Cranfield UNIVERSITY

Excellence in Postgraduate Education:

Manufacturing, Materials and Design

8 May 2014

Aspiring to excellence in postgraduate education

The Higher Education Academy

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Contents

Presentations from the day can be found at:

www.heacademy.ac.uk/events/detail/2014/08_May_Excellence_in_PG_Education

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Many thanks to The Higher Education Academy for sponsoring the event

Join the Linked-in group for continued discussion called **"Excellence in Postgraduate Education: Manufacturing, Materials and Design"**

Supporting organisations

Rolls-Royce, Institute of Engineering Designers, Institute of Materials, Minerals and Mining and National Centre for Universities and Business

Achieving Excellence
in Postgraduate Education

Achieving Excellence in Postgraduate Education

A foundational event hosted by Cranfield University to provide an independent forum to discuss the future of postgraduate education in manufacturing, materials and design. Forty-six representatives from the Higher Education Academy, Engineering and Design Accreditation Bodies, Engineering Professors Council, National Centre for Universities and Business, Manufacturing, Materials and Design Industries and a wide range of UK Universities shared best practice debating the attributes for achieving excellence in postgraduate teaching and learning.

There has been a dramatic expansion in the postgraduate student body in the UK in the past 15 years with enrolments growing by 45% between 2003 and 2010 (Morgan, 2013). Extensive research has been undertaken in the field of the student experience, teaching and learning at undergraduate level, however research in the area of postgraduate education is significantly lacking. The Higher Education Commission commented in 2012 that 'postgraduate education is a forgotten part of the sector'. Furthermore the bi-annual Postgraduate Taught Experience Survey (PTES) results increasingly provide a disappointing read to providers of postgraduate education. Student dissatisfaction has been proposed as one of the reasons for the decline in engineering and technology postgraduate student numbers of -13.5% (full time) and -15.4% (part time) over the last two years.

Manufacturing, Materials and Design

It is widely recognised that our rapidly changing economy is placing ever-greater demands on the skills and expertise of the workforce. If we are to compete in the global race, we need to equip our future leaders with the skills to adapt, innovate and flourish. Given the rapid technological change we are facing; science, technology, engineering and mathematics (STEM) skills are especially vital. As our economy recovers and rebalances, the Perkins Review (2013) deems it the right time to ask whether the current arrangements for the provision of engineering and manufacturing knowledge, skills and abilities are fit-for-purpose.

There is a serious risk that, if we do not act now to secure the future viability of the talent pipeline for engineering, falling student numbers could lead to a new wave of skills shortages. A National Centre for Universities and Business (NCUB) report (2014) highlights a mismatch between specialist subjects being studied at postgraduate level and the flexibility, agility and work-readiness competencies being demanded by industry. Perkins (2013) suggests that there is a need to invest in the quality of the teaching infrastructure and for Higher Education institutions to engage with employers to ensure that their provision is world class and in line with industry expectations. This concern is supported by a recent 'Engineering the Future' report which suggests that manufacturing organisations perceive education to be 'letting the country down' and that businesses are required to 'teach our recruits the ways of the world before teaching them about the business'.

Motivation

These drivers signify an urgent call to action and further research in the area of postgraduate education. Cranfield University has taken the first step towards creating a collaborative postgraduate student enhancement forum bringing together experts from across the field of manufacturing, materials and design postgraduate education. The event encouraged honesty and collaboration in exploring the overarching questions:

- What is 'best' practice in postgraduate education?
- How can excellence in postgraduate teaching and learning be achieved?

Short presentations throughout the day provided insight into measuring best practice, current challenges in education and future visions. A World Café event facilitated the opportunity for participants to explore a number of pertinent issues including content, teaching and assessment and methods of participation. Finally a debate between the Universities of Cranfield, Warwick, Cambridge and the Royal College of Art provided a platform to share, learn and investigate ideas for the future of postgraduate education.

The discussions, findings and outcomes from the event have been captured in this report and will be of value to a range of professionals, across higher education institutions, who are involved in the delivery of postgraduate taught courses. This includes policy managers, education managers, academics that plan and teach postgraduate courses, recruitment and marketing colleagues, international advisors and support staff. The findings will also be of benefit to researchers and practitioners interested in improving the student experience of postgraduate (PG) students.

