ISEE 2012
Educating the Engineers of Tomorrow

4th International Symposium of Engineering Education,
The Edge, The University of Sheffield,
18th-20th July 2012
Educating the Engineers of Tomorrow

Editor: Plato Kapranos
Sponsors
Welcome

I am delighted to welcome you all to Sheffield for the 4th International Symposium of Engineering Education (ISEE 2012). I am pleased to say that we have received a good number of quality papers from around the world that will form the core of our discussions and exchanges.

It was decided that over the two days we will follow a programme of oral sessions, supplemented with keynote presentations from industry & academia together with a poster session and exhibition.

The key to success in our previous meetings has been the informality, the camaraderie, and above all our willingness to openly share experiences and discuss good practice.

The two key words of our conference logo are ‘Engineering & Education’ and we are here to do them justice by paying homage to our engineering and educational traditions.

Yes, we do have long and well respected traditions in the fields of Engineering and Education. However, although we respect our traditions we are always looking for new ways of doing things, continuous improvements and answers to challenges in both fields.

To quote Albert Einstein “We can’t solve problems by using the same kind of thinking we used when we created them” and “Insanity is doing the same thing over and over again and expecting different results” and adding one of my own, “Lack of creativity and innovation leads to routine which gives a sense of security and stability, that in turn leads to stagnation, decay and eventual death”!

We are here to do things differently! We are here because we believe in continuous improvement. We don’t subscribe to the ‘if it ain’t broke don’t fix it’ syndrome, instead we say ‘yes this is great, but how can we do it better’?

We are here to not only discuss how we can give students insights into the limits of knowledge, but also how to get them motivated and engaged in the process of life long learning, how to be broad minded and ethically responsible and to provide them with un-tinted spectacles through which they can view the world in new ways.

So let us engage with each other and after two days leave with our minds feeling refreshed and brimming with new ideas.

I wish you a happy stay and a successful conference; enjoy the trip.

Plato Kapranos

Conference Chair
Sheffield,
July 2012
Ithaka

C.P. Cavafy

When you set out for Ithaka
ask that your way be long,
full of adventure, full of instruction.
The Laistrygonians and the Cyclops,
angry Poseidon - do not fear them:
such as these you will never find
as long as your thought is lofty, as long as a rare emotion touch your spirit and your body.
The Laistrygonians and the Cyclops,
angry Poseidon - you will not meet them
unless you carry them in your soul, unless your soul raises them up before you.

Ask that your way be long:
At many a summer dawn to enter
with what gratitude, what joy -
ports seen for the first time;
to stop at Phoenician trading centers,
and to buy good merchandise,
mother of pearl and coral, amber and ebony,
and sensuous perfumes of every kind;
sensuous perfumes as lavishly as you can;
to visit many Egyptian cities,
to gather stores of knowledge from the learned.
Have Ithaka always in your mind.
Your arrival there is what you are destined for.
But do not in the least hurry the journey.
Better that it last for years,
So that when you reach the island you are old,
rich with all you have gained along the way,
not expecting Ithaka to give you wealth.
Ithaka gave you the splendid journey.
Without her you would not have set out.
She hasn't anything else to give you.

And if you find her poor, Ithaka has not deceived you.
So wise have you become, of such experience,
that already you will have understood what these Ithakas' mean.
Acknowledgements

In organizing a conference there are many people behind the scenes who help to make the event a success and I feel duty bound to mention as many of these who have supported my efforts and I apologise in advance if I have overlooked anybody.

I would like to take the opportunity to thank the members of the Local Organizing Committee for their help in getting this enterprise off the ground;

The Chairing Group for their contributions via electronic means to this event and continuous engagement throughout the organizing process;

The International Advisory Panel for spreading the word.

I am indebted to Katrin Thomson for her invaluable support with the Conference web site and all the ad hoc demands made by me, and Kate Orgill for her administrative support.

I thank the staff at the Edge for helping me in the organizing and the smooth running of the conference.

I am grateful to all the colleagues who accepted and refereed the papers submitted; your help has been invaluable and well appreciated.

I am thankful to our numerous sponsors for their kind support that allowed us to keep the costs of the conference to delegates at quite a reasonable rate.

Finally, I would like to thank all our keynote speakers, those of you who submitted your papers on time and are presenting your work at the conference and all the delegates who found the time to attend, especially those of you who have travelled from distant parts of the globe to be here with us. Your presence here means that our efforts have been appreciated.

Plato Kapranos
Conference Chair
Sheffield,
July 2012
Local Committee

Dr. Plato Kapranos, Senior University Teacher, Conference Chair
His approach to teaching is based on personal continuous improvement through reflection, and on student centered learning. He is involved in the teaching of ‘Personal & Professional Skills’, Distance Learning, research into ‘Innovative approaches in teaching and learning’ such as On-line assessment and feedback, Use of classroom electronic response systems, Active Learning, Problem Based Learning (PBL), and the teaching of ‘Creativity, Innovation, Enterprise and Ethics for Engineers’ both for UG & PG levels.

Prof. Stephen Beck,
He is interested in quality enhancement of teaching and has served as Director of Undergraduate Studies and the Director of Learning and Teaching Development for the Faculty of Engineering. He is currently Faculty Director of Learning and Teaching, coordinating learning throughout the Engineering Faculty.

Prof. Russell Hand
Contributes to learning and teaching with the Department of Materials Science & Engineering and the Faculty of Engineering. For the past decade he has also been involved with teaching related matters at Faculty level firstly as Sub-Dean for Undergraduate Affairs and since 2008 Deputy Faculty Director of Learning & Teaching.

Prof. Panos Tsakiropoulos
Holds a Chair of Metallurgy at the Department of Materials Science and Engineering of the University of Sheffield and he is passionate about the training of engineers especially metallurgists.

Ms. Elena Rodriguez-Falcon
Until recently, Elena was Director of Learning & Teaching Development for one of the four Institutional Learning Priorities of the University: Inclusive Learning and Teaching. In addition, Elena is the University of Sheffield's Director of Enterprise Education and the Faculty of Engineering's Director of Women in Engineering.
**Dr. Martin Pitt**
He has recently received an ExxonMobil Excellence in Teaching Award from the Royal Academy of Engineering. He is currently the Chairman of the Working Party on Education of the European Federation of Chemical Engineering and Secretary of the Royal Society of Chemistry Tertiary Education Group. Member of the Management Committee of the Engineering Subject Centre of the Higher Education Academy from its beginnings in 2000 to the present day.

**Mrs Linda Grey**
Linda graduated cum laude, with a major in Computer Science, from the University of Kansas, USA, is now a Senior University Teacher at Sheffield. She is a fellow of the Higher Education Academy.
Current topics of interest: Effective support of overseas students in engineering, Inquiry based learning/independent learning, First year team teaching, and critical thinking skills, looking at global, cross-institutional student groups.

**Dr. Anthony Rossiter**
His educational interests are varied and he is a fellow of the HEA. He has played a major role in improving mathematics support for engineers and tries to enthuse colleagues to consider the potential of new technology available for improving the learning experience to students. He is a strong champion of the need for effective team work in both the design and delivery of the curriculum. He acts as chair of departmental Learning and Teaching Committee and all associated duties and committees.

