
• Requires advanced mechanical systems learning and advanced use of technology
• STEM Project with Cross-Curricular Links

http://www.tes.co.uk/teaching-resource/Laser-cut-coaster-and-holder-Task-for-Year-9-CAD-6219611/
http://www.tes.co.uk/teaching-resource/ANGRY-BIRD-CLOCK-6064643/
http://www.laserprouk.com/laserpro-mercury.htm
Resources Designed for Schools

Mechanism has been designed for Schools

Product Features

• Incorporation of Science, Maths and Engineering into Design and Technology
• Detailed design of gears, threads, moments, forces and the pendulum motion
• Customisation fulfils the Design in D&T

Optimised For Schools

• Materials and thickness suitable for lower-power lasers
• Ball bearing units replaced with paperclip pins and laser cut holes
• Number of parts significantly reduced
• Pendulum Escapement has been combined

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Resources Designed for Schools

Resource Pack

- Step-by-step guide allows students to assemble independently of the teacher.
- Includes set-up and experiment guide for students for out of school use.

CAD files are formatted appropriately for use on school software.
Pedagogic Models

Experiential Learning
- Concrete Experience
- Active Experimentation
- Abstract Conceptualization
- Reflective Observation

Taxonomy of Educational Objectives
- Remembering
- Understanding
- Applying
- Analysing
- Evaluating
- Creating

Teacher Knowledge
- Technological Pedagogical Content Knowledge (TPACK)
- Pedagogical Knowledge (PK)
- Content Knowledge (CK)
- Contexts


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Focus Groups

- 18 PGCE students from the Loughborough Design School built and critiqued the mechanism.
- Range of interest was distributed as to be expected. Some very enthusiastic.
- All were able to complete the assembly task but not all able to understand the mechanism and investigate its operation.
- Suggested methods for classroom integration and potential issues for pupils

Development and Testing of Resource

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<thead>
<tr>
<th></th>
<th>December</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
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<tbody>
<tr>
<td>Development of mechanical timer. Contact with LDS</td>
<td>Creation of resource pack. Planning with schools</td>
<td>Focus group testing. Planning with PGCEs</td>
<td>Interviews with PGCE teachers and mentors</td>
<td>Providing resource support for teachers</td>
<td>Final lesson observations, interviews, and student surveys</td>
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## School Case Studies

<table>
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<tr>
<th>School 1</th>
<th>School 2</th>
<th>School 3</th>
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| • Year 9 G&T afterschool club with low attendance  
• School would not commit resources to the resource until it had been fully developed and tested  
• G&T pupils participating had excellent performance  
• School produced extra activity resources.  
• Schools had excellent facilities but teachers could not explain technology  
• Students were not pushed to experiment with the mechanism. | • Year 8 curriculum class group projects. Mechanism incorporated into a faculty lesson activity timer  
• Pupils that normally do not perform well in D&T were really engaged in the project  
• Enthusiastic student presentations showed understanding of terminology and mechanism  
• Unable to access and learn about the laser  
• Did not perform experimental mechanism testing | • Year 9 curriculum class individual project.  
• Issue with pupils having already selected GCSE options.  
• Teacher struggled with technical content.  
• Pupils responded positively but had poor understanding of what they had built  
• School had purchased a new laser cutter, but nobody could use it.  
• Students had exposure to laser cutter but no knowledge. |
Conclusions

- Positive feedback from the students, with 89% approval. 44% would like to do more STEM projects. 42% would like to now build their own clock.
- The year 8 group from School 2 showed the most significant results.
- Broad spectrum of different ability pupils found interest independently from the teacher.
- The teachers knowledge is the limiting factor in all 3 schools.
- Teachers are coming from a non technology background.
- Resources must also be tailored to teachers.
Online Knowledge Base – clocks.lboro.ac.uk

- Collaboration with the British Horological Institute, Worshipful Company of Clockmakers and National Maritime Museum to develop online knowledge base
- A resource to pull children through into engineering by providing them with access to appropriately formatted expert knowledge
- Company sponsored competitions to encourage STEM activities in schools
- Use for pupils in research activities for their projects
- Links between schools and local industry experts to act as STEM ambassadors

Larger Teacher Training Project

- Currently in talks with the Royal Academy of Engineers and Laser Manufacturers to develop an engineering and technology teacher training program to be run at Loughborough University
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