



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

Engineering the Future

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SYNERGY
glasgow-strathclyde universities strategic alliance

Introduction

As we move through the third year of the Engineering the Future Project we are circulating this fourth edition of our Newsletter. There is again much to report.

If you would like a copy of our previous newsletters or if there is anything in this Newsletter to which you would like to respond or on which you would like to comment or about which you wish to obtain further information, please contact:

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Engineering the Future

Engineering the Future (EtF) is a 3-year project funded by a major grant from the Engineering and Physical Sciences Research Council which is exploring new ways of bringing together schools and universities to:

- enhance awareness of engineering as a profession within and beyond the school community
- promote enthusiasm for engineering among school pupils
- increase the numbers of young people embracing engineering as a career
- develop very good teaching of it in both schools and universities.

Founded on models of transformational change already in practice within Scottish education, EtF is exploring innovative means of developing a sustainable and transferable model of activities which encourage young people to study engineering and support them as they make the transition from school to university. EtF has been working with researchers, policy makers, practitioners and the industrial community to:

- identify key skills, mind-sets and dispositions needed by engineers to face changing demands through their working life
- provide experience of engineering activities within school classrooms
- support students' motivation and learning across the school-university transition and into studying in university
- develop pedagogy in university which challenges and supports students to extend their prior knowledge, skills and dispositions to become successful engineers
- embed these developments within national curriculum, assessment and qualifications policies and practice.

The reasons for relatively low numbers taking up and completing engineering courses are likely to be complex, but one significant problem is the lack of understanding at the school university interface. A central aspect of the work of the project is the development of collaborative networks of school and university staff. Using Electrical and Electronic Engineering (EEE) as a pilot study, the project enables staff and students from schools and universities to work together to create exciting and innovative programmes for school pupils.

There are two areas of parallel activity. One focuses on developing better understanding of contemporary engineering through enhanced partnerships between schools and universities. The other promotes and sustains better understanding of engineering through engagement with local and national policy communities. The project uses collaborative ways of working that, according to research evidence result in real, valuable and sustainable change.

School Developments

Curriculum Developments

In previous newsletters we had provided descriptions of the engineering related curricular inserts which had been developed for science and physics courses from S1 through to S6. More have been developed in the intervening period. For reference there follows a note of these school focused developments. If you would like fuller information on these inserts please do not hesitate to contact Elsa Ekevall at the contact address above.

S5/S6

Dollar Academy

Physics staff in the school working with colleagues and doctoral students in the Department of Electronic and Electrical engineering in the University of Strathclyde have developed six Advanced Higher Physics Investigations. Projects range from ultrasonic characterisation of viscoelastic materials to electrical sterilisation of liquids. The University has made facilities available in for pupils to carry out their investigations; the recorded data are analysed with the support of their teacher in school; this analysis forms the basis of their written report which is completed in school and in their own time. The pupils had access to state of the art research equipment, such as laser cutting apparatus, optical vibrometry, vacuum deposition, and worked with internationally reputed academic engineers. Apart from the immediate benefits to their learning this approach will, it is hoped, lead to an understanding of and interest in university study of engineering.

Holy Cross High School, Hamilton

Within the S5/6 Higher Physics Electricity and Electronics Unit the following activities were identified for development:

- the out of balance Wheatstone Bridge
- relationship between peak and r.m.s voltage
- relationship between frequency and current in a resistive circuit
- smoothing, op-amp saturation and calibration of a signal generator.

The teaching approach developed in this Unit was extended to the Higher Physics Radiation and Matter Unit focusing on activities involving photodiodes and solar cells, on measuring the wavelength of an ultra-sound transmitter and on practical applications of MOSFETs.

Lanark Grammar School

The focus was on S6 Advanced Higher Physics. Two Practical Investigation units were developed. The first required candidates in an Investigation on the Speed of Light to measure c using (i) Foucault's method, (ii) an electronic timing technique and (iii) measurement of ϵ_0 and μ_0 and insertion of these values into Maxwell's equation $c = 1/\sqrt{\epsilon_0\mu_0}$ and to compare/evaluate their final results. For the other Mobility of Charge Carriers Investigation, 2 different methods were employed using the characteristics of a n-channel Mosfet Transistor and then by examining the Hall Effect in an n-Ge semiconductor.