**Prof. Mike Bramhall**
Mike is a Professor of Engineering Education and is the Head of Learning, Teaching and Assessment for the Faculty of Arts, Computing, Engineering and Sciences at Sheffield Hallam University. He was until recently the Associate Director of the UK Centre for Materials Education, a Subject Centre of the Higher Education Academy, based at the University of Liverpool. As well as being a National Teaching Fellow he is also a Senior Fellow of the HEA. Mike was also an Associate Director of the Centre for Promoting Learner Autonomy at Sheffield Hallam from 2005 to 2010. He has interests in not only learner autonomy, but also in enquiry based learning, the use of media and technology in teaching and learning, and the personal and professional development of engineers. He has published widely in all these areas. He has recently developed an institutional policy and framework for 'Retention and Student Success' for Sheffield Hallam.
Chairing Group
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Dr Edmond Byrne, University College, Cork
Dr Kevin Cronin, University College, Cork
Dr John Fitzpatrick, University College, Cork
Prof David Shallcross, The University of Melbourne
Prof Panos Tsakiropoulos, The University of Sheffield

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Panos Tsakiropoulos, The University of Sheffield
Harro von Blottnitz, University of Cape Town
Richard Wakeman, Loughborough University
Paul White, The University of Sheffield
Malcolm Wilkinson, IChemE
Gregory Yablonsky, St. Louis University & Washington University in St. Louis
Opening Keynote: Teaching Engineering: Can we do it better? -Prof Peter Goodhew

There are many techniques for improving the education of engineering undergraduates. Everyone at this conference has probably engaged with at least one, and knows of many more. We will hear further examples during the conference sessions. My task in this presentation will be to suggest ways in which each of us can decide what techniques to deploy from this vast armoury of possibilities, while at the same time continuing to enjoy teaching (and the rest of life). Among the issues to be explored are: different techniques for different purposes; when to innovate; how to change your module (or, worse, someone else’s module); how to raise the resources to change anything, and; how to discover whether your change made a positive difference.

Session 1  Chair: David Wood

Paper 12: ‘Use of a Research Role Playing Exercise to Fast Track the Development of Early Stage PhD Researchers’, B Wynne, C Hinchliffe, P Prangnell and R Goodall


Coffee break
10.50-11.10  Paper 30: ‘Experiences of using a web based virtual shell and tube heat exchanger experiment by adult continuing learners’, Edmond Byrne, John Barrett, Tomáš Jiricek, Alan Kelly and Colm O Sullivan


11.30-11.50 Paper 5: ‘Using MATLAB to create cheap and accessible virtual laboratories’, John Rossiter

11.50-12.10 Paper 4: ‘Engineering in Recording’, Jeremy Wells

12:10-13:30 Lunch

13.30-14.00 Keynote: How many engineers do we need? -Dr Rhys Morgan Head of Secretariat for E4E, The Royal Academy of Engineering; in this role he advises the Government and Devolved assemblies of the UK on all aspects of education policy that affect the formation of engineers.

There is an apparent perennial contradiction of media scaremongering that manufacturing and productive industries are in decline in the UK and yet at the same time we hear employers are in desperate need of skilled engineers and technicians for their businesses. On top of this we hear that graduate engineers are unable to find employment. What is actually going on? Surely if there's a shortage we should be paid like bankers!

The Royal Academy of Engineering has been examining the present and future demand for engineers across the UK economy and the supply 'pipeline' to science, engineering and technology careers. Is our education system producing enough young people with the right qualifications to progress into engineering and is there anything we can do about it? Is the problem that engineering just isn't cool? What radical changes can we make?

14:00-15:00 Session 3 Chair: Panos Tsakiropoulos

14.00-14.20 Paper 65: ‘Leveraging commercial technologies to implement hands-on project-based learning of engineering principles’, Graham Green, Hannah Wade and Mark Walters


15:00-15:20 Coffee break
15:20-16:40 Session 4  Chair: Dermot Brabazon


15.40-16.00 Paper 20: ‘Chemical engineering curriculum: Are we preparing graduates ready to face future challenges?’ Jarka Glassey

16.00-16.20 Paper 25: ‘Is attending lectures relevant anymore in engineering education?’ John Fitzpatrick, Kevin Cronin and Edmond Byrne


Most -if not all- of the important skills in our life are acquired outside the traditional classroom setting. Yet we continue to teach using lectures where students passively take down information. Instead, we should really focus on the assimilation of that information and shift the focus from teaching to helping students learn. Over the past 20 years, instructors world-wide have begun to adopt Peer Instruction to get students to think in class. With the advent of new technology, the process can be significantly improved. A new data-analytics driven audience response system does away with multiple choice questions and helps instructors design better questions, manage time and process flow, and optimizes the discussions in the classroom.

17.30-18.30 Posters Session
Papers presented as posters: 7, 8, 15, 17, 19, 28, 31, 32, 35, 37, 40, 56, 63.

19.30 Conference Dinner
DAY 2  July 20th Friday
8.30-9.00  **Keynote:** "Examples and Lessons from Industry Engagement in Teaching Engineering"  **Mick Steeper, Siemens VAI Metals Technologies Ltd**

Mick Steeper is Technology Manager in the UK for Siemens VAI, the metals processing arm of the Siemens group. He has long experience of industry initiatives aimed at engaging young people with engineering in schools, colleges and universities. Mick will introduce three case studies, exemplifying these initiatives at three different levels:

- **Engineering Everywhere:** this schools-based activity developed and delivered by Siemens' STEM Ambassadors, takes engineering into the classroom with hands-on demonstrations of what at first appear to be trivial and familiar systems, but which turn out to be revealing and stimulating problems with wide possibilities for extended learning.

- **The Making of a Plate:** a mentored group project for materials science undergraduates at the University of Sheffield, aimed at giving students a representative experience of what a career in the steel industry is like. A rather more conventional group project engagement with the University's Mechanical Engineering undergraduates will also be described.

- **Steeluniversity.org:** participating in the development of an e-learning resource, one that aims to teach the technology of the steel industry to university students and early-career industry staff alike.

The way that Siemens plc is organising itself to improve its teaching-level University liaison (by taking a collection of ad hoc individual engagements and giving the staff concerned the support and resources needed to focus their delivery) will also be presented, and the early results of a broadened model, expanded from the former "research trickle-down" concept, will be shared.

Mick will conclude with his observations on what industry as a whole holds in store for its recruits, and whether the training and early career development of young engineers is really delivering a continuation of learning in the workplace.

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9:00-10:20  **Session 5:**  **Chair: Peter Goodhew**


9.20-9.40  Paper 45: ‘Content on Demand for Fourth Year Advanced Materials and Manufacturing Students’,  **Dermot Brabazon**, Lynda Donovan, Andrew Egan, Michael O'Mahony and Barry Smyth

9.40-10.00  Paper 27: ‘The Engineers Toolbox of Employability’,  **Danielle George** and Paul Rawlinson

10.00-10.20  Paper 50: ‘Enhancing employability: transfer of student-led activity’,  **Glynis Perkin**, Alison Ahearn and Fiona Lamb
10:20-10:40 Coffee break

10:40-12:20 Session 6     Chair: Ed Byrne
10:40-11.00 Paper 49: ‘Continuous feedback for integration of software engineering knowledge and skills through student workshops’, Konstantinos Dimopoulos
12.00-12.20 Paper 2: ‘Broader training of engineers on intellectual foundations?’ Panayiotis Tsakiropoulos
12:20-13:30 Lunch

13.30-14.00 Keynote: Dr Claire Hinchliffe: Centres for Doctoral Training: The PhD of the Future?
CDT in Advanced Metallic Systems.
Centres for Doctoral Training (CDTs) are a new approach to postgraduate research, increasingly being adopted throughout the UK. The influential Roberts Review of 2002 concluded that many UK PhD graduates, whilst expert in their field of research, lacked a broader knowledge of their subject and the interpersonal and communication skills, management and commercial awareness required by research and business employers. The CDT model aims to address these concerns through the provision of taught courses, a wide range of transferable skills training activities and increased student ownership of their training. Although it is still early days for many of the ~35 engineering centres, evidence suggests they are raising the standard of both PhD training and the student experience. If, as seems likely, the CDT model is here to stay, the next challenge will be to consider how this can be extended to the wider PhD cohort.