Keynote Speakers

Janet De Wilde

Janet De Wilde is Assistant Director, Scotland and Head of STEM for the Higher Education Academy (HEA). Janet set the scene for the day highlighting communication, team working, integrity, intellectual ability, confidence, creativity and leadership as key drivers of innovation. Janet lay down the challenge for Postgraduate education to drive an innovation-led economy consisting of exceptional and pioneering students.

Ian Bowbrick

Ian Bowbrick is the Director of Professional Development and Membership at the Institute of Materials, Minerals and Mining (IOM3). “Postgraduate education should be seen as an opportunity to pressure test your ideas and develop yourself – use it as a personal development tool”. Ian spoke of the need to align teaching and assessment methods with activities required of professionals in industry. “Industry is all about working in groups and leading projects”

John McCardle

John McCardle is Associate Dean (Teaching) at the Loughborough Design School where he has lectured in Product Design Technology, including electronics and computing for 15 years. John representing the Institution of Engineering Designers, suggested that the expansive diversity within design and engineering curriculum should be celebrated. “Much of the richness of postgraduate education is derived from the expertise of staff which needs to be encouraged”.

Rosa Fernandez

Rosa Fernández is Head of Research at the National Centre for Universities and Business (NCUB). Rosa demonstrated the explicit benefits for companies in recruiting graduates but highlighted the significant gap between occupational sectors and subjects being studied at postgraduate level.

Mike Percival

Mike Percival is Global Head of Manufacturing Engineering, responsible for skills and competences, processes, tools and methods across Rolls-Royce plc. “Postgraduate skills are different from undergraduate” Mike reinforced the need for pioneering students who have a both technical and transferable skills.

Michelle Morgan

Michelle Morgan is the Principal Investigator and Project Lead for the HEFCE funded Postgraduate Experience Project (PEP). Michelle identified lack of course funding, perception of value and lack of relevant ‘employable’ skills as some of the reasons for the significant decline in Postgraduate taught course student numbers. Her PEP project promised to consider the requirements of employers as a critical strand.

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University Debate:

Chair: Tracey Bailey Academic Professional Development Lead
Sean Tyrrel Dean of School of Applied Sciences

Rajkumar Roy

Rajkumar Roy is the Head of the Manufacturing and Materials Department at Cranfield University. Raj highlighted the opportunity for postgraduate institutes to expand their global influence and drive a technology and innovation led economy. He called for the development of a Manufacturing, Materials and Design Educational Roadmap aligned with industry recognised technology roadmaps.

Michael Newton

Michael Newton is a Principal Teaching Fellow and Deputy Director of Professional and Executive Programmes with Warwick Manufacturing Group (WMG). Michael presented three cases of how WMG are aspiring for academic excellence with industrial relevance including the facilitation of student-driven learning using a blank timetable.

Ashley Hall

Ashley Hall is a designer and Deputy Head of the Innovation Design Engineering programme at the Royal College of Art (RCA) where he is Head of Experimental Design, the GoGlobal project and IDE research. Ashley highlighted their Global Innovation Design course as an example of collaborative excellence and envisions hybrid education-incubation models for the future. “Open regulation permits emergent thinking and new development”.

Tom Ridgman

Tom Ridgman teaches manufacturing management at the Institute for Manufacture, University of Cambridge, following a 20 year career in the automotive industry. He spoke of the facilitation of knowledge navigation as opposed to knowledge provision and called for new methods of harnessing social media and technology in the classroom.

Student-led learning

“Unless a lecture is necessary to kick start knowledge we don’t use lectures”.(Michael Newton)

Warwick Manufacturing Group’s Open Access Postgraduate course emphasizes self-direction and encourages lecturers to be facilitators of learning. Students are provided with defined learning objectives and a blank timetable that they are responsible for populating.

The Institute for Manufacturing also see themselves as providers of direction and navigation as opposed to delivering knowledge and were aware of the need to overcome ‘collective disengagement’ of students. “We need to learn how to tap into social media and technology enhanced learning”.(Tom Ridgman)

Collaborative courses

Global Innovation Design is a joint Masters Programme between Imperial College and the Royal College of Art. Students study in New York and Tokyo during their first year and then in London for their graduation year. Graduates from the programme are expected to be central to innovation leadership in the 21st Century.

Industrial projects

Engaging with industry was seen as an essential component of Postgraduate education and all universities had a different approach. WMG students undertake 4 industrial projects and are expected to generate a saving of £50,000 for the company over two weeks whilst Cranfield students experience real-life pressure from industry funded industrial projects over 12 weeks.

