



Excellence in Postgraduate Education:

Manufacturing, Materials and Design

Innovation in postgraduate teaching methods

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Excellence in Postgraduate Education: Manufacturing, Materials and Design

Supporting organisations

- Granta Design
- Learning Science Ltd
- Didactic Services Ltd

Presentations from the day can be found at:
www.excellence-postgrad-manufacturing.org.uk

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Innovation in postgraduate teaching

The UK needs postgraduate education that is distinctive, of value and encourages innovation. The UK education system is currently heavily focused on assessment. Education should be so much more; about developing individuals and as a community through skills, ideas and imagination. With excellent practice in teaching and learning encouraged through the Teaching Excellence Framework, university academics are seeking more innovative practices and technology to enhance students learning experiences. This report outlines shared ideas from a symposium.

Innovation means different things to many. The Teachers Guild, Riverdale Country School, New York, asked a range of educators, what innovation meant to them. To Charles Shryock IV, innovation is about reframing challenges as opportunities; you don't necessarily need to make something new to be innovative. Innovation can be repurposing an older tool or method for a new purpose. The word "innovation" itself comes from the Latin words *in* and *novare*, meaning 'to make new.' By adopting an innovative mindset, we make ourselves new. Most organisations, including schools and Universities, take existing products and improve incrementally on them, but truly innovative companies and institutions address unsolved problems by taking a completely new approach.

If the primary role of teaching is to permit learning usually by example or experience, then a teacher still has to learn how to enable students to learn. In the UK, Valerie Hannon argues that teachers and lecturers are under such huge pressure, meeting targets, they have very little time and space to develop new skills and embrace new technologies in ways that enable them to do their job much more effectively. Saku Tuominen notes that there are many amazing institutions and teachers who are taking risks, some of which work, some don't, where any failure is seen as a learning experience. It is also crucial to embrace other communities to share the learning experiences, both nationally and internationally, since there are no boundaries to innovation.

The sharing of 'good practice' and 'lessons learned' among members of the higher education community can help teachers to concentrate on effective uses of technology and to avoid duplication of effort and expense. The lessons learned can provide a useful indication of benefits that might be achieved. The HEFCE e-learning strategy argues that using technology in learning and teaching provides benefits in terms of efficiency, effectiveness and, where appropriate, transformation of how students are educated.

This symposium is the 5th in an annual series, focused on excellence in postgraduate education. The inaugural event hosted at Cranfield University in 2014, was at a time when students were being asked for significant investment in their education. The ambition was to identify best practice and key attributes of postgraduate education, to future-proof postgraduate provision. The identified attributes were explored further (2015), and developed into a visual representation of a postgraduate education roadmap linked to industry. In 2016, the focus turned to partnerships and collaborative projects between our adult learners and industry. As the education provision moved from 'working with industry' to being entirely industry led, The symposium in 2017, considered future challenges of postgraduate or level 7 apprenticeships.

At the 5th symposium in April 2018, the basis of this report, participants from the postgraduate student community, universities, industry employers, across the fields of manufacturing, materials and design, shared ideas of innovation in postgraduate teaching methods, exploring challenges and opportunities faced by learners, employers and educators. The discussions and outcomes from the event are captured in this report and will be of value to a range of professionals, across higher education institutions, involved in the delivery of postgraduate taught courses.



Speakers



Sameer Rahatekar

Organiser
Research lecturer in
manufacturing



Susan Impey

Programme Director
for masters courses
in Manufacturing
Technology and
Materials



John Eastman

Director and co-founder,
Learning Science Ltd

John is a director and co-founder of Learning Science Ltd who supply education technology solutions to the higher education community. John's background is in chemistry. He was one of the first

users of Moodle for delivery of online learning. John was innovating in the use of Flash for interactive learning when ActionScript introduced around the same time. He has a passion for developing student focused solutions and in engaging with academics to help them realise their goals.



Babak Jahanbani

Head of Learning Systems
at Festo Didactic Services Ltd

Babak graduated with a B. Eng (hons) in Mechanical Engineering. He worked for British Sugar, GEC Alsthom and Lucas Industry as a Manufacturing Engineer. He subsequently worked

for a British-Turkish company equipping state universities with undergraduate equipment in Science and Engineering. Barak then set up his own company representing suppliers of Science and Engineering systems. In 2003, he became UK Sales Director for Feedback Instruments, a supplier of engineering teaching equipment before joining Festo Didactic in 2010 as Didactic Manager for UK.



Hannah Melia

Senior Product and Marketing
Manager (Education) at
Granta Design

Hannah leads the Teaching Resources Team at Granta Design and has responsibility for the development of CES EduPack and associated teaching resources.