14:00-14:40 Session 7     Chair: Martin Pitt

14:40-15:00 Coffee break

15:00-15:40 Session 8     Chair: Brad Wynne
Paper 48: ‘Congruence between non technical market required competences and competences met by new engineering programmes and graduates. The case of Spain’, Jose Albors-Garrigos, Blanca De Miguel Molina and Maria De Val Segarra Oña

Closing Keynote: Prof. David Wood: Accreditation of University Undergraduate Programs: A Global perspective.

University engineering faculties in the UK, USA and in many other countries are well experienced in the regular requirement for accreditation by professional institutions. Typically every four or five years the professional engineering society or the national organization representing the various engineering professional societies in the country, conducts accreditation visits to the university engineering school for a full inspection and analysis of the undergraduate engineering programs. In the UK the Engineering Council is the legally authorised organisation which is responsible for accreditation. Typically the EC licenses a discipline specific professional institution e.g. the IChemE to conduct the accreditation process for that discipline. This is not the case in the USA where the ABET (Accreditation Board of Engineering and Technology) is responsible for the professional accreditation of all university undergraduate engineering programs and ABET does not licence individual professional institutes to undertake the accreditation process. ABET accreditation is an example of Pan Engineering accreditation. ABET took the lead in 1989 in establishing the Washington Accord involving pan engineering organisations in a number of countries including the UK and Australia and this accord has been updated on several occasions since it was first established. It provides an international recognition of engineering accreditation between the signatories. The paper discusses the principles behind engineering undergraduate accreditation and asks if the typical accreditation system that is used today encourages or inhibits change. Engineering undergraduate programs in a number of countries have undergone a significant change e.g. the Bologna Accord in Europe with its two cycle program and the Melbourne Model in Australia with its two cycle program. Typically both of these innovations have a three year bachelor program and a two year master program. If these innovations are typical of the changes that might occur in tertiary education for the future, what is the impact for accreditation programs designed in the 20th century for three or four year bachelor programs including the MEng in the UK? The World of engineering education must recognise that as we move towards an Asian dominated global economy, some of the major manufacturing countries in this region have no independent professional accreditation for undergraduate engineering e.g. China which produces the highest number of university engineering graduates. Japan has JABEE, the Japan Accreditation Board for Engineering Education, and yet the majority of university chemical engineering schools do not accept JABEE accreditation. The paper will also make
The paper will provide a global perspective of Independent Professional Accreditation of university engineering undergraduate programs and will use the knowledge of the author with chemical engineering accreditation as an example.

16.10-16.30 Awards for best Poster Prizes & Conference close – Dr P Kapranos

6 Keynote presentations
26 Oral Presentations
13 Posters
### Delegate List

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Paper 2

Broader training of engineers on intellectual foundations?

Panos Tsakiropoulos*
Department of Materials Science and Engineering, The University of Sheffield

Abstract: The paper argues that Engineering Faculties and Engineering Departments should be concerned not only with the training and assessment of their students giving them ample opportunities to build strong foundations of technical expertise and develop leadership qualities of inventiveness and risk-taking, but also with nurturing in them intellectual qualities, such as compassion, modesty and honesty and a sense of adventure with a strong community sense. [full paper]

Paper 4

Engineering in Recording

Jeremy Wells*
Audio Lab, Department of Electronics, University of York

Abstract: One does not have to look very far to find controversy in the use of the name ‘engineer’ in the field of audio recording. It is a ubiquitous term but there are those who firmly believe that the act of ‘recording’ is not ‘engineering’. This paper briefly surveys definitions of engineering which exist in the literature and then applies these to specific, documented examples of recording processes. These processes are described in terms of the knowledge, training and technology they require for their execution. The purpose of these case studies is not to prove that recording is or isn’t engineering; rather it is to highlight how activities undertaken by those who make sound recordings can overlap with generally accepted notions of engineering. The primary motivation for this work is pedagogical: the presented activities can be used as examples in general engineering education and to illustrate the nature of engineering within degrees in sound recording and music technology. Links to materials for supporting teaching are also provided. [full paper]

Paper 5

Using MATLAB to create cheap and accessible virtual laboratories

J.A. Rossiter
University of Sheffield

Abstract: It is well known that laboratories benefit student learning, but access is severely restricted in practice due to timetabling and other constraints. Consequently a major aim of this paper is to propose mechanisms for augmenting students’ practical activities without requiring
them to enter a timetabled laboratory. Within the community this is often done with remote access laboratories and also so called virtual laboratories, that is laboratories that in fact are simulation only. The advantages of virtual laboratories are manifold, for example the whole class can access them simultaneously and of course they are cheap and often more flexible which means that staff can embed more interesting activities and learning outcomes than are possible with laboratory equipment. This paper will place some focus on the staff facing part of virtual laboratories, that is the design and coding of the activities. Most staff are busy and not computer experts and therefore coding complex scenarios is infeasible in general. However, it will be shown how the MATLAB/SIMULINK tool facilitates quite complex scenarios with relative ease of coding. Moreover, the software includes animation tools which are relatively simple to use and thus make the ‘activity’ feel more authentic. Several case studies are discussed in terms of the coding required to produce them and their fit into the curriculum. [full paper]

Paper 6

Using continuous assessment to generate continuous learning in engineering maths

Jonathan S. Cole*
Queen’s University Belfast

Abstract: The mathematics for first year aerospace and mechanical engineering students is delivered through two half-modules, one in each semester. Each course is taught over 12 weeks with a 2-hour lecture and 1-hour tutorial class per week. Students attend lectures as a single group but are divided into smaller groups (of 40 – 50 students) for tutorials. In these more informal classes, students work through practice questions. Solutions are provided on the university’s intranet a few days after the tutorial. The lecturer has been concerned that these classes are not as productive as they could be. Downloading of tutorial solutions was observed to be low throughout the semester although a surge in usage occurred just before mid-term tests and the exam.

Therefore, an experiment is underway in the first semester course with the tests being replaced by a system of continuous assessment based on the tutorial questions. In 2010/11, assessment involved an exam and four tests (one every third week). In 2011/12, students were awarded one or two marks each week, over ten weeks, based on their performance in the previous week’s tutorial questions. The marks available from continuous assessment counted towards 15% of the module mark. On average, 79% of the class presented work for assessment each week and motivation was generally not a problem. More uniform attendance at lectures and tutorials occurred in 2011/12 and exam performance improved significantly. The continuous assessment encourages weekly practice and there is some evidence that this has enhanced the students’ mathematical skills. [full paper]

Paper 7

Using student performance indicators to identify students in difficulty.
Jonathan S. Cole* and Geoffrey Cunningham  
Queen’s University Belfast

Abstract: The first author is Adviser of Studies for 136 aerospace engineering undergraduate students and is responsible for academic guidance and more general pastoral advice and support. A system for monitoring class attendance, for first and second-year students, has been implemented to give early warning of students potentially in difficulty. At various points in the semester, students with high absence rates were called for a discussion with the Adviser. This had the advantage, in some cases, of bringing serious personal problems to the attention of the Adviser. However, subsequent attendance rates for these students varied widely with both improvements and declines.

Analysis of attendance and exam results data has shown interesting features. Moderate correlations ($r = 0.6$) have been observed between class attendance and average marks in first and second year. Of the students who failed first semester exams, a high proportion (75%) had been called to meetings regarding their poor attendance. Strong correlations exist between students’ average marks in first and second year, and between second and third-year averages ($r = 0.8$).

Effort has been made to present some of this information to new students during enrolment week to encourage a more conscientious approach to study. The attendance monitoring system has been in place for only three years but initial evidence suggests that, for a particular class, a strong correlation exists between their attendance rates in first and second years. Changing student behaviour is challenging but it is believed that taking an active interest in their progress is appreciated. [full paper]

Paper 8

Diploma in personal and professional skills for Centres of Doctoral Training – Managing by instructional objectives.