At the RCA, first year Innovation Design Engineering students are taken abroad for a three week cross-cultural collaboration with academic and industrial partners. The projects integrate product innovation with production, policy, social and economic factors, and test student’s abilities to work in new cultures and climates. “We believe that innovation takes place in the gaps, collisions, chaos, coincidences and accidents that happen between things.” (Ashley Hall)

Industry / research active staff

“Trust staff and give space for visions to take place” Ashley Hall. All the universities valued staff with industrial experience and it appeared that part time teachers who also work in industry could be common practice in the future. “90% of our teaching staff has worked in industry”. (Michael Newton) Discussions highlighted that research active staff should not be undervalued and that a balance of both types of influence is required.

Presentation of Findings

Content

Participants widely acknowledged that technical content and subject specialists are important. For such technical specialists, the technology taught should be cutting edge. Observed good practice by the accrediting bodies incorporates the latest industrial technology by involving Industrial Visiting Professors and Teaching Fellows and/or technology derived from University research work in addition to technology from other universities' research work (rarely observed).

What is the value of recruiting staff with Masters Qualifications

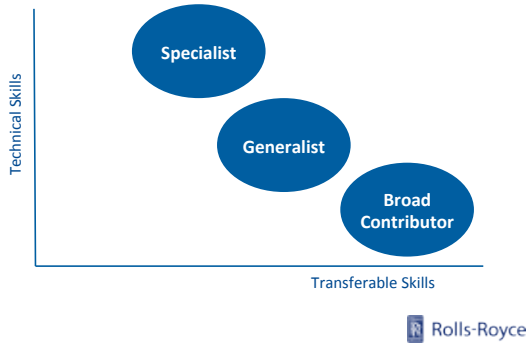
	SA	A	PA	D	SA+A
Analytical Thinking Skills	52	40	6	3	92%
Subject specialist Knowledge	46	34	14	9	80%
Research/ Technical Skills	33	46	18	3	79%
New ideas, help innovate	24	50	24	3	74%
Maturity	15	39	33	12	54%
Future leadership potential	16	34	44	6	50%
Guaranteed High quality graduates	6	24	52	18	30%

SA = STRONGLY AGREE; A = AGREE; PA = PARTLY AGREE; D = DISAGREE

It was generally recognised that in addition to technical specialists a range of skills was required. Janet De Wilde highlighted key remarks from employers recruiting postgraduate students. Of the top ten skills sought (see above), the highest valued was analytical thinking skills. Valued highly were research and technical skills, and the ability to innovate. A strong case was made for suggesting that a focus for postgraduate education should be raising the potential for future leadership.

It was recognised that one of the most powerful levers for improving productivity is the higher-level skills postgraduate or level 5 skills (Leitch Review, 2006). These higher-level skills are key to driving innovation, entrepreneurship, management, leadership and R&D. A range of transferable skills which can align to business and drive innovation include: communication, team working, integrity, intellectual ability, confidence and creativity.

From an employers perspective both technical skills and transferable skills are essential in a good postgraduate. There is space for all individuals but there is a "need to focus on getting the transferable skills right" (Mike Percival) and at a level relevant to the business to drive the business forward.



Teaching and Delivery Styles

Teaching, identified as the key influencer of student satisfaction (National Student Survey, HEA) should tap into passion, enthusiasm, aspiration and motivation. There was little appetite for lectures, as a one-way transmission of information.

Do we need exceptional pedagogies to navigate and apply knowledge? To encourage deep learning and innovation, suggestions included were practitioner-led education to contextualise taught principles. Learning through practice via project work particularly group projects was highlighted by all. However it was acknowledged that not all students undertake industry-based projects. Briefs which include a business element or the innovation of a product or process are critical. Enterprise initiatives and links with industry and commercial sectors are helpful as is collaborative and cross-disciplinary working.

Models for postgraduate courses should not be built around knowledge but on delivery, practice and latest technology to enable learners to move at a pace and style that suits them. The range of teaching should reflect the range of learning

styles. Enquiry-based, flipped classroom, problem-based, tutorial-based ways of working allow students to lead the teaching. Student-led teaching addresses engagement, responsibility and pace. There is no one-size-fits-all solution and action should be tailored to specific needs. Continuous improvement of courses to reflect industrial need and also the changing economy and lives of students requires flexible delivery. Postgraduate education could be more inclusive through blended learning; distance learning and module work blended together offers flexibility. Universities should cooperate in designing and delivering higher education that enables them to share resources.