She has a degree in Materials Science and Metallurgy and a Post Graduate Certificate in Design, Manufacturing and Management from the University of Cambridge. She has worked in the United States and Germany on medical device design and technology transfer.

Insight

Rajkumar Roy, Director of Manufacturing, extended a warm welcome to all participants. He set the scene for discussion by outlining some challenges with regards to postgraduates and the changing role of universities.

Learners and industry are seeking more innovative delivery. As an example, the level 7 postgraduate engineer apprenticeship, developed in collaboration with industry and the Institute of Apprenticeships has modules delivered digitally to learners in multiple workplaces simultaneously.

Postgraduate adult learners:

- have complex lives, often multi-tasking with full or part time work and dependents. How do they balance demands and be disciplined with study?
- are career focused, adaptable and versatile. Learners may not need to be subject experts, but move across disciplines rapidly developing appropriate knowledge and skills to adapt to organisations.
- often seek individual personalised content. This is not always easy to accommodate in universities where resources favour structured learning.
- 81% students expect digital (McGraw Hill Education, digital trends in higher education) however adult learners are not all social media and digitally savvy.

The role of Universities is also changing:

- The needs of society have to be at the centre of a university's activities, and a flexible adjustment to the many changing needs is necessary. The future of Universities lies not in developing buildings but in developing individuals.
- Information is a commodity, widely and freely available, the role of the Universities should be developing individuals, who can learn fast, navigate through the infinite amount of available information, synthesise and apply knowledge rather than deliver content.
- Technology enhanced learning is not moving fast enough. Should we embrace social media and crowd based learning and utilise it in effective and creative forms of teaching and assessment? Flexible pedagogy is already being delivered.

"Adult learners should be assessed on their learning ability"

Rajkumar Roy

- Dealing with complex problems with multiple parts is difficult. Our current customer focused and business opportunity approach for education and course content can add to the difficulty. Adopting a systems thinking approach could have key benefits in dealing effectively with complex problems.
- How do we blend learning with digital delivery supporting the intelligent connectivity of smart devices, the Industrial Internet of Things (IoT) and Industry 4.0? Should we invest in learning factories or the equivalent in the postgraduate environment?

Our speakers discussed approaches for enhancing postgraduate education with learning technology in science and engineering with a range of delivery routes;

- provision of accurate information and ways to engage and visualise with interactive software
- learning tools, simulations and interactive assessments
- technical training in production technology, the future production environment, learning factories and laboratory solutions.

Hannah Melia leads the Teaching Resources Team at Granta Design and gave examples of technology enhanced materials and materials process education. A better understanding of materials and innovation in their use must be part of solving problems such as resource consumption, energy use, air pollution and improving human health.

Materials matter in so many areas, there is a need to educate the next generation of materials scientists but also engineers, designers, scientists across broad range of disciplines. Granta CES Software provides engaging ways for students to explore and understand the world of materials, visualising properties, matching materials and manufacturing processes to applications, digging into the underlying science and evaluating environmental impact. Many tools are incorporated into the software to permit visualisation of content in range of ways, many of which will suit the learner.

A teaching resources website developed by Hannah allows resources to be shared, enriched and new ones developed. Presenting information in an engaging way enables students to learn quickly and develop skills to think critically, ask good questions, make good decisions and understand the system as a whole.

Hannah focused on student engagement, using an example of a masters course in sustainability. Ways of exploring sustainable development are given to learners in a way that avoids simplistic interpretations and approaches complexity in a systematic way. Many Universities are adopting a systems approach to teaching. There is no completely "right" answer to questions of sustainable development, instead, a thoughtful, well-researched response, recognizes



concerns of stakeholders, the conflicting priorities and the economic, legal and social aspects of a technology as well as its environmental legacy. The intent is not to offer solutions to sustainability challenges but to improve the quality of discussion and enable informed, balanced debate.

An invitation was extended to collaborate with academics around the world, support animations of materials processes and enjoy an increased number of animated online interactive teaching recourses.

John Eastman outlined that at postgraduate level, Learning Science typically used web based systems as a virtual learning environment and e-portfolio system to create integrated systems to:

- embed interactive learning content
- create collaboration opportunities
- streamline project choice and submission
- help students recognise the skills they are developing
- support student CV planning
- support core skills development

These solutions are used for both local and dispersed cohorts in single or multiple institution settings, through Centres for Doctoral Training or Doctoral Training Partnerships. Jon outlined what worked well and not so well, the challenges and pitfalls as well as the successes. Examples were given of creative techniques to support laboratory practicals, student engagement and interactive simulations. Dynamic smart worksheets can be used to provide real-time feedback. As the student types, feedback allows learning from mistakes in real time. This completes the feedback cycle, raising the learning potential of every interaction. In this way online assessment and detailed feedback is obtained while completing reports.