P. Kapranos*  
The University of Sheffield

Abstract: Our graduates need help developing transferable skills as well as the technical knowledge and expertise to succeed in their chosen careers. For this reason, we designed the „Skills Diploma“ that supports and certifies our graduates in these areas. The Diploma in Personal and Professional Skills for Centres of Doctoral Training (CDT“s) has been built into the 4 year PhD scheme in the following format: Part of the Diploma in Year one provides training in essential personal effectiveness skills to enable students to carry out their PhD research projects; training covers skills such as networking, communication & presentation, motivation, assertiveness, project and time management and creative thinking and later in Year three, students build on the personal skills training delivered in year one and focus on skills required in business and industry. Students record their reflections and development in their Personal Development Planning (PDP) log supported by tutorials. Sessions are interactive including work in small groups, short presentations, individual reflection, plenary discussions and structured
tasks. Students are encouraged to take a reflective approach to their learning and to identify their own additional training needs.

The proposed learning outcomes for the Diploma have been aligned with Bloom’s Taxonomy of Educational Objectives, and appropriate assessment methods have been identified to ensure not only that these objectives are met but provide evidence of the level of achievement of the students. Assessment is continuous and includes: class work, group presentations, report writing, peer assessment, web-based (guided) pre and post-learning, as well as web-based exercises and quizzes. Students also complete a „personal portfolio“ with a reflective analysis of their experiences, providing a record of their progress through the modules, as well as useful feedback for staff on how the modules might be improved for future cohorts. [full paper]

Paper 12

Use of a Research Role Playing Exercise to Fast Track the Development of Early Stage PhD Researchers

B.P. Wynne1*, C.E. Hinchliffe1,2, P.B. Prangnell2, R. Goodall1
1 Centre for Doctoral Training in Advanced Metallic Systems, Department of Materials Science and Engineering, The University of Sheffield
2 Centre for Doctoral Training in Advanced Metallic Systems, Manchester Materials Science Centre, University of Manchester

Abstract: This paper reports on the student experience of a week-long group research role playing exercise, based on the manufacture of metal foams, developed for early stage PhD researchers. The main focus of the task is to highlight to students the critical transferable skills such as time management, project planning, literature analysis, personal relationship building, etc., needed for successful completion of a large research project. This is done in parallel with a number of classroom based seminars on developing good practice in research. The task involved developing a process route for the manufacture of a metal foam within 3 days of experimentation. No guidelines were given on how the task should be undertaken and the groups were given complete freedom to plan, allocate resource, execute, analyse, and re-evaluate their strategy without any outside influences. In all cases a metal foam was produced, but a subsequent survey of the participating students suggested that in order to improve their effectiveness in future projects they would prioritise background research, experimental planning, setting of goals, re-evaluation of goals, meeting the academic support, and seeking 3rd party assistance. Thus it is concluded that the traditional methods of highlighting good practice in research, such as seminars, should be supplemented by role playing activities like that presented here to reinforce the ideas presented in the classroom, which can often appear dry and detached from reality. [full paper]

Paper 13

Integrating Sustainability into Civil Engineering Education: Curriculum Development & Implementation
Derek Sinnott * and Ken Thomas
Department of Construction and Civil Engineering, Waterford Institute of Technology

Abstract: This paper describes the development and implementation of a curriculum for a new level 8 degree in Sustainable Civil Engineering in Ireland. The programme maintains the core outcomes essential for a civil engineering degree, reinforced by programme accreditation, while providing engineering graduates of tomorrow with the new technical and non-technical competencies to become active drivers for sustainable global innovation. The paper outlines how a number of complexities, including limited resources, lower enrolment figures and a changing student demographic were addressed to attract prospective students and provide quality assurance. [full paper]

Paper 14

Investigating the use of audio feedback in engineering mathematics modules.

Kate Durkacz and Elaine Mowat
Edinburgh Napier University

Abstract: Assessment and feedback are an important part of student learning, and there is evidence that good feedback leads to improvements in both learning and student engagement. This work is concerned with the use of audio feedback on two Engineering Mathematics modules at Edinburgh Napier University. The modules are both compulsory modules which include class tests as part of the assessment strategy. In the past, the written mathematical feedback provided throughout each script has been considered as both appropriate and sufficient. The audio feedback, which is being trialled on both modules, is in addition to this feedback, and provides an overview of each student’s performance, thus enabling improvement in core mathematical skills. The method used for providing the audio feedback will be explained, and the strategy for summarising the students’ performance will be discussed. The methods used for obtaining feedback from the students will be explored, and the students’ opinions and ideas will be reported. There is of course extra effort required to provide an individual audio file for each student. However, the response from the students has been extremely positive, and their enthusiastic reception of the audio feedback has made it worth the extra time being spent by the lecturer. Audio feedback is continuing to be provided on the two Engineering Maths modules. [full paper]

Paper 15

Using PBL with undergraduate engineering students.

Marta Cabeza1*, Belén Díaz1, Lorena Freire1, Isidro Sánchez2
1 Department of Materials Engineering, University of Vigo
2 Civil Engineering Department, University of Alicante
Abstract: This paper describes the application of the new methodology of Problem-based Learning (PBL) in two undergraduate Materials modules for students of the Energy and Mining Engineering Degree at the University of Vigo and of the Civil Engineering Degree at the University of Alicante. This PBL system has been adopted by several universities in Europe because the students can acquire several skills (solving problems by themselves, self-directed learning, and collaborative work) which would be impossible to develop using other methodologies. Moreover, students assume responsibility for their academic education. We have already been using the PBL system for 4 academic years in a final-year Materials Engineering (Metallurgy) module. The result has been satisfactory, although some corrections have been introduced in subsequent years. This year, for the first time we have used PBL with younger students and the challenge has been how to motivate them to use this methodology. We have found three essential differences between using PBL with older or younger students. In the latter case, the formulation of the problems has to be clear and involve a restricted number of solutions. Secondly, the tutor needs to monitor the groups and the schedule of meetings closely in order to ensure the problems are solved. Thirdly, the method of assessment used has to be able to detect “bystanders”.

Paper 16

Materials education: adapting to needs of the 21st Century

Arlindo Silva¹, Ana G. Pereira-Medrano¹, Hannah Melia¹, Mike F. Ashby¹,²
¹ Granta Design, Ltd, Education Division
² Engineering Department, Cambridge University

Abstract: What are Universities for? The short answer is: the creation, preservation and transmission of knowledge. The last of these – transmission – is what this Engineering Education symposium is about, but it can’t be divorced from the other two. This paper is about the transmission of materials knowledge in ways that recognize the broader technical, economic and social conditions in which it takes place. A Materials education today must balance both depth, leading to expertise in the subject, and breadth, allowing material issues to be judged in the light of contemporary economic and societal concerns of the present and the future. This is consistent with the increasingly integrated nature of technical education and society’s need for engineers that can make things happen. Materials’ teaching has already integrated a great deal. At one time metallurgy, polymer science, and glass and ceramic technology were taught in different departments, even at different universities; today they are generally integrated into a single program under the heading of Materials Science or Engineering Materials. There is now a move beyond this, towards what we will call Materials Systems and Design, integrating broader technical, economic, environmental and social issues and the skills necessary to make an effective engineer. This framework will encompass all the implications of, and trade-offs in, the adoption of materials in innovative design: not just the technical implications such as cost, strength or manufacturability, but also environmental
impact, social awareness or material scarcity. Students will be prepared to take advantage of new technologies and learning opportunities throughout their careers. [full paper]

Paper 17

Granta Design's Teaching Resource Website

Hannah Melia, Marc Fry
Granta Design Ltd.

