



*working together to enhance understanding,
commitment and participation in engineering*

Engineering the Future

Newsletter 1

March 2007

EPSRC Engineering and Physical Sciences
Research Council



Introduction

The Engineering the Future Team intend to use a Newsletter to keep you up to date with developments in the Project and with news items which may be useful in promoting engineering as a career.

A date for your diary - Monday 11 June

Monday 11 June is the date of the first Engineering the Future seminar which will also serve as our launch event. This will be held at Ross Priory, the University of Strathclyde's conference centre on Loch Lomond. Though the final structure of the day has yet to be decided we plan for each school-university partnership to make a brief presentation of their work so that their experiences can be shared with all participants. The aim is to have a day that is informative, raises the public profile of the Project and, most importantly, is enjoyable.

Please keep this date free!

Agilent digital oscilloscope offer

As you know Agilent Technologies has been working closely with the Project. Agilent is a major US company based in Santa Clara, California with a net revenue last year of U.S. \$5 billion and 19000 employees worldwide. Agilent Labs, their central research organization, has a branch site in South Queensferry.

The company's commitment is demonstrated by their making available to each school in the Project a digital oscilloscope, supported by the necessary software. You can claim this to support any Project activity which involves development of provision for S5/S6 pupils.

Advisory Board

The Project Advisory Board meets for the first time on 14 March. The Advisory Board includes senior representatives from SEED, Learning and Teaching Scotland, Careers Scotland, Education Directorates, educational research and industry. We want the members of the Advisory Board to ensure that we are up-to-date with national policy developments so that these can be used to support the Project. But we will also use the Advisory Board to pass on to the policy community information from the Project, reflections and issues for development.

Extended Advisory Group

We are also setting up an Extended Advisory Group made up of colleagues from a wide a range of relevant organisations and interests to provide information for our work and to reflect on it. Membership includes colleagues from such areas as GTCS, CPD providers, specialist schools in England, higher education recruitment, careers education, and industry. All schools and education authorities involved in the Project are members of this Extended Advisory Group.

Student questionnaires

First year EEE students in both Universities have been asked to complete a questionnaire to provide basic information on their views on engineering and on how the education system has supported them in following an engineering course. Analysis of these is at an early stage but there are some interesting (and generally supportive) messages for schools.

1. almost all students find that what they have studied in school has been relevant to them in their university course to at least some extent
2. many students identify other school subjects which would have been beneficial to their studies in engineering if they had studied them: these include technological studies, chemistry and business management
3. some students identify Advanced Higher courses in physics or maths as being helpful to their studies in engineering, either having studied at that level or wishing they had had that opportunity
4. many students report positive school experiences
5. many students report that they found the problem solving aspects of school maths and physics to be helpful or motivating
6. some students found the lack of relationship between maths in school and the 'real world' to be problematic even tho' they now saw the relevance of what they had studied
7. for many students relationships with the teacher and/or class members were important for motivation in school
8. many students had not considered engineering as a career choice until comparatively late in their school life
9. many had carried out careful investigations into EEE as a career choice balancing it against other engineering or physics related courses

Students also identified concepts in their university courses which they have found challenging. These included, in particular, complex numbers, aspects of differentiation, AC circuits and theory, mesh analysis and Thevenin and Norton's theorems. An issue for investigation is whether study at Advanced Higher correlates with students not facing such challenges.

Current developments in schools/universities partnerships

Lanark Grammar School (Gerry Paterson)
Glasgow University (Catrina Bryce)
S5/S6

After initial consideration of the Principles Papers sent out for the cluster group meetings, the following points were initially agreed for developments in relation to Advance Higher Physics.

- The most likely topic areas are in “Electrical Phenomena”.
- It is essential for the developments to support achieving the AH Physics Learning Outcomes.
- The aim is to develop 3 or 4 projects, suitable for the AH Investigation, which would be available to students as options in the course.
- 3 possible areas for such development were identified initially:
 - The use of fibre optics to measure strain in constructions such as bridges
 - Electrostatic screening for mobile phones
 - Fluid flow, the Bernoulli Principle, Wind Turbines
- It was also agreed that there should be explicit reference to engineering applications in all possible aspects of the taught AH course.
- A key issue is likely to be funding for equipment, eg, to make prototypes for the fibre optics investigation and to trial them. Catrina agreed to try to cost what would be needed.
- There will probably be a need to do some piloting of the developments as they are taken forward, to avoid impractical plans.