Personal Development: Teachers and Learners

The role of a teacher to help students learn how to learn was acknowledged as one of designer, collector, facilitator, supporter, providing opportunities to consolidate the learning. Context is important, as is setting clear outcomes that harness context and good design of problems with challenges. Present challenging high level focussed design of activities and problems such as using the latest technology. Learners need to practice problem solving and implementation rather than just learning through case studies. An environment for effective learning and where students can practice transferable skills is important.

What influences student satisfaction?

Scale	Rank	Beta
The teaching on my course	1	0.326
Personal development	=2	0.211
Organisation and management	=2	0.209
Academic support	4	0.156
Assessment and feedback	5	0.082
Learning resources	6	0.027

Impact of learning experience on overall satisfaction

Multiple regression of **National Student Survey** 2011 dataset

Identifying key skills of learners at the start of the course is important as is the inclusion of opportunities for self reflection and 'breakdown moments'. Students don't want to go into postgraduate study to polish the skills that they learned at undergraduate level; they want postgraduate study to be challenging, they want to be taken to the edge and further, they want a revolution! This is a personal journey and often it is at these times where the most is learnt. Students are adult professional learners and should feel valued. For both teacher and learner postgraduate education is a partnership.

Assessment

PTES 2013 featured 89 institutions with over 58,000 respondents. Of eight categories across all institutions 'assessment and feedback' has the least satisfaction (with lowest marks) and is therefore of critical concern. Feedback needs to be fit for purpose, there is little tolerance at postgraduate level of poor feedback.

Concern was raised that students are focused only on marks and if assessments are aligned on technical demonstration then that is where students are going to focus. Assessment also needs to address transferable interpersonal skills. Peer group involvement was recognised to be very important in both learning and assessment. Building acceptance of failure into the assessment process was suggested to aid learning. It was suggested that learning outcomes could be measured in terms of students' capacities to build new knowledge, their ability to problem solve, to be proactive to lead their own learning effectively and to lead others.

> "Universities need to get the balance right between technical and transferable skills"
> Mike Percival, Rolls-Royce

Presentation of Findings

Employability and value

Do employers want postgraduates? One of the issues identified in an HEA STEM ITG report is a belief that employers value a postgraduate qualification more than undergraduate but evidence suggests this is not the case (e.g. Connor et.al., 2010). It was echoed by others that there is a perception gap between the postgraduate who believes a masters will give an advantage in the workplace and many employers. A significant number of employers do not appear to value higher education and the value of a Master's degree to business. Employers state that there is no indicator of leadership or work wisdom (Connor et al, 2010: Leitch, 2006) and therefore assessments with such indicators may be more than advantageous.

"Organisations are looking for more than the top marks - organisations want to see diversity"

It was noted (NCUB) that there are increasing sustained numbers of postgraduates in all subjects and increasing qualifications in the labour force in all sectors. However skills needs were highlighted (management and leadership) and qualifications are considered less relevant than other attributes for employability. Flexibility in role and practical skills are in short supply. Without additional managerial skills training talented juniors are often incapable of performing senior roles. The higher up in the hierarchy, the more important leadership and specialist knowledge become.

Where are our postgraduates currently working? One area flagged as a problem was that the subjects of postgraduate study and available occupations do not match. However the scale of numbers is still short of the scale of need, thus demand is expected to stay strong. This is especially caused by retiring/leaving talent and diversity of destinations as typically STEM graduates move into non-STEM sectors. Destinations of postgraduates by subject are more varied than undergraduates and 51% of postgraduates in the UK end up in the education sector. The implication is that postgraduates are more versatile. Postgraduates are a valuable resource regardless of the destination.

"We've identified a whole range of key ingredients and call to action for postgraduate education, we have set ourselves a challenge for how to do things differently"
Gill Cooke, HEA

Achieving Excellence
in Postgraduate Education

Perceptions and requirements of postgraduate education are changing rapidly along with the cultural and economical backgrounds of our global students. Discussions identified a wide rage of attributes that were considered as necessary for 'excellence' in postgraduate education and suggestions of what future models of postgraduate education might look like were explored.

Innovation: Content, Delivery and Assessment

The need for innovation in all aspects of postgraduate education was highlighted early on by both the HEA and the accreditation bodies and was a re-occurring theme throughout the day. The ability to add value to an organisation through the implementation of innovation was also identified as a differentiating factor between employing postgraduates as opposed to undergraduates. Science and engineering postgraduates are proportionally more prevalent in innovating firms than undergraduate (UKIS, 2011).

