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## Designing the Future – Engineering Education Colloquia Series

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### Abstract

It is imperative to ensure engineering graduates develop the right knowledge and capabilities to navigate the changing role of the Engineer. This will only happen through academia and industry collaborating in a more coherent manner, collectively targeting the future challenges. The Designing the Future project aimed to enhance Engineering capability in the UK through the proposal of a clear and realistic agenda for the future of Engineering Education. By bringing together representatives from relevant professional bodies and institutions, employers and engineering disciplines the project worked to foster a meaningful dialogue and support for action from those with a vested interest in the direction of UK Engineering Education. The project was comprised of a series of four colloquia based on a 4S Model for delivering programmes of study (subject, staffing, student perspective and space) and dissemination of guidance in these key areas. Outputs from the series included a road map and key guidance points for engaged with future challenges.

**Keywords:** engineering education, subject, staff, students, learning spaces

### Background

At a time when higher education is undergoing transformational change driven by the funding regime, increasing focus on employers' needs and students' aspirations, increased international competition and the grand challenges of climate change, poverty alleviation, health and well being and resource depletion there is no greater time to test whether our engineering degree programmes are fit for purpose. The current high level of debate across government, industry, the professional bodies and Higher Education reflects the changing role of engineers in society and the need to ensure there is sufficient capability and capacity to tackle these challenges. It is also necessary to consider changes to the roles of the engineering academic and higher education if teaching skills and relevant industrial experience are considered equally important as research profiles, if education sufficiently equips students to decide, plan and compete and if the available learning environments are to be effectively exploited. Those with a vested interest in UK engineering education need to agree what the engineering degrees in five and ten years time should look like by building on the strong reputation for a research-led approach to learning and the education of engineering graduates who can think logically, creatively and independently to solve problems. Capability of supply into the industry must be guaranteed therefore, those responsible must work more closely with industry to ensure that graduates have developed an appropriate set of competencies that will promote effective practice from the day they commence.

Information relevant to this process must be disseminated to highlight the current good practice, focus debate and to induce change where needed. It is recognised that due to the nature of programme development and higher education, available guidance can be vague or simply not transferrable. Therefore, it must be analysed and synthesised to capture the findings in the form of practical recommendations that are relevant and transferrable across all engineering disciplines.

This approach is crucial to ensure that UK Higher Education is addressing the requirements of the knowledge economy and remains a world exemplar in a sustainable approach to engineering

education. To do so requires regular reflection, consensus and support for action in order to maintain relevance and innovation in programme delivery. The Designing the Future project has approached this from a holistic programme perspective, and synthesised the findings through an employer, educator and student lens, in order to identify practical guidance that is timely and transferable across all engineering subjects. The project has initiated a collaborative approach to assisting UK Engineering Education address the requirements of the 21<sup>st</sup> Century in terms of attraction and employability and to ensuring it remains a world exemplar in a sustainable approach to engineering education.

## Rationale

The aim of the Designing the Future project was to enhance the skills and knowledge base of the UK engineering-related workforce through clear articulation of future requirements for engineering education. The objectives set to achieve this aim were:

- Bring together stakeholders relevant to the future of UK Engineering Higher Education for facilitated discussion;
- Establish a clear rationale for improvement with support for action;
- Use this support to set achievable goals for the future of UK Engineering Education including output dissemination and wider participation; and
- Produce meaningful guidance that will inform future curricula, improve the capability of staff to navigate student and employer needs for an enhanced student learning experience and inspire new perspectives to pedagogy and programme design.

The School of Engineering at the University of Leeds is committed to sustaining world-class engineering programmes through engagement with all engineering stakeholders. Outreach was facilitated through the project partners and the Royal Academy of Engineering to establish an expert base for information management, knowledge sharing, group work and plenary discussion. This was expected to provide more benefit than isolated, situational observations and recommendations by engaging stakeholders which have the impact and influence to sponsor the recommended action.

## The Approach

The aims and objectives were met via a validated position paper that informed a series of four colloquia. A review of relevant publications was conducted in line with the key themes proposed by the 4S Model (Figure 1). It was the intent of the position paper to highlight the current perspectives towards best practice and the issues surrounding UK Engineering programmes, verified by the project partners, and from this paper, propose a position from which to address them in workshop.