A second working meeting identified a range of other possible engineering-related topics that could be tackled in AH Physics projects.

- Speed of Light using ϵ_0 and μ_0 type experiments.
- Refractive Index of water, glass or plastic.
- Wavelength of laser light using interferometers.
- Using polarisation to determine some physical constant.
- Using Mosfet Transistors relating to Mobility, Hall Effect {incorporating the digital scope}.
- Calculation of Drift Velocity involving speed of electron signal along a wire.
- Electromagnetism: again possible use of the Hall probe to calculate μ_0 using 3 different methods.
- Measurement of Doping Density –
 - C versus V_r in MOS Capacitor
 - Conductivity
 - Hall Effects.
- Experiments involving calculation of ϵ_r .

Catrina is considering how she can help with these in respect of resourcing and ideas. There will be another get together to develop more detail.

Holy Cross High School (Brian Smith, Linda Glancy, John Burns)
Strathclyde University (Roy Chapman, Tony Gachagan, Tony Mulholland)
S5/S6

The following key points have emerged from discussions.

- An engineering approach *can* be taken to achieving the Higher Physics course Learning Outcomes in at least 5 areas. There are possibilities involving use of the Wheatstone Bridge, strain gauges and ultrasonics, for which the school has at present a single kit that demonstrates basic principles.
- It is also possible to address Higher Physics LO3 (to write an experimental report) via engineering and in ways which would be motivating and enjoyable. The basic requirement for the Outcome 3 experiment is to measure the relationship (preferably linear) between 2 variables. The current 3 experiments carried out at Holy Cross are: pressure-depth; refractive index measurements; and Q versus V or I versus F for a capacitor. Suggestions for introducing EEE-related elements are:
 - Use ultrasonic techniques to measure the depth of the pressure sensor in the current pressure-depth experiment.
 - Vary feedback resistor in standard inverting op-amp circuit to determine relationship with gain. The amplifier could then be used in conjunction with an ultrasonic transducer, for example, to show an improvement in received signal after amplification.
- The university colleagues will try to supply images/information on the application of a Wheatstone Bridge in practice and both Holy Cross and Strathclyde will continue to consider engineering-based experiments to match Outcome 3 objectives.
- There is a real need for appropriate instrumentation in the school to make the relevance of engineering to H Physics “transparent”. The issue of engineering resources in schools may be a major issue for the success of the whole project. Brian and Linda argue that doing things with their hands is a crucial factor in engaging pupils in engineering. Engineering activities in H Physics have to take account of existing resources or ones which may realistically be obtained.

Roy Chapman and Tony Gachagan visited the school on 16 January to see the equipment available for the range of practical Higher Physics experiments. They considered the school’s equipment to be old. The school staff have also visited the EEE Department at Strathclyde to view demonstrations of current research activity and to attend a first year Electronic and Electrical Theory lecture. The school and university staff agreed that the lecture highlighted the different approaches in teaching styles between large size university classes and the smaller S5/6 class. It also demonstrated that some of the initiatives that they are trying to introduce through this project at secondary school level also need to be addressed in the delivery of university courses – in particular, the scheduling of common material in the

Mathematics and EEE courses and providing the students with examples of real world applications of the taught material.

Tony Gachagan has passed to the school a DVD of lecture and laboratory material for Year 1 students at Strathclyde on ultrasonics and other aspects of EEE. It will be possible for other schools in the project to have access to this material.