"Content needs to be cutting edge" Ian Bowbrick suggested achieving innovative content by involving industrial visiting professors to incorporate the latest industrial technology and practices. He also highlighted the need for a conduit for technology derived from innovative academic research, across institutions, into the curriculum as soon as is practicable.

Postgraduate education should also have relevance to the global economy and changes in economy. In addition to bringing the latest technologies, the content and activities need to reflect sustainable development design and manufacture and the circular economy to be socially responsible for and with technology.

A knowledge led economy is important, but it was recognised there is a critical need for innovation for job creation. A number of comments focused on the need and drive for innovation. How do we develop the ability of an individual to be a change leader? A good change leader would need technical and transferable skills as well as the ambition for change and improvement. Not all students have experience of innovating, thus we need to embed knowledge and leadership with innovation.

Innovative methods of delivery and assessment that reflect the roles that postgraduates are going to fulfill in industry was deemed essential and examples included: briefs which require the development of a product or process, industrial implementation of innovation and a 'dragon's den' style assessment to pitch ideas to potential investors.

Pioneering: Teachers and Learners

By enrolling for postgraduate study students have already embarked on a personal journey, a change in mindset and have flagged themselves as potential pioneers. Employers and the HEA call for an increase in truly pioneering students who are capable of intellectual engagement and the application of learning, sometimes to unrelated areas (innovation), to critique, appraise and to handle uncertainty.

Interpersonal and 'softer' skills such as communication, leadership and integrity as well as passion, motivation and 'belly fire' were repeatedly identified as the attributes that differentiated pioneering and more employable students. Postgraduate education institutes are responsible for facilitating the transition from students who are passive, or passengers at best, to pioneers who can drive their own education and employment prospects

Concern over the ability of faculty staff to develop pioneering students was raised and it was felt that feedback between teacher and learner plays a crucial role in the personal development of a student. It was determined that excellence in postgraduate education requires teachers to be champions in order to develop and encourage the required skills from their students. Further research is required to establish what makes a pioneering teacher and how training in postgraduate education can facilitate this.

Discussions reflected concerns of the Engineering the Future report that students are being taught to 'pass exams'. The current system places too much emphasis on marks and this is a barrier to developing pioneering students. "We have to re-educate and re-focus students to communicate what is important" to ensure that the right skills and outlook is established.

> "We have global outreach with postgraduate students who will become CEO's across the world" Raj Roy

It was not only employers who valued pioneering students but the postgraduate institutions themselves. Alumni who are successful and influential in their chosen careers increase the value and reputation of the university. Postgraduate education is not just about creating wealth for the UK, or about livelihood but about excitement and discovery internationally.

Discussion, Conclusions and Recommendations

Flexibility and Customisation

"Is best practice for one group of people the same as another? Should we be asking 'what is effective practice?"

Continuous improvement of courses to reflect innovative practice and the changing economy was assumed to be current practice in postgraduate education however the flexibility to adapt to the needs of industry, organisational changes and changing lifestyles of students such as flexible working and digital technologies was also identified as a necessity.

It is widely recognized that people have multiple reasons to pursue postgraduate study so the solutions to teaching and learning must also be multiple. Flexible delivery and the customisation of courses to reflect the needs and ambitions of students and their career paths is required to better reflect the diversity of the real world and overcome the gap between subjects and career options.

"It is about creating wealth. Students can select the modules that they want to study based on what they want to achieve in careers and transcripts will reflect the modules they selected rather than a specific course". Students are on a personal journey and should be the drivers of their learning which includes their personal development.

Discussions also called for a greater appreciation of the diversity of cohorts of postgraduate students. It was recommended that experience, expectations, requirements, knowledge, strengths, weaknesses and preferred learning styles should be assessed early on in order to adapt courses to support and benefit from this diversity.

Postgraduate education needs to be flexible enough to develop new courses that respond to industrial requirements. "Design is fast paced as universities try to cover the broad church of activities and topics included within design industries" John McCardle.

"Postgraduate education needs to be driven by the people actually doing it"

Models of Future Postgraduate Education

The question "What will postgraduate education look like in 15, 20, 25 years?" posed by Raj Roy provoked much discussion with no universal answer. However several proposals were pertinent.

