Industry 4.0
Implications, issues and opportunities for higher education

What is Industry 4.0?
Industry 4.0 is a term used to represent what many perceive as the fourth industrial revolution, where the previous three were (chronologically) predicated on steam, electricity and equipment automation respectively. Industry 4.0 reflects convergence of manufacturing, the Internet of Things, cloud computing, data exchange & analytics and autonomous/smart operation. Such combinations are typically referred to as cyber-physical (CPS) systems, examples of which include smart grids (designed with a focus on energy efficiency), autonomous vehicles, robotics systems, process control systems and smart factories. Key characteristics of such systems include interoperability (e.g. between machines, devices, sensors and people – the Internet of Things/People), information transparency, technical assistance to humans e.g. in making sense of complex data and undertaking tasks that are difficult for humans, and decentralised decision-making e.g. autonomous operations. Improved human-computer interaction is also essential ranging from the simple e.g. touch operation to the more sophisticated such as new ways of visually presenting complex data to enable agile decision-making and using technologies such as gesture recognition and virtual/augmented reality.

Implications of Industry 4.0
McKinseys, in their report “Industry 4.0: How to Navigate digitization of the manufacturing sector” (2015), suggest that Industry 4.0 will offer high potential impact at relatively low cost due to manufacturing equipment requiring relatively little replacement and where the main expense will be in sensors and connectivity (such low-costs are at variance with the high cost of automated machinery within the Industry 3.0 period). The McKinsey report was based on a survey of 300 experts from a range of sectors who estimate that Industry 4.0 will increase revenues by 23% and productivity by 26%. It is anticipated that this will be achieved through more flexible and modular production that will allow faster responsiveness to changing demands (production volumes and product varieties) and improvement in quality through minimising waste and reducing maintenance and repair costs. However significant challenges have been identified. For instance, a large proportion of companies expect their business models to be impacted with new competitors, giving rise to significant uncertainty. Furthermore, companies feel ill-prepared for Industry 4.0, and cite a range of key areas of concern including staff know-how and skills in an increasingly complex and converging environment, data security, data ownership, system safe-guarding, data standards and holistic wireless connectivity.

Issues and implications for HE
The most significant implication for HE is that companies feel ill-prepared for the complexities and challenges of Industry 4.0, particularly in staff know-how and skills and innovative R&D. These are classic HE-industry engagement territories, however due to the converging nature of Industry 4.0, HE will need to develop more joined-up, collaborative and interdisciplinary ways of providing value to industry across, for example, manufacturing, manufacturing IT, engineering, business IT, business and product design disciplines. At the very minimum, this will mean reviewing the graduate skills & experience profiles that it aims to develop in learning programmes as well as the learning outcomes of employer CPD programmes, all to reflect converging disciplines and employability/transferable skills. It will also mean that HE R&D, employer engagement and research-informed teaching and learning programmes need to be tightly inter-connected, with highly tuned cross-discipline relationships developed and maintained between HE, employers and employer/professional bodies.

Opportunities for HE
The most significant opportunity for HE is to develop expertise and offerings in Industry 4.0 to proactively support employers in managing a complex business, manufacturing and IT environment,
through developing learning programmes that produce appropriately equipped graduates, CPD programmes for employer staff and innovative R&D and consultancy services. All of these will need to involve a high degree of transdisciplinary partnership working between HE and employers, involving disciplines such as manufacturing, manufacturing IT, engineering, business, business IT and product design including specialist areas such as state-of-the-art human-computer interface design, data sharing and analytics, data security, data ownership and holistic wireless connectivity. Such engagement should ideally include a high degree of student engagement, building on Jisc initiatives such as students as innovators and students as change leaders which both capitalise on the power of student creativity, motivation and digital skills to inspire educational innovations.

There are also opportunities for HE to work with manufacturing supply chains. For instance, in the automotive sector, Jaguar Land Rover has developed a suppliers group that aims to promote a high degree of collaboration between suppliers (including SMEs) in areas such as skills development and knowledge-sharing. Engaging with such manufacturer-led groups will help HE to considerably lower the barriers to engaging with individual SMEs.

HE can additionally provide added-value to individual sectors by working with a range of sectors e.g. automotive, aerospace, food processing, chemical, consumer goods healthcare and acting as the conduit for drawing out and sharing Industry 4.0 know-how, skills and best practices across such sectors. This again, will require trans-disciplinary collaboration.

HE can also draw on lessons learnt from HE-employer engagement in the automotive sector which developed the “Formula Student” initiative (run by the MechE), where university student teams design, build, test and race a small-scale formula style racing car as part of their learning programmes in a (now) annual world-wide university competition, where judging criteria include a range of trans-disciplinary and employability skills. It would be possible to create a similar competition in the Industry 4.0 arena, where students are posed challenges and could utilise emerging Makerspaces / Makerkits to address their challenges through exploring, designing, prototyping, building, testing, operating and automating systems and Internet of Things devices/sensors using micro-controllers, cloud computing and software tools including 3D printing. Such MakerSpaces and Makerkits provide a learning cyber-physical eco-system that can support student experiential and collaborative learning and are now at a cost-point that would allow them to be provided to students individually or in teams (more information about makerspaces can be found in Nesta’s report “Made in China: Makerspaces and the search for mass innovation”).

Iain Cameron, an expert on industrial strategy, describes UK HE education involvement in cyber-physical systems in his article Industrie 4.0, Cyber-Physical Systems and Servitization.

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