Dollar Academy (Deborah Keys, Pamela Webster)
Strathclyde University (Gordon Hayward, Ivan Andonovic, Walter Galbraith)
S5/S6

The Dollar staff and their Strathclyde colleagues have had meetings in the school and in the University involving a good deal of discussion of the relationship between the current school physics curriculum and the modern world of EEE in the university and industry. Concerns were raised regarding the quality of the current curriculum by the staff in Dollar; the university colleagues considered aspects such as the use of the cathode ray oscilloscope and of terminology such as *emf*, *lost volts* and *work done* to be very outdated. The significance of preparation for SQA examinations was very apparent in the work of the school (as in all schools); the nature of external examinations is a key factor affecting pupils' actual learning experiences. The Dollar staff identified the old Engineering Higher as the kind of course that is needed. Both the Dollar and the University staff would welcome a 'top down' approach to achieving the intentions of the project – in other words, get 'engineering science' into the curriculum and then work out the details. The school would like to introduce a package on 'engineering science, economics and physics' among their 6th year programmes.

However, in the present circumstances, the school/university partnership is working towards creating engineering experiences for S5 pupils. They have a broad plan for developments, with a focus on possible projects to be undertaken by pupils in late May/June after completing Highers, when there is space in the S5 timetable. A range of such projects has been proposed and further school/university interaction is planned to take them forward.

There is an interest for the project in the reaction of Gordon to the Higher Physics teaching he observed in the school. He described it as much the same as his own school physics experience but with much better teaching than he remembered. Points relevant to our concerns relating to continuity across the school/university interface and the preparation of students for university study include:

- the teaching stressed the multidisciplinary nature of the subject
- Dollar pupils experience no difficulty with the electrical aspects of physics – they seemed easy by comparison with university expectations
- teaching was at a very easy and relaxed pace – whereas the university pace is very much faster.

The university staff also thought a lot of the school's electrical kit seemed very old fashioned, but in good working order – fine for the basics but a lot of it no longer exists in the real EEE world.

Though Dollar is developing work this year for S5/S6, Debbie has provided a “brainstormed” list of ideas for possible engineering activities in S1/S2 and the upper primary school, which have been sent to the writers of the 3-15 Science Review outcomes within *A Curriculum for Excellence* to use in suggesting types of engineering work.

***Belmont Academy (Douglas McNeil, John McLellan, Ross McMahon)
Glasgow University (Tim Drysdale)
S3/S4***

Belmont staff attended a meeting with the East Ayrshire schools and a university representative before Christmas which raised issues similar to those discussed with Dollar staff, relating to the need for structural changes to curriculum and examinations to ensure a high status for engineering – including the re-introduction of something like Engineering Science and much action to “market” the concept of engineering – in addition to the current project strategy of aiming to sow engineering experiences through the existing science and physics curricula.

In respect of the development of engineering activities in the Standard Grade Physics programme, a productive school/university meeting in February identified a range of proposed development tasks, related to Standard Grade physics topics, expanding on a set outlined by the department in December. There are 3 or 4 key ideas for development, linked mainly to the 'Using electricity' and 'Electronics' Standard Grade topics.

Tim Drysdale offered various supportive ideas, aimed at engaging, motivating activities employing a range of new materials, which could be adapted for use in a teaching period and would enable an appropriate emphasis on engineering concepts.

The department also proposed the idea of adding web links to electronic versions of SG course notes, which would highlight various relevant engineering issues. Eventually these could be accessed more directly for class use via Smartboards, but even without this facility would provide useful sources of reference for staff. Reference was also made to a current initiative of the Institute of Physics to promote engineering described in the IOP January Newsletter.

The department will develop the proposed ideas and will have further discussion with Tim after Easter.

***St Aloysius College (James Cluckie)
Strathclyde University (Stephen McArthur, Phil McGlone)
Glasgow University (Phil Dobson)
S1/S2***

Both the school and the university staff attended a cluster group meeting in January. This considered, among other things, the guidelines for the development work which had been sent to the schools, noting that the Key Principles for development work appeared to be quite exhaustive but recognising that they might be updated as they

were considered by everyone involved in the project in the course of the development of curricular inserts and learning/teaching approaches.

There was some interest in the possibility of using 1st and 2nd year university students as helpers and role models.