Abstract: Granta Design Ltd. is an independent, private company owned by its founders, employees, the University of Cambridge, and ASM International—the world's largest professional society for materials engineers. Over 800 universities and colleges currently use CES EduPack, Granta’s educational software to support and help enhance materials, design and sustainability related teaching across engineering, design and science courses. The Granta Teaching Resource Website (http://teaching.grantadesign.com) is a new initiative that contains over 225 resources contributed by academics in the materials education community. The resources are intended primarily for materials related courses at the undergraduate level. Most are password protected and only available to educators using CES EduPack, however a growing number are open access. At present the site includes:
• Exercises with Worked Solutions (350+)
• PowerPoint Lectures (70+)
• Videos and Webinar Recordings
• Databases and Project Files
• Teach-yourself manuals
• White Papers

Granta plans to further develop the website and the resources it contains. We are very interested to hear about good resources that we should link to, resource websites we should collaborate with and for suggestions on ways it can be improved.

Paper 19

LEAP: A Learning Environment for Antennas and Propagation

Patrick Murphy and Conor Brennan*
School of Electronic Engineering, Dublin City University

Abstract: The paper describes the use of a range of open-source web application development tools to create an on-line learning environment for a new MEng module on antennas and propagation. While the specific content of the module is of interest to students in telecommunications engineering the various web technologies lend themselves well to creating interactive tutorial pages for students of any discipline. [full paper]
Paper 20

Enquiry-based learning in engineering curriculum: Are we preparing graduates ready to face future challenges?

Dr Jarka Glassey*
School of Chemical Engineering and Advanced Materials (CEAM), Newcastle University

Abstract: Application numbers to chemical engineering degrees provided by the UK Universities are at an all time high and, despite the current economic situation, the prospects of fresh graduates are, as yet, not affected significantly. However, the anticipated demographic changes, together with the higher education funding changes within the UK, add to the impetus of continuously reviewing the curricular provision in this subject area. The changes in the world-wide market, as well as societal challenges we are facing, require a review of not only the content of the traditional chemical engineering curriculum, but also the mode of delivery of the fundamental knowledge and skills in this area. The School of Chemical Engineering and Advanced Materials at Newcastle University initiated a substantial curriculum redesign process leading to the introduction of an Enquiry Based Learning approach via industrially relevant case studies throughout the whole curriculum. This approach is learner centred and enables effective development of professional skills within the subject context. Focus groups of industrialists/students and questionnaire outcomes from past graduates fed into the review process. The structure and outcome of the review process will be described and student evaluation of the major changes provided to share best practice with other chemical engineering providers. [full paper]

Paper 22

International frameworks for accrediting engineering education.

Ian Freeston*
European Network for Accreditation of Engineering Education, Engineering Council

Abstract: This paper reviews recent developments in international frameworks of requirements of national agencies for the accreditation of engineering programmes, including the purpose and value of such frameworks, and considers their possible future development. The European Network for Accreditation of Engineering Education (ENAAE) was established in response to the Bologna process, and in 2006 published a framework for authorising the award of the EUR-ACE label to nationally accredited First and Second Cycle programmes. The Washington Accord, established in 1989 and now administered with five other accords by the International Engineering Alliance (IEA), is an agreement of mutual recognition of the education necessary for registration as a professional engineer. What should be the basis, structure and content of such frameworks? Recent informal discussions between the ENAAE and the IEA on the comparability of their respective frameworks suggest that it may be possible to identify a single international framework for the accreditation standards of national agencies. Would such a single global framework add value to programme accreditation for students, universities and
employers, or would it inhibit innovation in programme content and teaching methods? What sort of organisation would be needed to implement, monitor and update a single global framework? [full paper]

Paper 23

Engaging the disengaged indefinitely, and with no budget: Creating a sustainable model for student library ambassadors.

Mike Clifford*, Elizabeth Gadd1, Jenny Coombs2, Carol Hollier2, Ginny Franklin1, Karen McCormick1, Paul Maynard3, Peter Willmot3, Maurice FitzGerald4

1 University Library, Loughborough University
2 George Green Library, The University of Nottingham
3 Wolfson School of Mechanical & Manufacturing Engineering, Loughborough University
4 Loughborough University

Abstract: University Libraries offer a wide range of services and facilities to help enhance the student learning experience and to aid the transition into learning at University. Often, too few Science and Engineering students fully engage with the services and facilities on offer and therefore do not benefit from the opportunities available to them. Drawing on research highlighting the value of peer support, and the fact that students are far more likely to use their peers as an information source than ‘experts’, Loughborough University Library obtained small project funding in 2010 to employ four Student Ambassadors in a pilot project to improve student engagement with the Library. The successful project demonstrated the potency of the idea in engaging with students, particularly non-users, a large proportion of which are based in the Science and Engineering Faculties.

In the absence of continued funding, the challenge, addressed here, is how to make such posts sustainable. Past experience at both Nottingham and Loughborough Universities has proven how difficult it is to recruit students on a voluntary basis to engage with University Libraries. In this paper, an innovative and creative method of recruiting and supporting “Learning Resource Leaders” (LRLs) at Nottingham and Loughborough Universities is discussed. The strategies employed have resulted in the recruitment of four LRLs – two at each institution – supported by an industrial sponsor who provides a package of non-monetary incentives. The paper also describes the techniques used by the LRLs to disseminate information about the resources offered by the University Libraries and to engage with the student cohort. [full paper]

Paper 25

Is attending lectures relevant anymore in engineering education?

John J. Fitzpatrick*, Kevin Cronin, Edmond P. Byrne

Department of Process & Chemical Engineering, University College Cork
Abstract: A case-study was conducted on a group of undergraduate chemical engineering students to assess the relevance of attending lectures from a student perspective and to understand why these students attend and do not attend lectures with a view to developing approaches to teaching which are of greater interest and benefit to student learning. The students were surveyed by means of a questionnaire-type survey. The majority of students stated that lectures are still very beneficial to their learning and are not an out-of-date mode of education, with around 8% of students stating that lectures are out of date. Consequently, attending lectures is still very relevant today to student learning. The major reasons for lecture non-attendance were time conflict issues with other scholarly activities, such as continuous assessments, and poor quality teaching. The students provided a number of suggestions to improve lectures and lecture attendance, including the incorporation of active learning in lectures, linking lectures to assessment, adding extra value to what is already in the notes and the lecturer should be enthusiastic and be able to capture the interest of the students.
[full paper]

Paper 27

The Engineers Toolbox of Employability

Danielle George¹ * and Paul Rawlinson²

¹ School of Electrical and Electronic Engineering, The University of Manchester
² TBG Solutions

Abstract: It is recognized that it is difficult to replicate the learning experience from a work placement within a University environment. This paper aims to address improving the employability prospects of engineering graduates, looking at both the academic and the industrial perspectives. A pilot unit will be developed with learning outcomes creating synergy between academic and industrial recruitment needs, and a major emphasis on the employability facts regarding a placement in industry. The skills developed through a purposeful approach to the curriculum will be evaluated by the School’s Industrial Advisory Board to further enhance the employment prospects of our graduates, thereby maximizing the value of a degree and increasing the influence of graduate engineers within the knowledge economy. Such a unit could easily be disseminated to interested Universities. The paper will also address the very real issue of engaging engineering students in what are so often seen to be non-engineering subjects. [full paper]

Paper 28

Using workshops to learn engineering in industrial plants.

Valero-Herrero, Maria*; Vidal-Carreras, Pilar I.; García-Sabater, José P.

Abstract: This article presents a new learning methodology employed in the postgraduate course "University Specialist Program in Lean Manufacturing" which is offered by a Spanish’
university. In this course, workshops to implement lean manufacturing tools are utilized. In these workshops, the tools that have been learnt in the classroom are implemented in an industrial plant. This methodology is particularly useful for those knowledge areas in which the implementation of the content developed in the classroom is the most important aspect. In the traditional classroom-based education, passive and rote learning are the styles most usually adopted. Education in the field can give a major boost to students’ self-motivation and self-learning. In this case, real-world business problems, previously detected, are used. In the workshops the personnel of the company are involved, both direct labour and indirect labour. This article describes the advantages and disadvantages of this type of learning, how to address the problems and the conclusions. Clearly, the use of workshops to teach has got an added value for the course. The implementation of continuous improvement tools in industrial plants allows learners to acquire the skills, capacities and knowledge required. In spite of being the first time that this methodology has been used by the professors who teach the course, the initiative has turned out highly successful. [full paper]

Paper 29

Understanding thresholds in first year engineering: Digging beneath Mohr’s Circle.