S3/S4

Balfron High School

The school have placed an engineering focus on the SSERC 'Pimp my Trolley' activity which looks at car safety, asking pupils to design a crumple zone for a vehicle; measurement was

carried out using a wireless accelerometer that highlights some excellent engineering technology. This sits within the Standard Grade Physics transport section. Engineering characteristics of the activity include: solution-orientation; optimising solutions; systems – understanding how things work together; teamwork; and problem-solving. The activity involves individual independent thinking and group collaboration to understand and apply knowledge about forces and materials and to evaluate and improve the solutions proposed through practical trials.

Belmont Academy, Ayr

The school explored building engineering links into the S3/4 Telecommunications and Electronics units. Given the central role of electronics in modern engineering the main focus has been on this topic. A Project on LEDs and photodiodes was introduced into this unit which afforded S3/S4 pupils opportunities to use a wide range of equipment including signal generators, CROs, LEDs, coloured filters, fibre optic cable and a parabolic reflector. Commercially available light emitters and receivers were used to demonstrate how the principle of sending signals through optical fibre could be improved. Optical fibres were used to link an LED and photodiode. The main improvement was better light transmission resulting in a stronger received signal. There was some discussion on how the emitters and receivers had been designed (engineered) to improve efficiency.

Dollar Academy

The focus of development was the creation of an S3/S4 'compressed course' in which pupils would be taught 3 certificate courses in 6 lessons per week during S3/S4 rather than in the 9 lessons normally expected. The course integrates Physics, Economics and Technological Studies (PETS). The intention was to streamline the teaching of Physics and Technological Studies to free up teaching time to run additional activities and to organise trips and speakers. At the end of the first year the pupils carried out a mini-project integrating the three subjects that focused on renewable energy. In Physics the pupils looked at solar energy, in Technology they explored the production of energy from wind turbines and the economic argument for renewable energy was investigated in Economics.

Holy Cross High School, Hamilton

The development demonstrates one application of ultrasound by measuring distances directly. This has relevance to the Health Physics topic in the SG course where ultrasound is used to measure various distances to an unborn baby and thus to build up a picture. There are many engineering applications such as sonar, weld testing, car reverse indicators, car alarms or distance sensors in robotics.

St Aloysius' College, Glasgow

The focus has been on activities related to radioactivity and nuclear physics associated with the Intermediate 2 Physics course. The engineering activities are based on chain reactions, building a radiation detector, nuclear plant simulator, advantages and disadvantages of nuclear power, and disposal and storage of materials.

St Joseph's College, Dumfries

The partnership developed a radio project to fit in with the Standard Grade Physics (S3) Telecommunications topic. This project involves building a radio receiver from cheap, easily sourced components which should be as simple as possible so as to provide a ready illustration of how each part of a radio works. Pupils use everyday materials such as toilet roll tubes, crystal earphones, diodes, terminal blocks, terminal blocks, aerials, lemon batteries and capacitors. The radio is ideally something students could construct at home.

Williamwood High School, Clarkston, East Renfrewshire

Activity involved S3 pupils in collaborative investigation of 'hidden circuits' in 'black boxes' with clear engineering functions and applications. This is situated within the electronics section of the course. Pupils are provided with six closed boxes containing a potential divider with equal resistors, a potential divider with resistors in 10:1 ratio, a resistor and capacitor in series, a diode to give half wave rectification, and a MOSFET circuit. In each box the circuits are in a different order. Pupils are given a list of desired outcomes and have to identify which circuit can be used to produce each outcome, having available low voltage AC and DC inputs, voltmeters, ammeters and hand-held oscilloscopes.

S1/S2

Balfron High School

The decision was made to develop a project on Bat Detection & Ultrasonic Propagation in which each pupil uses a transducer to monitor sounds inaudible to humans in order to track bats. This involves using the device to investigate the nature of ultrasound, using the device to survey a local bat population, working in groups and working out of school. The school experimented with sonic tape measures, individual ultrasonic effects and car reversing systems. The pupils were asked to come up with ideas for new practical applications for ultrasound.

Dollar Academy

With university partners the school has developed an insert for use in an S1/S2 Communications unit; the project will involve pupils in technology classes designing and building a device that indicates when plants require watering. This concept will be explored further in science with some pupils using specially engineered wireless devices to monitor the water level in the soil and receive a text message when the plants need watering.