Both groups in the cluster (the other is the Balforn High School/Strathclyde one) have been communicating by email which is working well. The group felt it would be beneficial to set up Moodle for the cluster with different forums for each school group. (This has now been done.) Guidelines and/or training would be useful. The group felt that although they would be producing high quality materials, in the long run it would be good to have them done professionally. It was noted that often it is cheaper to get a professional than to spend money and time on training. They would consider possible CPD opportunities and the training needs of other teachers during the development and trialling phases.

James and his university colleagues believe that incorporating engineering material into the S2 Physics class would be the best starting point. They considered that the Engineering Activities should be project based, and perhaps have a team management aspect to them. The material should present a “big picture” and have a number of black box systems which interact. The detailed classroom activities will then be based around developing knowledge and building circuits which relate to the systems within the black boxes. The two options are ‘Mission to Mars’ and ‘Energy for the Developing World’. Anticipated timescales: projects to be launched by April 2007 and may last 2 or 3 lessons. Initial teaching material ideas are being drafted by Stephen McArthur.

The science department is in an unusual position this year. It has been given extra time in 2nd year which equates to 9 hours. The plan is to use this time for the project. The aim is to develop materials for 7 hours of work (with the expectation that it will fill 9 hours) that look at energy and electronics. The school has Microelectronics for All (MFA) kits with four inputs and four outputs. The intention is to give the course an engineering background by incorporating a Mars Rover challenge. The challenge will include different topologies and conserving/generating energy. Brian Stimpson of Strathclyde University has offered to pass on the materials he has found preparing for investigations on Mars Rovers with his mechatronics class. The decision was taken to build into the classwork a team working element to appeal to anyone not keen on electronics.

Some of the suggestions for S2 developments in St Aloysius have been sent to the writers of the Science Review outcomes within *A Curriculum for Excellence* to exemplify possible ways of covering engineering activities in the early secondary science curriculum.

Balforn High School (Roy Pearson, Phil Slavin)
Strathclyde University (Gareth Pierce, Craig Michie, Martin Judd)

This group also took part in the cluster meeting described under St Aloysius above.

There has been a group meeting at the school and the school staff have visited Strathclyde University.

A number of possible engineering activities to do with wind farms have been identified. (The school's geography department is developing work which will involve the construction in the school grounds of a wind turbine: this will be open to at least some exploitation by physics). The wind turbines' possibilities have been considered mainly with an older age group in mind, though there is a potential for projects for younger pupils, too.

There has been some discussion about where to locate engineering activities in the S2 science curriculum. Balfron HS teaches discrete topics and the electricity module is taught to different classes at different times throughout the year. The project aim is to develop materials to fill four periods (just under four hours of work) towards the end of S2. At this stage the pupils are already thinking about what scientists do before they choose their career subjects. The materials will have an element of careers information and an extended investigation activity.

Further meetings of school and university staff will develop these ideas.

There has also been discussion of the possibility of industrial visits to the schools.

A Curriculum for Excellence

Since the publication of *Building the Curriculum 1* many may have heard little about the development work of *A Curriculum for Excellence*. In fact a lot has been going on in the area of science.

Outcomes are being written for each of the major science areas. Outcomes are no longer simple statements of what is readily assessable. Rather they provide a target for experiential learning which give a purpose to learning and direct learning activities. They should not constrain learning but support personalisation and choice and depth of study. The potential to develop a range of skills and to make evident their contribution to building the four capacities is crucial. A first group of science outcomes 'goes public' later this month at a series of regional seminars. This project has been interacting with those developing the science curriculum and its outcomes. School-university partnerships have suggested possible engineering related outcomes which have been forwarded to the writing team. We hope that the final documentation will give clear indications of the potential for engineering activities within primary and early secondary science.

Close to home there are four projects based in Education Authority partnerships, supported financially by SEED, working on ideas which may be relevant to our thinking.

1. Glasgow, South Lanarkshire and North Lanarkshire are 'Aiming for Excellence in Science'. This is a fully collaborative project which aims to offer pupils engaging activities and to develop CPD activities
2. Stirling and Perth & Kinross are developing 'Rich Tasks/ICT in Primary & Secondary'. This action research takes the form of a group of multi-disciplinary projects where teachers will plan and deliver enriched learning experiences, leading to a wide range of teaching and learning materials.
3. South Lanarkshire and Argyll & Bute are working on 'Rich Tasks in Secondary'. These will develop interdisciplinary approaches for S1 – S3.
4. The three Ayrshire authorities are using ACfE as an opportunity to work together to build on their existing strong network structures across the authorities.