K.M. Quinlan1*, S. Male2, J. Fill1, Z. Jaffer3, A. Stamboulis3, C. Baillie2
1 University of Oxford, Oxford Learning Institute
2 University of Western Australia, School of Environmental Systems Engineering
3 University of Birmingham, School of Metallurgy and Materials

Abstract: Meyer, Land and others (2005) asserted that there are “threshold concepts” that open up required ways of thinking in a discipline, yet are troublesome for students. Understanding aspects of a curriculum that serve as such “thresholds” can assist with designing curricula, teaching methods and assessment approaches. This paper develops the work of threshold concepts in 1st year engineering by combining the results of research programmes in three institutions: the University of Oxford, the University of Western Australia and the University of Birmingham. We look at the case of Mohr’s Circle (a graphical representation of the state of stress at a point in a material). While students and tutors initially suggested it as a potential threshold, there are other, more conceptually troublesome issues that underlie it. We identify those troublesome aspects. In particular, we use this case to show what the general thinking processes of engineering identified in the project (including understanding the relationship between mathematics and the physical world) mean in the context of a particular example. The paper also illustrates methodologies developed by the team for investigating thresholds in engineering. We conclude by briefly considering some potentially useful teaching and learning approaches for addressing such thresholds. [full paper]
**Paper 30**

Experiences of using a web-based virtual shell and tube heat exchanger experiment by adult continuing learners.

**Edmond Byrne***, 1, **John Barrett**1, **Tomáš Jiřiček**2, **Alan Kelly**3, **Colm O'Sullivan**4  
1 Department of Process and Chemical Engineering, University College Cork  
2 Institute for Nanomaterials, Advanced Technologies and Innovation, Technical University of Liberec  
3 School of Food and Nutritional Sciences, University College Cork  
4 Department of Physics, University College Cork

**Abstract:** This paper describes the experiences of adult continuing learners at University College Cork (UCC) in employing a virtual web-based shell and tube heat exchanger experiment. The experiment was developed at UCC as part of a ‘ComLab’ European project. The development of the virtual experiment consisted of two stages; stage 1 involved the design and build of the model heat exchanger and the collection of experimental data, while stage 2 consisted of the development of the virtual online experimental interface. The learners using the experiment are engaged in a two-year part time evening Diploma in Process and Chemical Engineering and the experiment forms part of an assessment exercise for a module on Heat Transfer and Applied Thermodynamics, taught by the principal author, which incorporates the principles of heat exchanger design.

The virtual and online nature of the laboratory were useful features for these learners as it could readily be used during the night-time classes (and by a high number of users simultaneously) and could be accessed remotely outside of class time, unlike a real laboratory experiment. Feedback was obtained on a longitudinal basis from learners over a number of iterations of the experiment and was generally very positive, with learners preferring the virtual online experiment to a real laboratory experiment, as well as universally finding it both useful in developing their understanding of heat exchanger design and operation and highly user-friendly. The virtual shell and tube heat exchanger experiment can be accessed online at: http://cs1.ucc.ie/~jb7/exch/ [full paper]

**Paper 31**

A community for sharing best practice and resources for teaching risk.

**Nicola Stacey** and **Jo Bowen**  
Health and Safety Laboratory, Harpur Hill, Buxton

**Abstract:** The Risk Education Network is a community of practice set up to facilitate the delivery of the teaching of risk concepts, primarily to engineering undergraduates and graduate trainees. It is a free resource that can be used by teachers, lecturers and course directors, across the world, to seek advice from those with experience of teaching risk concepts, thereby sharing good practice, information and ideas. The network is facilitated by the Health and Safety Laboratory, with support from industry and professional bodies. Members can access
teaching resources as well as the expertise, knowledge and experience of peers. The network has various features designed to encourage interaction and build a shared purpose via a powerful online tool. [full paper]

Paper 32

Experimental learning using a computer-based virtual reconstruction of an accident investigation.

Nicola Stacey¹*, Nick Underwood², Anton Gordon¹, Dean Turner¹, Dr Graham Schleyer² and Olanrewaju Okunribido¹
¹ Health and Safety Laboratory, Harpur Hill, Buxton
² School of Engineering, University of Liverpool

Abstract: This paper describes the development of an interactive computer-based laboratory exercise for first year engineering students, in which they take the role of an accident investigation team sorting through information and analysing evidence. The accident the students investigate is based on the actual collapse of a passenger walkway at the Port of Ramsgate in 1994, which was investigated by the Health and Safety Executive (HSE) with forensic support from the Health and Safety Laboratory (HSL). The exercise was initially paper-based using the photos and witness statements taken during the actual investigation, original design drawings, a metallurgical analysis by HSL, and the wooden scaled models of the accident scene and failed component that were built by HSL for use in the court prosecution of those found ultimately responsible.

Feedback from students informed the design of a computer-based version. For example, some of the more difficult underlying engineering principles are animated. A large amount of information is organised and presented so as to engage students and help them make sense of what happened and the underlying responsibilities. The new computer based version has been used at the University of Liverpool since 2010. Removing the dependence on the wooden model also means that other universities could potentially use it, and the authors are keen to explore how this could be achieved.

The active experiential nature of the real-life scenario and role-playing helped students to consider the wider implications of their activities as professional engineers in society. The exercise also encouraged team working, verbal communication, and literacy. [full paper]

Paper 35

Educating the Engineers of tomorrow

Elena Rodriguez-Falcon¹*, Alaster Yoxall², Jenny Moore³
¹ The University of Sheffield
² Sheffield Hallam University
³ University of Exeter
Abstract: Service-social embedded enterprise learning has a long history in Mechanical Engineering at the University of Sheffield. In terms of student satisfaction, engagement and employability this method works, but the impact of this technique has not been fully analysed and evaluated. This is critical for development of the module and how it may be implemented more widely. The authors obtained funding from the Royal Academy of Engineering in partnership with the National Higher Education STEM programme, which allowed more detailed analysis using phenomenography, a methodology that allows qualitative evaluation of the different ways in which participants experience or think about something. Phenomenography effectively encourages a more detailed reflection by the participants on their experience, than can be captured through other assessment methods. The viewpoint of all engaged in the module, students, customers, practitioners and external contributors was obtained and assessed, and the results are presented here. In the light of these results, delegates will be invited to consider how service-social embedded enterprise learning could be implemented in their own HE. [full paper]

Paper 36

Enhancing engineering employability in the 21st century; Handling uncertainty and complexity through ‘new entrepreneurship’.