Industry Led Learning

Throughout the day concerns surrounding the perceived gap between postgraduate education and industrial practice were raised. Organisations are investing in internally-led training rather than postgraduate education. Competition in the form of private and independent education providing industry-approved courses, are bringing the perceived value of postgraduate education into question by both prospective students and employers. Universities will need to move swiftly to meet the future needs and requirements of the manufacturing, materials and design sectors.

"The activities and content need to reflect what graduates are going to do including acknowledgement of start ups and entrepreneurs". Proposed steps towards addressing this gap included the re-orientation of postgraduate education towards a career driven output including entrepreneurial and start up activities. It was also proposed that universities' need to make it clear what the objectives are and if they are "setting people up for work or research or both".

Crossing the 'perception gap' and giving employers the confidence that postgraduate institutes can deliver the skills that they require was posed as a significant challenge. Working alongside employers to provide industry-led education and courses that add value through a flexible framework for industrial professionals was offered as a model for the future. Lifelong learning was also offered as a solution to the concern that employers would lose members of staff after funding postgraduate study. A flexible and adaptive model for employees should offer training and education as it is needed throughout the career of an employee.

The role of University Industrial Advisory Panels was called into question and Ian Bowbrick observed that 'Industrial Advisory boards are very passive'. Many universities were proud of the industrial experience of their faculty staff and participants went further to suggest that universities should encourage flexible contracts to enable a simultaneous career in industry and academia. Some of the questions raised for the future included: "Should we insist that faculty members have industrial experience? Should we be offering staff placements? Should our VC's work part time in industry?" Universities should encourage flexible contracts to enable a simultaneous career in industry and academia.

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Hybrid Education-Incubator

A proposed model of education for the future that directly addresses the perceived gap between academic and industry was a hybrid 'Education-Incubation' model. It was suggested that incubation businesses could be started from within a postgraduate course, encouraging students to foster business ideas whilst they are studying and leave with an operational business plan. This provides the students with skills and knowledge that can be instantly implemented and also has benefits for the institution who could have a stake in the business.

> "This is a starting point for us to develop our postgraduate taught experience, so that we can work with industry to provide our engineers of the future with the best possible Postgraduate experience
> Janet De Wilde, HEA"

Technology Enhanced Learning

"Future postgraduate education needs to focus on knowledge navigation as opposed to knowledge provision."

Although teaching and learning has changed significantly over the last 50 years there are still a multitude of benefits provided by the digital world that remain untapped. Students sit in classrooms with an overwhelming amount of information at their fingertips, access to information is no longer a USP.

Students no longer benefit from one-way style lecturing and instead teachers are required to facilitate the effective navigation through the infinite amount of available information providing guidance and direction.
"To accelerate the careers of our postgraduate learners we need to teach them how to learn and go deep, quickly" (Tom Ridgman).

Digital technologies are lowering barriers to education and latest technologies are important as a hook to engage learners. Research is required to establish how we tap into the world of social media and personal digital devices more successfully. Instead of going head to head with Facebook in a battle for the attention of students we need to embrace and utilise it in more effective and creative forms of teaching and assessment.

Closing Comments

The enthusiastic and motivated presentations, debates and discussions identified some outstanding examples of excellence in postgraduate education and furthermore highlighted many ideas for future improvement. It is unquestionable that postgraduate education has received inadequate attention and that a significant amount of further discussion, research and action is required to aspire towards the provision of an effective, flexible and valuable postgraduate learning experience. This report is the first step towards creating a community with the common goal of aspiring towards excellence in postgraduate education.

CALL TO ACTION

The Excellence in Postgraduate Education: Manufacturing, Materials and Design event highlighted three main action points on which a revolutionary improvement in postgraduate education could be based:

1. The development of a manufacturing, materials and design postgraduate education road map that links to those of technology and business

2. A clear taxonomy of postgraduate education across sectors

3. Research into all aspects of postgraduate teaching, learning and overall experience in collaboration with industry; specifically answering the questions:

- How can the gap between industry needs and postgraduate education be tightened?
- How can postgraduate teaching, delivery and assessment better reflect the requirements of future careers?
- How can postgraduate education provide the required flexibility to adapt to changes in industry needs and student lifestyles
- How can advances in digital technology be harnessed within postgraduate education?

Next **'Excellence in post graduate education - Manufacturing, Materials and Design'** event will be on the 30th of April 2015

Cranfield University

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