In addition, any school can join the Register of Interests and build up links with others working in the same curricular area.

Contact <http://www.acurriculumforexcellencescotland.gov.uk>

Engineering as a career

Good news for those who want to study engineering

The employment outlook is good for those who want to study engineering. Recent figures show that young graduates who studied Science, Maths and Engineering are more likely to agree that their job prospects have improved (76%) compared to students of other subjects (58%-70%). These are also the graduates most likely to feel that their jobs are appropriate to their degree subject (72%).

But this is more than job satisfaction. There are higher graduate earnings premia for Medicine, Physics, Chemistry and Engineering compared to all degrees in terms of the additional lifetime earnings of graduates. Engineering graduates can expect to earn close to an extra half million pounds over their working life. Typical annual salaries just now are:

Engineers and IT Professionals	£ 34,844
Professional Occupations	£ 32,040

And employment prospects are better. Science, Maths and Engineering graduates are more likely to be working full time (58%) than those who studied other subjects (26%-50%). Science, Maths and Engineering students (69%) are also more likely to have the added security of a permanent contract compared with graduates in other subjects

We will be working with Guidance/Careers staff in the project schools in the coming months and with Careers Scotland to identify the nature of current guidance related to engineering careers. We hope subsequently to use the results of our discussions to find ways of helping Guidance/Careers staff to improve the status of engineering as a university and career route and to ensure that optimum advice about it is available at all stages of the school.

For the present, some information about sources of engineering careers advice is offered below.

So where to get information on careers...

A good starting point is the latest Science, Technology, Engineering and Maths (STEM) Careers Catalogue launched by the Engineering and Technology Board (etb)

enginuity • [Engineering and Technology Careers Catalogue 2007](#)

ETB Contact Address 10, Maltravers Street, London, WC2R 3ER

To find the on-line version of this resource catalogue visit:
www.enginuity.org.uk

The enginuity careers catalogue, print or on-line, features information from a large number of organisations.

Another good careers info source...



scenta

<http://www.scenta.co.uk>

As Scenta says: The science, engineering and technology sector is massive in the UK. There are around 6,000 engineering companies alone in the UK, with around 800,000 engineers employed here. It's also one of the most diverse professions around. Looking to pursue a career in science, engineering and technology (SET)? Advise others on careers in SET? Working in SET but looking for a new job in the sector? If the answer is yes to any of these questions - then scenta careers is here to help.

Science & Engineering Organisations & Schemes

There are a large number of sites which offer information and activities for young people who might be interested in engineering. Some of these are:

1 Best Community - Royal Academy of Engineering

<http://www.raengbest.org.uk/>>

The Royal Academy of Engineering Best Programme, 'Better engineering, science, technology'. For teachers there are links to Young Engineers (9-15), Smallpeice and Headstart (university links with upper secondary school), Engineering Education (links upper secondary pupils with university and industrial experience). For pupils there are links to a number of fun and puzzle sites which include science and engineering activities.

2 Engineering Your Future

<<http://www.engineeringyourfuture.com/>>

..includes large scale project activities for schools, materials and support

3 NOISE - New Outlooks In Science & Engineering

<<http://www.noisemakers.org.uk/modules/articles/>>

NOISE (New Outlooks In Science & Engineering) is a UK-wide campaign funded by the Engineering & Physical Sciences Research Council (EPSRC) to raise awareness of science and engineering among young people. The site contains news articles, descriptions of 'cool' jobs and blogs contributed by young graduate engineers.

4 Young Engineers

<<http://www.youngeng.org/home.asp>>

competitions and clubs

5 BAE Systems Education Programme

<<http://www.baesystemseducationprogramme.com/>>

Provides information and support for schools, operates a work experience scheme and has a dedicated site for young people