Edmond Byrne
Department of Process and Chemical Engineering, University College Cork

Abstract: Universities, professional bodies and governments prioritise graduate employability and seek these through ‘generic’, ‘soft’, ‘entrepreneurial’ and ‘transferable’ skills. The UK’s Higher Education Academy published a list of 39 ‘aspects of employability’ to assist in the ‘examination of curricula from [the] point of view of employability’ (Yorke and Knight, 2006). These capabilities generally align with good pedagogical practice and include for example, ‘critical analysis’, ‘reflectiveness’, ‘creativity’ and ‘coping with complexity’. However, some clearly appear to focus on interests that align more specifically with business aspirations such as for example, ‘stress tolerance’, ‘influencing’, ‘arguing for and/or justifying a point of view’. This paper argues that universities, given their role and duty as leaders in the development of knowledge and understandings have a consequential responsibility to develop employable graduates who will be equipped to lead and change their (future) organisations for societal good (and ultimately for the good of organisations themselves) rather than to be led in seeking to continually serve up whatever type of ‘oven ready graduates’ that the market economy may envisage. It proposes that, in the wake of the increasing complexity and uncertainty that surrounds 21st century society, engineers’ employability will be best realised by graduates who possess additional capabilities to the aforementioned, such as for example, metacognition (learning how to learn), independent critical thought, recognising inherent uncertainty and complexity, resilience, humility and openness to (integrating) new perspectives. Such engineers embody Gibb’s (2002) ‘new entrepreneurship’ paradigm, contrasting with a narrow conception of entrepreneurship based primarily around business and new venture management.
[full paper]
Paper 37

Teaching safety in engineering

Martin J. Pitt*
Chemical & Biological Engineering, University of Sheffield

Abstract: The UK Health and Safety Executive (HSE) would like all engineering degree courses to teach students about safety in their respective discipline. The Engineering Council (EC) requires as a condition of accreditation that degrees should include risk assessment (which is not quite the same thing as safety). There is an Inter-Institutional Group (IIG) on health and safety which includes the engineering institutions and some safety organizations, which has been working to promote safety in engineering degrees, and has projects to produce material for this purpose. Some of the work of the IIG and the HSE, separately and jointly is presented, along with experience of teaching safety, and a graduate survey of the topics found most useful. [full paper]

Paper 40

Using Webinar in postgrad course.

Vidal-Carreras, Pilar I. *; Valero-Herrero, Maria; Garcia-Sabater, Julio J.

Abstract: In the current environment there is significant training demand and the training offer is also abundant in many areas. Thus, being able to innovate in the training of professionals is a key aspect in order to attract students to postgraduate courses. Simultaneously it is essential to be able to improve the results obtained with training in case the demand falls. An innovative alternative to meet this demand in education is presented in the webinar (web seminar). Thus, this article presents a webinar teaching experience in a postgraduate course through the program Policonecta (Adobe Acrobat Connect Pro). The main features of the program are that it allows the theoretical teaching, user participation and evaluation of students. It describes the experience in the postgraduate course about lean production at the Universidad Politécnica de Valencia. It highlights how the use of this technology opens new possibilities for professors by providing a framework where they and their students can perform the same activities of the traditional classroom without geographic restriction. The advantages and disadvantages of that experience are indicated by presenting the conclusions and some possible options for resolution. Note that students, professors and professionals have evaluated this new approach very positively. Webinar allows combining professional life with the completion of the course. [full paper]

Paper 41

Global engineering challenge: A curriculum innovation to inspire rather than assess.
Recognising the need to inspire students and develop graduates equipped to meet the challenges of an increasingly globalised world, the University Of Sheffield Faculty Of Engineering developed an exciting new faculty-wide non-credit-bearing project and skills week for all 900 first year student engineers. Projects based on the Engineers Without Borders Challenge acted as a vehicle for developing broad professional, employability and academic skills within a global engineering context.

During the week, working in multi-disciplinary groups of 6, students were challenged to tackle real-world problems from a global perspective, thinking not only about the technical issues involved in solving problems and engineering creative solutions, but also the social, ethical and environmental considerations required for effective, sustainable solutions. Group project work was interspersed with interactive sessions on topics that progressed the project and / or developed generic skills. These were facilitated by postgraduate facilitators dedicated to hubs of 36 students (6 groups). The week culminated in presentation / competition for best project.

This paper describes the challenges involved in organising a non-credit-bearing project on this scale, across different departments and the co-ordination, development and training undertaken by staff, students and facilitators. Results and evaluation of surveys of student motivation and engagement in this project are also presented. [full paper]

Paper 45

Content on demand for fourth year advanced materials and manufacturing students.

Dermot Brabazon¹*, Lynda Donovan², Andrew Egan³, Michael P. O’Mahony³, Barry Smyth³

¹ Faculty of Engineering and Computing, Dublin City University
² PERCOLATE Project, University of Dublin, Trinity College
³ CLARITY: Centre for Sensor Web Technologies, University College Dublin

Abstract: There is growing recognition of the key role that social and informal learning play in Higher Education. There is also increasing interest in technologies that enable, capture and channel this type of learning to students at their point of need and personalised to their ability. The objective of this project was to leverage research technologies from the areas of adaptive hypermedia, social and semantic search to create an application to deliver learning resources to students tailored to their specific learning needs. In this project, some 130 digital learning resources, specific to a final year advanced materials and manufacturing module, were made available to the students via a Help Block plugin in the Moodle Virtual Learning Environment. The students were required to use the Help Block as a just-in-time learning resource to help them complete a continuous assessment assignment. The assignment required the students to select an advanced manufacturing process and associated material describing the manufacturing process steps, control and specifications and presenting the technological benefits of the process and material used relative to competing processes and materials. Post-trial, students were asked to complete a questionnaire to describe their experience with the Help Block in terms of whether it assisted them in completing the assignment, for example, and
its ease of use. The system, evaluation findings, and some suggestions for future system enhancements are presented in the paper. [full paper]

Paper 48

Congruence between non-technical market required competences and competences met by new engineering programmes: The case of Spain.

Jose Albors-Garrigós¹, Blanca de-Miguel-Molina¹, Maria-del-Val Segarra-Oña¹
¹ Ind. Engineering College, Universitat Politècnica de València

Abstract: The extent of competency gaps in engineering graduates that has been perceived by business and industry has been analysed by various authors in North America and Europe. Several non technical competences have been pointed out such as: listening skills, sharing information and cooperating with co-workers, adapting to changing work environments, customer orientation and focus, ethical decision making and behaviour, etc. Other authors have addressed the need of emphasizing the preparation of engineering graduates for globalization in a context of an open economy or the communication needs of engineering graduates. On the graduates side, it has been pointed out how income results show that jobs with higher participative and methodological competency requirements are better paid and that higher requirements in terms of competencies increase graduates’ job satisfaction In this context, this paper analyses the gap between addressed competences by the new European Space engineering curricula set out in Spain and the perception of industry leaders of the real situation based on a survey carried out in the region of Valencia on 150 industry representatives during 2010. [full paper]

Paper 49

Continuous feedback for integration of software engineering knowledge and skills through students workshops.

Konstantinos Dimopoulos*
The University of Sheffield International Faculty, CITY College, Department of Computer Science, Thessaloniki

Abstract: In order to address the problem of integrating skills and knowledge acquired in other courses, we have designed a course where students under the guidance of a lecturer develop software. The students follow the complete software development process over 12 weeks in a specially designed “workshop session”, where they receive and integrate in-class feedback from the lecturer, in addition to the feedback of their formal submissions. To support this process, the students maintain a web site where they log their work, and receive feedback concerning their effort from the lecturer. In this paper we describe the course details and the feedback process, and present the student perception of the course. [full paper]
Paper 50

Enhancing employability: Transfer of student-led activity.

Glynis Perkin¹*, Alison Ahearn², Fiona Lamb¹

¹ Loughborough University,
² Imperial College London

Abstract: Student-led, employer-focused, extra-curricular activities are endeavours linked to engineering and science learning, and are initiated, developed and sustained by students with some assistance and input from members of staff, Professional Bodies and employers. Imperial College London has a history of well-established student-led activity. However, Loughborough University, with the help of Imperial and HE STEM funding, has initiated similar activity within its student body. Following the successful initiation and transfer of activities at Loughborough, further HE STEM funding was obtained and staff from the two institutions worked together with their students to host two student-led symposia, one at Imperial and one at Loughborough. The symposia are fundamental to sustainability of these enterprises. They allow students to learn from each other and to showcase their activities to staff and students from other institutions. In this paper, we discuss the implementation of knowledge transfer achieved through staff-to-staff, student-to-student, and staff-to-student meetings and workshops in addition to the student-led symposia. We also detail difficulties faced, lessons learned, evidence of sustainability, and benefits to participating students, staff and their institutions. Finally the paper describes planned activities to engage more staff and students from institutions across the UK. [full paper]

Paper 52

Guide to implementation of structured engineering PhD programmes – An Irish perspective.