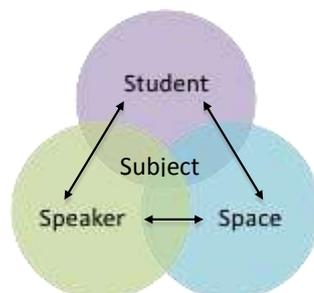


Figure 1. 4S Model

The position paper identified the key issues related to each of the areas impacting the delivery of effective programmes: the subject, the speaker or engineering academics, the student and the space. These issues are summarised by colloquia in Table 1.

**Table 1. Engineering Education Issues**

Colloquium	Issues
The Subject of Engineering	<ul style="list-style-type: none"> <li>•How can engineering curriculum remain fit-for-future?</li> <li>•Are university processes sufficiently flexible to respond to short-term changes in industry demands? Should they be?</li> <li>•Does the UK SPEC inhibit the development of technically capable graduates?</li> <li>•The level of compliance with the QAA benchmark statement</li> <li>•What is required to ensure the development of appropriate engineering attributes?</li> <li>•How should pre-graduation experience be improved?</li> </ul>
Staffing for Improving Engineering Education	<ul style="list-style-type: none"> <li>•The need for an expansion of the Professional Standards Framework into competencies covering all forms of academic staff</li> <li>•Addressing potential gaps in the current framework in terms of experience requirements</li> <li>•Recruiting and retention related issues – research profile requirements</li> <li>•The need for a continuing professional development tool to aid with career development</li> </ul>
Synthesising the Student-Employer Perspective	<ul style="list-style-type: none"> <li>•Helping students consider how their programme of study will impact employability</li> <li>•The role of the engineer in society</li> <li>•Post-graduate education and life-long learning</li> <li>•The student experience</li> <li>•Incorporation of industry practice in education/practitioners in teaching</li> <li>•Hard to fill vacancies and skill shortages</li> <li>•Engaging with SMEs</li> <li>•Ensuring that the best engineering graduates enter the profession</li> <li>•Attractiveness of engineering as a career – communicating pay employability</li> <li>•Attractiveness of graduates to industry – employability skills and experience</li> <li>•Better communication of labour market requirements</li> <li>•Addressing the diversity/gender imbalance</li> </ul>
Engineering Space	<ul style="list-style-type: none"> <li>•Consideration of the learning environment as part of the building, campus and community</li> <li>•Effective communication pathways between estates and academics</li> <li>•Evidence-based guidance, support models and metrics</li> </ul>

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Issues were translated into workshop format as outlined in Table 2.

**Table 2. Colloquium Format**

Colloquium	Format and Content
The Subject of Engineering	<p><b>March 16, 2011, The Royal Academy of Engineering Presentations:</b>                      The Subject of Engineering, Denise Bower, University of Leeds                      Engineering Knowledge, Fiona Lamb, Higher Education Academy Engineering Subject Centre</p>

	<p>Engineering Knowledge, Clive Neal-Sturgess, University of Birmingham  Engineering Attributes, Barry Clarke, Vice Chair, Engineering Accreditation Board  Pre-graduation Experience, Kamel Hawwash, Regional Director HE STEM Programme  Engineering Education, UK SPEC requirements, Deborah Seddon, Engineering Council</p> <p><b>Discussions:</b>  Engineering from now to 2050 – A Road Map to the Future  The Evolution of the UK SPEC</p>
Staffing for Improving Engineering Education	<p><b>June 8, 2011, Engineering Subject Centre, Loughborough University</b></p> <p><b>Presentations:</b>  The PSF Review, Helen Thomas, The Higher Education Academy  The Roles and Requirements of Academics in Engineering, Ian Dunn, Coventry University  Professional Development, Liz Willis, Engineering Subject Centre  Teaching Skills Needs, Denise Bower, University of Leeds</p> <p><b>Discussions:</b>  Building on the PSF Review  Career Development Tools for Academics in Engineering</p>
Synthesising the Student-Employer Perspective	<p><b>October 12, 2011, JCB Academy</b></p> <p><b>Presentations:</b>  Helping Students Transition and Take Responsibility for Learning, Bob Pendlebury, JCB Academy  Transitioning and Incorporating Practice into Teaching, Becky Clark, University of Leeds  Lifelong Learning, Fred Maillardet, University of Brighton  Understanding the Student Perspectives, Martin Clark, University of Leeds  Employer perspective - Translating Learning Outcomes into Competencies, Adam Locke, Laing O'Rourke</p> <p><b>Discussions:</b>  Bringing Outside-In  Bringing Inside-Out</p>
Engineering Space	<p><b>December 20, 2011, Coventry University</b></p> <p><b>Presentations:</b>  Engineering Education and Teaching Spaces, Simon Steiner, The Higher Education Academy  Communicating Requirements to Estates, Ian Dunn, Coventry University  Lessons Learned from Liverpool, Peter Goodhew, University of Liverpool  Virtual Engineering Education, Elizabeth Miles, Coventry University</p> <p><b>Discussions:</b>  Matching Mode and Environment  Best Practice</p> <p><b>Tour:</b>  ACT UK Simulation Facility</p>