Dumfries Academy

The school and its university partners have developed an engineering-based unit of work related to wind turbines. The school are using a wind turbine kit from MUTR which takes 2/3 weeks to complete. The challenge is to find a design configuration to produce as much power as possible; pupils can change the angle, number and type of blades and measure power through a voltmeter and an ammeter. This is set in the context of the Energy section of the S1 course and encourages pupils to develop understanding of key ideas about the role of engineering in addressing problems arising from global warming and finite fossil fuel resources.

Lanark Grammar School

S1 focus has been on an engineering challenge with an enterprise link involving all S1 pupils in the construction and testing of bridges within their science classes, the winners going on to a final full day event where they use K'nex to design and build a fairground attraction with help from S5/S6 pupils. The project involves pupils engineering a bridge using straws, sellotape and paper. The pupils must apply their scientific knowledge, problem-solve, work harmoniously as a team, keep to time and resource limitations, and, most importantly, have fun with their experience of engineering.

St Aloysius' College, Glasgow

An Electronics Module based on the Mars Rover was developed for S2 pupils which could also be used in S3/4. The outcomes tie in with existing guidelines. The problem is based on a real situation and mirrors the reality of professional engineering. It is characteristic of engineering in that it is solution-oriented, adopts a systems approach, makes use simulation

and requires team work. Motivation is enhanced in that the learning is driven by a particular need and pupils are given specific responsibilities. The learning is experiential, the pupils have responsibility and the principles of teamwork are addressed explicitly.

Williamwood High School, Clarkston, East Renfrewshire

The project is designed around an Energy / Electricity topic for S1 pupils; because at present there is no teaching of microelectronics at this stage this project fills a gap in current provision. Pupils learn first hand in a practical way how to solve problems relating to home security. They learn about basic input-process output systems and the use of certain electronic components as the basis for many different systems. The basic scenario is to build a security system for a room incorporating several different methods of detection and different alarm systems. This builds on pupil interest in crime prevention and detection (CSI) and introduces them to aspects of modern technology.

Woodfarm High School, Giffnock, East Renfrewshire

The focus is on S2. The development involves thermistors and the engineering application is focused on the need to know the temperature of food. The pupils learn about thermistors, identify applications and then use a thermistor to measure the temperature of a potato as it cools.

Trialling

A major focus of this year's work with schools is the trialling of each of the inserts developed in the previous two sessions. Trialling is being carried out both within the schools which are participants within the project and in schools outwith the project. Through this means we can ensure that each insert is subject to the critical examination not only of teachers who know and share the mindsets of the project but also of teachers who have not had the same opportunities to develop these views. This methodology ensures that we can test the extent to which the materials can be readily made use of by colleagues in other schools, the sorts of support material which may be required.

A summary of schools involved in trialling:

- Armadale Academy, West Lothian: Wind Turbine
- Carnoustie High School, Angus: Developing Renewables Project (linked with Geography)
- Eastwood High School, East Renfrewshire: Pimp My Trolley
- Farr High School, Highland: LEDs & Photodiodes
- Firrhill High School, Edinburgh: Bat Monitoring
- Gracemount High School, Edinburgh: Security Devices or Nuclear & Radiation or LEDs/LDRs
- Liberton High School, Edinburgh: Pimp My Trolley
- Lochgelly High School, Fife: Wind Turbine
- Milne's High School, Fochabers, Moray: Radio Project
- Tarbet Academy, Argyll and Bute: Engineering Bridge Challenge (1st yr)
- Trinity Academy, Edinburgh: Mars Rover.

Careers Education

As a consequence of the evidence provided by school pupils and university students that they had received little careers information related to any form of engineering, it was decided that Engineering the Future should develop its own careers materials. The issue was not merely one of availability of materials but of the current philosophy of careers education in schools. Staff in schools confirmed the view held by members of the team that this seeks to empower young people by expecting and supporting them to take responsibility for identifying their needs and interest and then responding to their expressed views by pointing them towards sources of information.

In the context of engineering there are weaknesses in this approach. In particular, pupils do not start with positive or even accurate images of what engineers do. Those parents who have contact with engineering occupations provided young people with positive messages about engineering as a career but many parents do not have this immediate experience and may presumably all too often have shared the prejudices held by many. Given these barriers to an interest in engineering as a career, few young people are likely to seek and therefore be provided with information on this career. Regrettably some extant careers education material confirms the stereotypes of engineering held by many in our society.