Babak Jahanbani introduced the background to Festo and the 'hands-on' approach to technical education particularly in manufacturing. Manufacturing increasingly uses techniques such as data analytics, advanced process monitoring and the internet of things, in order to enhance productivity. The adoption of these 'smart' manufacturing technologies has created the need for a higher level of engineering skills and expertise than has been required to date.

During manufacturing operations it can be difficult to halt production to provide process-specific staff training. For this reason larger companies have set up internal training facilities that simulate the manufacturing environment to provide this training. These dedicated, close to production training activities are referred to as Learning Factories. The aim of these factories is to enhance a trainee's competence in a production process.

Dowling and Ahearne¹ explain that the advantages of 'learning by doing' have been recognised for a long time. For example, in the 1960s Edward Dale proposed through his 'Cone of Learning', that after two weeks, we remember only 10 per cent of what we read, but 90 per cent of what we do. The Learning Factory approach helps to address this, by providing hands-on training in manufacturing. These facilities can be located within either academic institutions or companies.

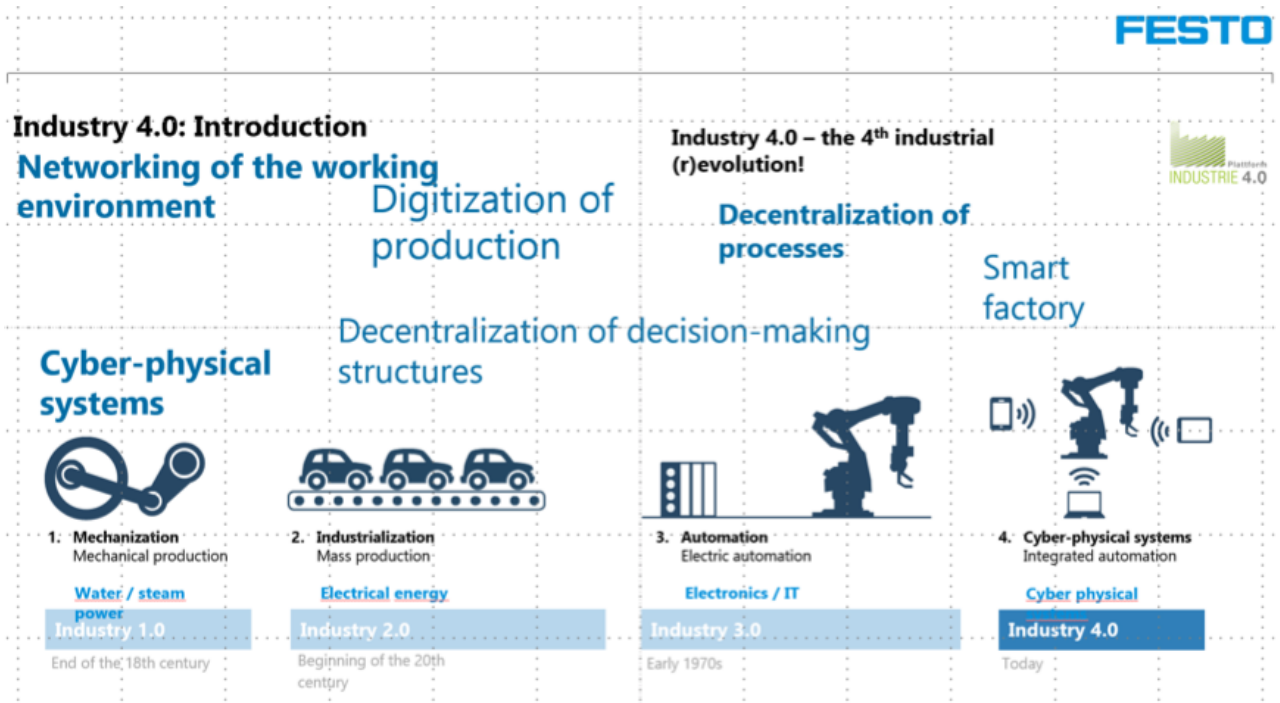
Examples of Learning Factories are the manufacturing facilities at Daimler Chrysler, Mannheim (turbo charger manufacture) and at Volkswagen, Wolfsburg (auto parts). In the UK, a number of sites deliver practice based learning. For example Middlesex University deliver robotics, haptics and design technology. University College Dublin have opened a Learning Factory in Smart Precision Manufacturing¹. Associated lectures support the practical work carried out in the Learning Factories.