## Discussion Summary

The key messages and outputs from each colloquium are summarised in the following.

### Colloquium 1

*Key message: Good practice in isolated clusters, the need for better stakeholder engagement, the importance of different staffing models and flexible, experience related and creative development.*

Participants developed a road map to 2020 for future engineering education requirements including experience, employer and employee needs with reference to programme learning outcomes, the

Engineering Council's UK-SPEC and accreditation requirements (Figure 2). The Engineering Professors' Council will take ownership of the actions and the Engineering Council will use the project's feedback to inform their 2013 review of the UK-SPEC. The road map can be found appended to the case study.

### Colloquium 2

*Key message: Communicating the need for different engineering academic job profiles that recognise the importance of teaching and industrial experience to engineering education and addressing tensions with recruitment based on research profile.*

Participants were able to review the proposed revision of the UK Professional Standards Framework (UK PSF). Discussion focused on the adequacy of the expansion, the ability of the PSF to address gaps in terms of experience requirements, recruiting, retention and research profile issues and requirements and the need for a continuing professional development tool for engineering academics. Participants identified the need for additional assistance from the engineering academic perspective in balancing recruiting and development tensions surrounding research-led and industrial experience requirements including relevant industry awareness and getting reality into the classroom. Engineering specific supplements should be considered. This is also important when considering the future implications of programme Key Information Sets.

### Colloquium 3

*Key message: Increased exposure to opportunities through information provision and industry involvement. Decide – Plan – Compete.*

The event was based on developing guidance to help students to *Decide* on engineering as an option that they wish to pursue, *Plan* to acquire the appropriate skills and experience during their education, and *Compete* successfully for opportunities in industry. Following this model participants identified support requirements for helping students transition into industry and engage with the employability agenda by bringing outside perspectives into education and promoting the student perspective in an outward facing manner (Figure 2).

Decide	Plan	Compete
<ul style="list-style-type: none"> <li>• Self-awareness</li> <li>• Context- talks, stars</li> <li>• Get professionals involved</li> </ul>	<ul style="list-style-type: none"> <li>• Challenge – learning opportunity, repeat, fail personal skills</li> <li>• Self-awareness</li> <li>• Lives outside degree</li> <li>• Ownership of learning</li> </ul>	<ul style="list-style-type: none"> <li>• 'What can I do for you?'</li> <li>• Need for flexible approach and application</li> <li>• Get alumni involved</li> </ul>
<ul style="list-style-type: none"> <li>• Decision tree software</li> <li>• Exposure to new graduates</li> <li>• Simulation or preparation for HE/Industry in school</li> </ul>	<ul style="list-style-type: none"> <li>• Placement followed by self-reflection/competency assessment – communicate how this is tied to learning outcomes</li> <li>• Communicating all the requirements of being a 'professional'</li> </ul>	<ul style="list-style-type: none"> <li>• Nurture 'can do'/positive attitude</li> <li>• Provide business awareness of specific organisations and industries</li> <li>• Evidencing targeted behaviours</li> </ul>

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Figure 2. Snapshot of Support for DECIDE, PLAN, COMPETE

### Colloquium 4

*Key message: Standing firm and deciding when and when not to compromise learning environment objectives in a value engineering situation.*