In the light of this Engineering the Future developed its own careers materials and trialled them with S2 and S4 pupils. It was agreed that these should be informative, accurate, present engineering in an attractive light and themselves be attractive in format to young people; they should be introduced actively to young people at key choice points in their schooling. Initial trialling demonstrated a positive response from pupils who have made it clear that they have rarely been provided with such detailed information about engineering as a career.

Pupil and teacher responses to further trialling are currently being evaluated.

University Developments

University colleagues in both the Universities of Strathclyde and of Glasgow have continued to play an active part in the development of the school curricular inserts. Schools in Edinburgh are being supported in their trialling by colleagues in the University of Edinburgh School of Engineering and Electronics.

Progress has been slower in promoting development of teaching and learning within university courses. The lack of dedicated time for development and the perception that research is afforded priority may well be contributing factors to the pressures on staff.

The University of Strathclyde Department of Electronic and Electrical Engineering used the university wide move to 20 credit units as the fundamental course building block as an opportunity to rethink its provision. Following discussion with colleagues there, a bid for funds to the University's Teaching and Learning fund was drawn up by EtF and was successful in obtaining resourcing for a 0.5 FTE post to support the development of assessment which promotes active learning.

The Department has further developed its links with Dollar Academy to provide (as described above) Advanced Higher candidates from the school the opportunity to carry out investigations drawing on the Department's resources and the knowledge and skills of their staff and students. We have argued that this could provide a model for developing the investigation in within the Science (or as we would prefer STEM) Baccalaureate. Universities can draw on a wide range of resources, human and material, which can support candidates in such studies; further they can provide access to networks which can provide further opportunities for support.

In the University of Glasgow discussion with the Faculty of Engineering's newly appointed schools liaison manager was helpful in sharing thinking and identifying the need for more structured support as young people make the transition from school to university. A bid to the university's Learning and Teaching Fund to develop means of supporting young people after they have made the transition is being considered.

Meanwhile individual members of staff have been reviewing their own courses.

Partnerships with Industry

Agilent

Agilent has continued to contribute to the Project in several ways. Partner schools have made extensive and creative use of the digital oscilloscopes provided by the company. Engineering the Future has benefited greatly from Agilent's advice on public relations. In addition to the \$35000 provided last year to commission a scoping report on e-learning, the Agilent Foundation provided a further \$35000 to support the development of a pilot in this area, described later in the newsletter.

Industry Questionnaire

As reported in the last newsletter fifteen large engineering companies whose contact details had been provided by University staff with industrial connections responded to a brief questionnaire on the qualities they wished to see in engineering graduate recruits. The results were in line with larger national surveys but allowed us insights into the thinking of these organisations.

It was agreed that, in the current economic climate, the views of small and medium enterprises should also be sought. The questionnaire has been redrafted slightly and responses are being sought from these smaller engineering companies which collectively make a notable contribution to the economy of Scotland.

Partnerships and Links with Scottish Education

Curriculum for Excellence: Science and Technologies

Provision for engineering within Curriculum for Excellence is a major issue for the EtF team. We welcome the fact that within the draft statements of experiences and outcomes in Science and Technologies 3-15 there are opportunities for the development of engineering. We would wish to go beyond this enabling approach and embed engineering more explicitly in the curriculum so that all pupils in all schools would have opportunities to experience engineering and develop the relevant skills which are transferable and highly valued by employers.

Engineering the Future participated in the engagement processes in both Science and Technologies. We outlined the arguments for ensuring that all young people in our schools should have an entitlement to experience engineering education through embedding this in the curriculum. Our arguments are economic and educational:

- High level engineering is crucial to progressing the Scottish Government's principal purpose of sustainable economic development.
- There is economic need for a larger body of people with such skills to build a strong indigenous high tech economic base.
- It requires high levels of scientific and mathematical competence in the service of useful design, creativity, innovative thinking, problem-solving, confidence, drive, determination to succeed, teamwork and business acumen.
- Many young people - including ambitious high achievers - have very limited or distorted ideas about what engineering involves and do not associate creativity, problem-solving and enterprise with their science and mathematics classes.