Alongside mass production, there is also a trend in industrial production towards the individualisation of products. That is why more flexible production facilities are needed. Industry 4.0 provides new possibilities. By using components that are independently networked in an intelligent way, configure themselves and are



therefore capable of 'plug and produce', production facilities are able to meet the steadily growing requirements immediately. There is a requirement for a new generation of workforce, those who can perform in highly dynamic and complex environments in a number of relevant technological fields.

Automated systems still need to be designed, built maintained, optimised and integrated, perhaps operated from smart devices (android tablet or smart phone). Individuals also need competence in problem solving, and organizational, social, and leadership skills. An ambition might be that if plant goes down in one part of the world, another in a different part of the world can take over in a matter of minutes without anyone needing to go there!



1. Denis P Dowling and Eamonn Ahearne, School of Mechanical and Materials Engineering, UCD, Engineers Journal, 23 February 2016

Further discussions

All participants were invited to share in discussions in the areas below, providing the following insights:

- Technology based and industrially oriented curriculum;
- Academic curriculum development and effective assessments:

Technology-based learning and industrially oriented curriculum

Relevance

- Product examples/case studies to reinforce learning
 - o Increases engagement
 - o Encourages high level thinking skills
 - o Authenticated case studies
 - o Increases the pace of learning
- Address considerable diversity in PG learners and facilitators, gender neutral examples provide context and relevance.
- Learning factories - need to be able to play and tinker
- Create a network, a partnership, socialise to support learning process.

Access (to reliable content)

- Varied presentation of graphical data, charts, tools, important to visualise content.
- Access to accredited source data to support the content being visualised, and to question reliability of data base (legal implications).
- Analysis techniques for data which is used in any examples given to the end user.
- Important for taught content on the statistical use of data, good use of big data.

Agility

- Adaptable, flexible learners, learning to learn.
- Make change happen –dealing with change and the consequences of change.
- Speed of responding to clients: importance of speed, visualising (contrary to current teaching in project management).
- Inputs and outputs of a process, tailored to industry requirements.
- Making agile decisions, dealing with constraints, consequences and impact of engineering decisions, empowering.



Academic curriculum development and effective assessments:

The discussion focused on the use technology enhanced learning to:

- reduce the one way flow of information from the teacher to student and share from high achieving students and circulate flow of content for all learners.
 - o good examples of Middlesex University using students' experiences
 - o face-to-face discussion integrated with interactive virtual learning
 - o video and multiple choices then face-to-face sessions for further discussions
 - o Putting lecture notes online are not effective
- spark interest of students in a given taught subject/course.
 - o use student engagement and shared interest to start flow of learning.
 - o active way of learning (group discussion, bringing lab into class) better than passive (e.g. watch videos; students watch for less time than expect).
 - o efficient integration of software-hardware extremely important especially when VLE is concerned e.g. augmented reality.
 - o in active learning using VLE better to have a feedback system in place to get the student to make a choice and receive feedback.
 - o using augmented reality, how parts are designed, processed, students learn.
- explore varied ways of learning to maximise the learning process
 - o students need background knowledge to embark on some discovery during a teaching/learning session.
 - o visual ways to enhance learning capability in students with different levels of background.
 - o reinforcement via VLE! Such as discussion boards on blackboard. Use of social media, skype, evernote to create a discussion board.
 - o Festo are involved in Sheffield UTC, trained instructors. Hand-on experience is a great influence.
 - o element of machine learning in a VLE system that can enhance itself based on students experiences and assessments.

Summary and next steps

Summary

Innovative postgraduate teaching methods include a range of strategies to engage the learner and provide access to accurate information with range of visual, animated or interactive formats for all. Accessible content with a range of engaging strategies can build understanding and learning. Hands on learning can be virtual or in a real production environment with learning factory provision fit for the future.

Postgraduate learners and teachers will benefit from a 'University of skills', developing confidence and capability. Such skills are using technology, enhancing creative problem solving, improving critical thinking and curiosity. Agility and speed of acquiring and disseminating information was also noted as part of the skill set that Universities can support. Notably, even small changes to teaching practice can enable learning to flourish.

Next steps

An invitation is extended to collaborate with academics around the world, support animated on-line interactive teaching resources in manufacturing, materials and design

- Develop industrial advisers to the UK on industry 4.0 in digital security and the digital space.
- Adopt a systems thinking approach to problem solving.
- For teachers to explore changes to teaching practice to enhance learning.
- Explore hands on learning and learning factories.
- 'Agility of thought' and 'comfort with change' form a valuable part of the skill set that 'Universities for skills' can support.

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Next '**Excellence in Postgraduate Education - Manufacturing, Materials and Design**' event Thursday 25 April 2019