D. McMorrow¹, S. Naher²* and D. Brabazon²

¹ DCU Careers Service, Dublin City University
² School of Mechanical and Manufacturing Engineering, Dublin City University

Abstract: Structured PhDs are relatively new in Ireland. Traditionally PhDs have been awarded on the basis of a large research project in a particular area which provides evidence of significant novel knowledge gain and contribution to the area of study. In recent years, all Universities have introduced structured PhD programmes. Structured PhDs provide training in the generic skills as well as in the subject areas which are required to carry out the proposed research work. A detailed analysis of the courses for current engineering structured PhDs in Ireland is presented in this paper. It is likely the current economic situation in Ireland will have an adverse effect on the implementation of structured PhDs in engineering education. This paper therefore focuses on resource implications for structured PhDs, which are typically greater than traditional PhD programmes. The current regulations and implementation strategy of graduate study is different in different universities. At EU level funding schemes, such as Erasmus Mundus Joint degrees and the Marie Curie People initiative, support the development
of these programmes. Financial support from national, European and International funding agencies are presented. The number of structured PhD programme are likely to grow and be sustained by taking the steps outlined from this review in developing strategies for future structured PhD programmes. [full paper]

Paper 55

Implementing a maths support system for first-year engineering students.

Jonathan S. Cole\textsuperscript{1*}, Timothy J. Crawford\textsuperscript{2} and Mohammad S. Zubairi\textsuperscript{2}
\textsuperscript{1} School of Mechanical and Aerospace Engineering, Queen’s University Belfast
\textsuperscript{2} Learning Development Service, Queen’s University Belfast

Abstract: The first-semester mathematics course, Engineering Mathematics 1, for first-year aerospace and mechanical engineering students revises fundamental topics, most of which are on the A-level syllabus. While students with A-level grade B or C tend to achieve marks over a wide range in this course, it has been particularly noticeable that students with alternative entry qualifications (such as National Diplomas) struggle greatly. This is of concern given the high level of mathematical content in other first-year modules.

The University’s Learning Development Service (LDS) offers academic support on various topics including maths, writing and study skills. Students can avail of one-to-one appointments (including via Skype) or workshops but it is usually left to students to take the initiative in contacting the Service.

In 2011/12, a weekly, one-hour session of maths support was arranged, with input from the LDS, for students without A-level maths who were enrolled on Engineering Mathematics 1 to assist their progress. Two groups containing four aerospace and four mechanical students were organised. The students worked through practice questions and had opportunity to discuss mathematical problems from other modules. Student attendance averaged 56% but varied greatly – three students each attended only one of the ten sessions, three came to at least nine sessions. Module results also showed much variation and no correlation with attendance at the support classes is apparent. Provision of maths support should continue, probably more time should be allocated, an informal atmosphere with much one-to-one help is necessary and students with common backgrounds should be grouped together. [full paper]

Paper 56

Analysis of critical thinking skills of international masters students in engineering for a cross-institutional group.

Linda Gray\textsuperscript{1*}, Michael D Bramhall\textsuperscript{2}, Chris Corker\textsuperscript{3}, Kenisha Garnett\textsuperscript{4}
\textsuperscript{1} Automatic Control and Systems Engineering, University of Sheffield
\textsuperscript{2} Faculty of Arts, Computing, Engineering and Sciences, Sheffield Hallam University
\textsuperscript{3} Faculty of Development and Society, Sheffield Hallam University
\textsuperscript{4} Sheffield International College
Abstract: UK academics sometimes express a perception that students from some cultural backgrounds are unwilling or unable to apply critical thinking skills within their academic programmes. This may not be due to a lack of ability or confidence, but may be due to the way in which they have been previously taught and assessed and their understanding of critical thinking. This paper reports on the results of a study of masters level engineering students from two universities. The study investigated students’ conceptualisation of critical thinking: it produced evidence of similarities and differences across cultural groups that points to a need to address, perhaps within the curriculum or during induction, differences in students’ understanding of critical thinking. [full paper]

Paper 58

What can go wrong with group work and peer assessment? A case study

Martin J. Pitt*
Chemical and Biological Engineering, University of Sheffield

Abstract: It is generally agreed that group work is essential for the practising engineer and should therefore be part of the degree. Assessment is a necessary evil for both staff and students, but becomes much more challenging for group projects. One solution which has been promoted is for some form of peer assessment in which students rate each other’s contribution.
It is rare for academics to experience group work and assessment from the point of view of the student. However, in an exercise, groups of lecturers were given a group task, and also asked to peer assess. The spectacular failure of one group illustrates what can go wrong in such circumstances, and should be cautionary for those using group and peer assessment. [full paper]

Paper 63

Deciphering the Effect of Curricula on the Perception of Third Level Engineering – a Comparative Analysis

Aoife Nic Chraith, Claire Marshall, Kevin Kelly
Department of Mechanical and Manufacturing Engineering, Trinity College Dublin

Abstract: Recent PISA surveys have shown that Ireland’s relative ranking in Mathematics has fallen sharply, while Finland maintains its position at the top of the international table. Simultaneously Ireland is experiencing a shortage of engineers and falling/static demand for engineering programmes, in common with many Western economies, while Finland maintains both a strong public image of the profession and sufficient supply of able students into university.
The recent economic woes experienced in Ireland have thrown the difficulties in the STEM area into sharp focus, and there is, at least currently, a momentum for change in the education system. With Finland having successfully progressed through a similar crisis in the 1990s, and having transformed its education system, it seems appropriate to examine what lessons can be learned.

The structure of the education system at secondary level in both countries, with particular focus on the STEM area, is compared and conclusions are drawn with regard to the relative performances in the PISA scores and the public perception of the profession, including its effect on student recruitment. [full paper]

Paper 64

Engineering education and sustainability: International Comparisons.

David G Wood*
Department of Chemical & Biomolecular Engineering, University of Melbourne.

Abstract: The question is often asked if current engineering education programs equip our graduates with the skills to understand and tackle issues of sustainable development, particularly those issues that have a more obvious and direct impact on society. Because of the author’s background, this paper uses chemical engineering education as an example and the structure and content of the undergraduate programs are discussed in terms of how they provide the graduate with the necessary skills to address modern sustainability issues. The situation in the countries of Europe is probably well known to the conference attendees, however, engineering education differs in the regions of the World and the paper presents detailed international comparisons.

There are three issues that are considered to impact on the suitability of graduate engineers to address the 21st Century global sustainability challenges:
1. Quality of the Engineering and Science education
2. Numbers of graduate engineers produced
3. Breadth of the engineering education

These are discussed in detail in the paper using chemical engineering as an example and it is considered that graduate engineers from all disciplines have a formation similar to that of chemical engineering. [full paper]

Paper 65

Leveraging commercial technologies to implement hands-on project-based learning of engineering principles

Graham Green*, Hannah Wade, Mark Walters
National Instruments
Abstract: Hands-on project-based learning has been shown to increase students’ attention and understanding of engineering concepts. However, for experimentation to play an equal role in engineering education alongside theory and simulation, presents significant challenges to educators in terms of cost, accessibility and ratio. These challenges can be overcome by collaborations between educators and industry to leverage commercial investment into hardware and software tools that can be purposed specifically towards engineering education. For example, as industry drives advances in analogue-to-digital chips, instrumentation companies are able to provide oscilloscopes at a cost and size such that each EEE student at The University of Manchester can now receive their own. Using “a lab in your bag”, practical assignments and students’ own experiments can be completed at home. This is also made possible through high level programming environments that abstract programming syntax, without detracting from the fundamentals concepts that must be taught.

As educational products are developed based upon industry technology, experimentation is becoming relevant and accessible to every student, even in traditionally theory-based courses such as RF and Communications. By enabling students to do real engineering, they graduate as inspired, employable innovators, equipped to tackle the grand challenges we face.

[full paper]
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