We made specific proposals regarding both Science and Technologies. We proposed that Science be renamed Science and Engineering in order to signal engineering as a high level area of study and to drive the Scottish educational system to give real attention to applied science and innovation. Further this would open up the methodology of science teaching to include the motivating practical applications, creativity, problem-solving and teamwork associated with engineering, guaranteeing that all pupils gain such experiences and skills in science. In our submission on the Technologies we argued that there should be more explicit reference to and explanation of the relationship between technology and engineering to make clear how engineering both develops new technologies and applies existing ones in the process of making the products on which society, culture and the economy depend. This submission also argued that there should be much more explicit reference within the Technologies documentation to the essential links among technology, engineering and science. We proposed that this would be facilitated by linking explicitly all four of Science, Technology, Engineering and Mathematics in a 'STEM region' of Curriculum for Excellence. This would be the most effective way of ensuring that all young people gain real awareness, understanding and experience of engineering and technology as 'science and mathematics in action', a crucial contributor to economic and social well-being.

We also provided examples of statements of experiences and outcomes in both curricular areas which could be edited to make explicit reference to engineering.

The inserts being developed by the schools partnerships in the Project clearly relate to draft experiences and outcomes and to the commitment to experiential learning, personalisation and choice and depth of study within Curriculum for Excellence. We were happy that it was readily possible for a number of our inserts to be written up as exemplification to be

published nationally within Curriculum for Excellence as exemplars of ways in which Science experiences can be provided and outcomes achieved. We believe that others can also be so written up and publicised.

Curriculum for Excellence: Building the Curriculum 3

Building the Curriculum 3 makes important statements about the organisation of and contexts for learning. The document explores the means by which the commitment of Curriculum for Excellence to ensuring that learning takes place (and must take place) not only in the subject classroom but through interdisciplinary projects and the wider life of the school can be made a reality. A number of schools involved in the project have developed work that moves outside the classroom walls: through interdisciplinary work; through the use of the local environment, through special focus days, and through events and competitions. These are being discussed with colleagues within the CfE team.

A Consultation on the Next Generation of National Qualifications in Scotland

While this consultation focused largely on qualifications at SCQF levels 4 and 5 (Intermediate 1 and 2, Standard Grade) we took the opportunity to take forward our argument (already expressed in the discussion on the review of SQA Physics) that certificate examinations must assess what is central to learning in a subject. There is very clear evidence that high stakes assessment, such as Higher and Advanced Higher, impacts powerfully on learning and teaching; rightly, teachers, in seeking to ensure that candidates gain the qualifications required for the next stage of their life, will focus on what is assessed. If we limit our examinations to the reproduction of facts and the application of a limited range of algorithms, it is not surprising that some young people proceeding to university to study in the fields of science and engineering lack the facility to solve problems other than those which are presented in straightforward ways and/or in ways which they have already experienced. If NQ courses which lead young people to study engineering are to prepare them to deal with problem solving in a wide range of contexts, this must be reflected in the assessment. We argued also that young people following such courses must have opportunities to develop their skills in team working and in using their initiative. Again unless such qualities are formally recognised through the assessment procedures then they are unlikely to be valued teachers or learners as they seek to gain qualifications.

More particularly we argued that numeracy must not be considered as set of decontextualised skills. Young people should be encouraged to build links between different ways of mathematical thinking and representation and between these and the contexts in which they are employed; young people must develop the confidence and mindsets to apply their knowledge and skills in new and unknown contexts.

The adoption of a range of assessment methodologies would facilitate learning across the curriculum in accordance with the expectations of Curriculum for Excellence: engineering is indeed ideally placed to facilitate cross curricular learning in the sciences, technologies and mathematics and indeed, for some young people, beyond this into such areas as economics, business studies and modern languages. We believe that the 'rich tasks' approach has much to commend it in reducing fragmentation.

Scottish Baccalaureate

Engineering the Future welcomed the proposal to introduce a Scottish Science Baccalaureate which could support our aims and contribute to increasing sustainable economic growth and environmental health. Given the specification of subjects which will contribute to this Baccalaureate and given the need to build links among the STEM subjects we believe that this Baccalaureate should be renamed as the Science, Technology, Engineering and Mathematics Baccalaureate. This would send out a clear message about the importance and high status accorded to all of these areas of study, would make clear the links and synergy among them, and would promote interdisciplinary learning among these areas which have too often in the past been artificially separated and would contribute to raising the awareness of the principles underpinning engineering and its relationships with the sciences, technology and mathematics.