Discussion centred on identifying elements from the spectrum of learning spaces for the effective generation of engineering competencies. This ranged from the physical to the virtual, traditional

lecture theatres to creativity labs and simulation. It was proposed that learning space design workshops should be used to create a model of the ideal learning space using metaphors and the identification of actual examples to inform new design. It is important to set the minimum requirements clearly in terms of layout as well as capacity and communicate the student experience as the paramount objective. Participants felt that competencies were rarely targeted individually and students were more engaged by the use of a variety of modes and spaces. Consensus was that there was a 'place' for everything. Highlighted within discussion was the need to consider the level of competency, at what point in the programme, the timing of the use of spaces and most importantly that, unlike other disciplines, engineering education cannot be achieved in one space. Participants identified various exemplars including: Mechanical Engineering at the University of Strathclyde; Engineering at the University of Coventry; The Constructionarium; and the ACT UK Simulation Centre.

## Evaluation

The project objectives of discussion, support and dissemination were achieved. The colloquia served as the first point of impact and dissemination with participants from a wide range of programmes and institutions across the UK. Colloquia success was attributed to good attendance and a high level of debate and willingness to learn and share knowledge and experience. Anecdotal feedback received by the project team included:

"I thought the colloquium very productive. I have several new challenges to pose here...";  
"I found the day relevant and meaningful. I am keen to support this process in any way I can";  
"I really enjoyed yesterday much more than I had expected... This was overall by far the best day, though of course, no day suited everyone!" and  
"I thought the day... went well and yet again stressed the need to put learning into context with the real world of engineering."

From this initial feedback it was determined that the approach taken was appropriate. The objectives related to goal setting and guidance generation were also achieved and their impact will be monitored by the project partners over the lifespan of the roadmap.

## Further Development

The project will be sustained through partner organisation support and dissemination and with future schemes looking at:

- Gaining ownership for road map actions (Project Leader and Project Partners)
- Collation of identified good practice for staffing models and learning environments; and
- Continued efforts to bring together stakeholders for discussion and knowledge sharing particularly industry bodies and engineering academics.

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Driver	Action	Short-term			Mid-term			Long-term			
		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Remain fit for future	Development of doc (using IGT 2050 as model) -include guidance on balancing review with stability	Environment scan for future related initiatives and reviews									
Improved engagement with SMEs, local employers and higher apprenticeships	Formation of a HE/FE/SSC Engineering Advisory Groups	●									
	Employer benefit communication programme	■									
	Raise awareness of other options (Eng)	■									
	Case study development (i.e. bringing industry in from day 1)	●									
	Formation of regional partnering clusters - focus on placing students, vulnerability to corporate change and employer visibility	■									
	SWOT analysis of the impact of funding changes	■									
	Mapping of industry needs	■									
Challenging the System - Need for different staffing models and tailored CPD	Investigation into the appropriateness of current recruitment models including staff w/o PhD's, CEng/Eng as a requirement, Industrial experience	■									
	Development of Eng Academic Competency Model	■									
	Develop career path models for the Eng 'pass' academic (within current context R/C, REF)	■									
	Identify models of industry involvement/help staff become more aware/flexible and broaden teaching skills	■									
	CPD opportunity review	■									
	Development of flexible CPD tools for Eng academics	■									
	Promote industrial sabbaticals	■									
Keeping UK Eng attractive to best applicants	Investigate global comparators	■									
	Formation of EU/US partnering system for HEIs and industry	■									
	Panel for discussion of UK 'CAT' for Engineering applicants - review other sector models	■									
	Greater collaboration between STEMNET and HE	■									
	Defining the future customer review including the role of the student as a driver for change	■									



Increased pre-graduation experience	Review of international practice and approaches to flexibility, community based projects, etc.				
	Map engineering model against other disciplines including models for early recruitment				
	Work with clusters, include NGOs in the provision of projects and placements				
	Pilot/case study identification and development for new models of work-based learning and learning needs structure to support WBL				
	Establish a panel for discussion of credit for participation and interaction between HE/WBL and professional qualification - build on Eng gateways pathway				
Defining effective skills development and responsibility	Mapping of skills requirements by level				
	Research into transferrability of industry assessment				
	Review of evidence based learning environment research for guidance note on where learning best takes place				
	Identify skills that can be 'tested' and creative approaches				
	Compare approaches to engineering education with other professions				