The achievement by young people of Advanced Highers in Physics, Mathematics and Technological Studies appears to be a significant factor in allowing them to make a successful transition to studying engineering at undergraduate level. There are several strands to this:

- the more demanding level of content within the Advanced Higher provides young people with a more gradual, though still challenging, progression gradient from school into the first year of university study
- Advanced Higher courses in general require young people to be more independent learners who take greater responsibility for organising and managing their learning, thereby developing skills and mindsets which will support a successful transition to university study
- Within the sciences the Investigation Unit formalises this demand by requiring candidates to select a topic for investigation which is likely to be of personal interest to them.

Within the structure of the Science (or STEM) Baccalaureate we believe that the interdisciplinary project will afford S6 pupils an opportunity to take greater responsibility for their learning and develop independent research and study skills including a high level of planning, preparation and research. As importantly the project must afford candidates the opportunity to apply and further develop their learning in contexts outwith the classroom which require them to address real problems and make the link between study in school and action to change and improve the world in which they live. Candidates must have the opportunity to choose projects which are related to areas of interest and to future career aspirations.

The Government and SQA must involve the university departments, including Engineering Faculties, fully in the debate on the means by which they can support and contribute to supporting the interdisciplinary work. Universities can draw on a wide range of resources, human and material, which can support candidates in such studies; further they can provide access to networks which can provide further opportunities for support. Faculties and departments should be encouraged to develop specific support for Baccalaureate candidates as they undertake the interdisciplinary project.

Dissemination

The EtF team has commissioned colleagues in the University of Strathclyde Learning Services to develop templates for the teaching materials produced by the school and university partnerships. We would then hope to have these disseminated electronically; there are a number of sites currently being investigated for this purpose. We have been in discussion with colleagues in Glow not only about opportunities for dissemination but also about the means of affording opportunities for supporting collaboration among staff and pupils using these materials. We believe that this is necessary to promote sustainable change in which the materials that have been developed are not only available for others to use but are also used by them.

E-learning

As noted above funding from the Agilent Foundation supported a scoping exercise to take forward the development of e-learning materials. The EtF team had articulated certain premises:

- the project must motivate pupils strongly to use any ensuing facility
- it must successfully engage them with key ideas in the field of electronic and electrical engineering
- it must be sufficiently flexible to avoid the vagaries of fashion
- it is likely to make use of a media-rich suite of activities and resources
- it must have the potential for global delivery.

The EtF team initiated a partnership with TPLD, a serious games software specialist company based in Dundee, which was commissioned to carry out the detailed scoping work on this project. Based on findings from research and from the experience of teachers in the Project, it was agreed that the solution would ensure that pupils at key points within their school careers when major educational decisions are taken develop broader and deeper understanding of what it means to be an engineer and improved understanding of the key roles played by engineering in our society.

The scoping study established the feasibility of creating a prototype engineering laboratory centred on games based learning with the following key features:

- the target audience would primarily be younger secondary school pupils
- the virtual environment would be modular in structure
- players would work together in teams to solve a variety of real world, engineering-based problem
- a range of scenarios would be provided each of which would permit players to undertake different roles
- modular missions would relate to the content of national curricular policies and would develop the skills identified as fundamental to successful engineering
- the Management System would allow for new modular missions and challenges to be added.

With the support of a further grant from the Agilent Foundation and with the support of a commission from the Smallpeice Trust to TPLD the Biodome has been developed. This is a

game which challenges players (S1/S2 pupils) to work with and in competition with others to create ecologically balanced worlds making use of technological developments from the earliest implements to the products of today's sophisticated engineering industries.

This is currently being piloted in a number of schools before finalisation.

Research

It is crucial that full data are collected to inform future developments in this area. Our model of collaboration ensures that all participants contribute to the research processes. This has been effected not only through questionnaires, but through participant observation in classrooms, interviews with teachers, focus groups of learners, and detailed records of meetings. We have sought to ensure that information is fed back to participants and have sought to ensure that their views are clearly reflected in the development of the Project.

Conferences and Journals

Engineering the Future has again been represented at a number of conferences and seminars.

We had a stall at the Institute of Physics Conference in the University of Stirling in early June 2008. This was attended by physics teachers from across Scotland and our stall focussed on the school inserts; a number of colleagues showed considerable interest in the work we are doing.

Members of the EtF team attended EE2008, a major engineering education conference in Loughborough in July where we presented a paper and ran a workshop. In the autumn we again had a stall at Science and the Parliament; we presented a symposium at BERA (the British Educational Research Association); we held a seminar and two round table discussions at the Scottish Learning Festival (the Minster for Schools and Skills attended one of these); and we prepared two papers for SERA (the Scottish Educational Research Association). With the start of the new calendar year Elsa Ekevall and two of the teacher participants presented a paper at the UK conference of the Association for Science Education and we will have a stall at their Scottish Conference in March. We have submitted proposals for papers to the SEFI (European Society for Engineering Education) conference in Rotterdam in July, ECER (European Educational Research Association conference) in September and the Scottish Learning Festival also in September: The SEFI proposal has been accepted and we await news on whether the others have been accepted.

We have begun the processes of submitting papers to journals (as opposed to conferences) with a submission to a Special Issue of the IEEE Transactions on Education which focuses on outreach to prospective electrical, electronic and computer engineering students. We have identified a number of other topics for papers and appropriate journals to which to submit them; proposals and papers are currently being written.

Seminar

The second of our Engineering the Future seminars was held on 2nd June 2008 in the University of Glasgow Western Infirmary Lecture Theatre. This was attended not only by project participants from schools and universities, but also by representatives of the policy community, representatives of industry, critical friends and a representative of EPSRC which has funded the project. A full report has been prepared and distributed but some key points are noted here.

Gordon Hayward, Principal Investigator, highlighted key issues central to engineering education today, including the role of engineering in binding all branches of science and technology and the inherent versatility of an engineering degree which produces graduates with many transferable skills. There is at present a major opportunity to create a school curriculum which links science and technology to engineering and the economy.

Kate Miller of EPSRC followed this. She explained that previous projects have found that engineering activities can have an impact and increase enthusiasm but they appear to have only succeeded in the short term. To maintain enthusiasm in the long term, young people need to experience engineering through the year in schools and right the way through school. Engineering must be embedded within schools to keep pupils enthused.

Val Corrie, Rector of Balfron High School, referred to the rapidly changing world, competition with other countries, and the need to equip young people for jobs that don't yet exist. Engineering can provide young people with transferable skills such as analysis and synthesis, problem solving, creativity and innovation. The opportunity exists now to change what is delivered in schools and the way it is delivered.

Louise Hayward, Co-Investigator, discussed factors in transformational change. The three key components are educational integrity, personal and professional integrity, and systemic integrity. She remarked on the dichotomy observed by John Holman, National STEM Director and Director of National Science Learning Centres, where Science, Technology, Engineering and Mathematics are represented in the school curriculum as **STEM** and in the world outside school as **STEM**. To enhance understanding of and participation in engineering and to achieve sustainable transformation there must be changes within policy, systems, culture and practice.

David Cameron, Director of Children's Services, Stirling Council, considered that EtF has been an essential project given the importance of engineering and applied science to the Scottish and UK economy. At a time of enormous change in economic and social terms, Curriculum for Excellence offers great opportunities for creativity and flexibility in our schools. Engineering the Future will inform the hard decisions needed as we wrestle with the dilemmas that Curriculum for Excellence poses.

A very popular aspect of the day was the opportunity to see the developments in the schools taking part in the project who all showcased the engineering experiences they have developed in partnership with their university colleagues. The young people present from each school demonstrated and explained the work they had done and the impact it had had on their learning. Later the pupils produced a final round up of the day from their perspective and presented this to the participants.

A number of organisations involved in science and engineering education organised displays:

- The Engineering Development Trust www.etrust.org.uk
- The Institute of Physics www.iop.org
- Young Engineers Clubs www.yecscotland.co.uk
- SETPOINTS www.scienceconnects.org.uk
- The BA (British Association for the Advancement of Science) www.britishtscienceassociation.org/web
- The Royal Society of Edinburgh www.rse.org.uk
- and TPLD (www.tpld.net) our partners in developing e-learning.

Finally some key quotes which sum up the day and our views on the importance of all young people understanding engineering and considering it as a positive career option:

