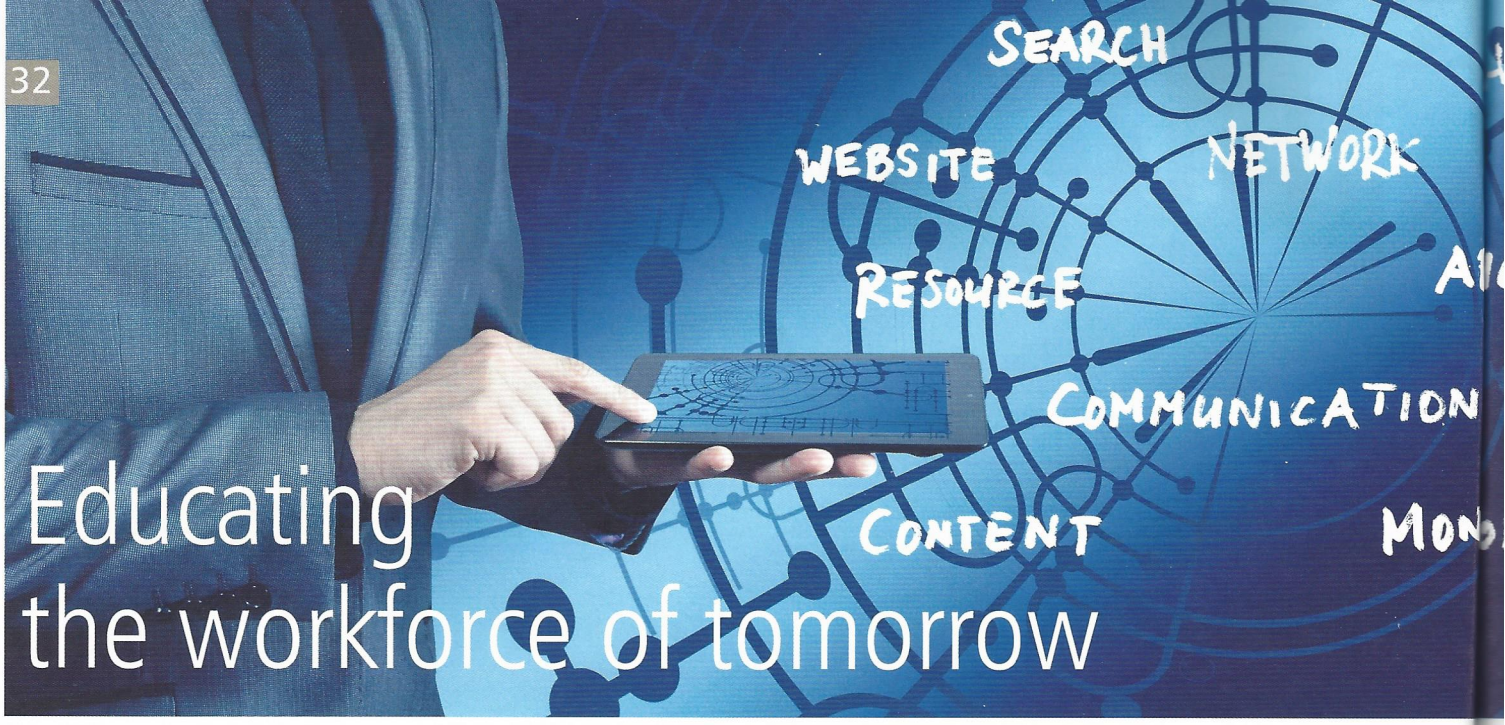

Educating the workforce of tomorrow

As 'smart manufacturing' or Industry 4.0 and its associated technologies start to transform the industrial sector, a strategy is needed to re-educate and retrain the workforce of tomorrow.

By **Dr Joseph Flynn**[1] and **Prof. Dirk Schaefer**[2]

AT present, the design and manufacturing sector at large is experiencing a fourth industrial revolution, also known as Industry 4.0 (I4.0). It is anticipated to bring about "the comprehensive transformation of the whole sphere of industrial production through the merging of digital technology and the internet with conventional industry" [1]. The major technological themes surrounding I4.0 include: big data, cloud computing, cyber security, automation, cyber-physical systems, smart factories, the internet of things and the internet of services [2]. In many ways, these themes do not map onto the skillsets of the current industry workforce. As such, a strategy is needed to re-educate and retrain the workforce of today, and to design the education programmes for the workforce of tomorrow.

This article continues based on the premise that I4 should, in principle, be embraced and that considerable revenue will be available to those that transition quickly and successfully. This aligns with recent forecasts, suggesting that in the UK, manufacturing could receive a boost of £455 billion from industrial digitalisation [3]. With this in mind, it will explore the possible effects that I4 could have on existing job roles, identifies some of the skillsets that will be necessary in the near-future, and issues a call to the community to identify their future requirements and some necessary actions to form an I4 workforce strategy.

Industry 4.0 and future workforce requirements

There is no doubt that automation replaces various job-roles. However, new employment opportunities tend to emerge in the form of up-skilled or previously unforeseen job-roles. In fact, a recent UK study suggests that industrial digitalisation could lead to a net increase of 175,000 jobs over the next 10 years in the UK [3]. A crucial part of this period of adjustment is education, re-education and retraining.

Recent studies agree that job roles with lower cognitive, creative or empathetic attributes will be most at risk [5]–[7]. Another study frames this differently, stating that high levels of routine are the common factor [8]. This framing is particularly interesting as level of routine can be independent of cognitive load. This actually questions the view that academic attainment and wages reduce the risk of technological unemployment. Some cases that support this assertion include the use computational intelligence within legal services [9] and the medical field [10]. What is clear, though, is that education, re-education and retraining will be essential if employment is to maintain pace with technological development. This education and training is likely to have to cater to a variety of cognitive abilities, creativity levels and skillsets.

The authors recently hypothesised that countries such as France and the UK score well in terms of readiness for I4.0 [11]. So why is it, that Germany is widely regarded as being the forerunner in the I4.0 race? The answer lies in the fact that 'readiness' is only one part of the story. Germany has embraced I4.0 as early adopters and has opened new I4.0 training and education centres across the country, spanning pre-18 schooling, higher education and vocational training. Start-up companies, such as the German Innovation Centre for I4.0, are also addressing the need for practical enhancements and further education to accelerate the transition. This responsiveness within education is critical to ensure that it can maintain pace with shorter innovation cycles within industry. After all, technical education is a pull-demand market dictated by industry [12].

It is clear that technological imperatives and necessary skillsets are changing as a result of increased servitisation within industry, unprecedented gathering and exploitation of data, global collaboration and connectivity via the internet of things (IoT) and social networks, and the creation of cyber-physical systems. A recent study by Stanton Chase [13] identified an on-going talent shortage in the context of I4.0. In the same survey, 30% of the respondents identified a lack of technical skills as the biggest barrier to industrial innovation, whereas 20% of the respondents identified management as stifling development. The three most sought after management skills were: change management (42%), cross-functional management (38%), and

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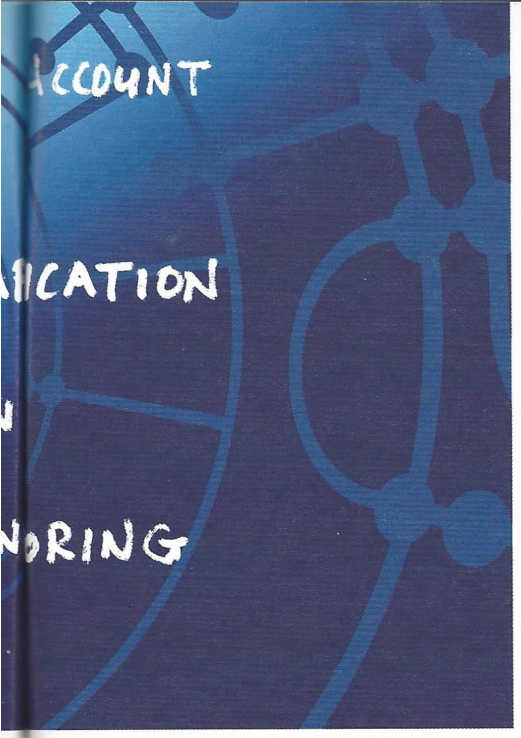

technical skills (12%). As such, it is clear that education should not only address technical relevance, but also business and management relevance.

Businesses within I4.0 will be generating significant volumes of data. However, it is very difficult to qualify whether a business is maximising the potential usage and revenue afforded by this data [14]. Imagination and creativity are required to fully-explore the usage of production data in this sense. It is the authors' belief that creativity in business will be vital as I4.0 evolves. By way of example, it is reasonably trivial to identify opportunities for efficiency gains in production processes, maintenance and workforce requirements. It takes slightly more creativity to identify mechanisms to gather data from products that are in-service to drive product development. Further creativity still is needed to appreciate how data can be used to manage a supply chain by better communicating requirements and fluctuations. However, these are all reasonably adjacent to the core of the business operation. Where real innovation could take place is less obvious. For example, the provision of data to influence insurance premiums, the automatic creation of compliance documentation, the use of data to dictate the commissioning of new factories and the provision of data for investments and trading. These are just examples of how new thinking could unlock entirely new revenue streams from data that is primarily used to control a production process.

How should education respond?

Educating and (re-)training the I4 workforce of near-tomorrow is something that has to be addressed across all levels. Following the German school of thought, the competencies required to succeed in I4.0 context ought to become part of middle-school and vocational education. I4.0 competencies are nothing outlandish, they are essential from an employability point of view. Along these lines, it can be expected that degree apprenticeships will become more and more attractive in future. The Higher Education sector at large is urged to respond much more quickly to the pressing need of preparing tomorrow's workforce – or we, as a nation, will fall behind. One has to critically rethink the number or years until a degree programme becomes dated or even obsolete. The cycle is shortening, and much faster than many want to believe. Hence, a recently communicated idea of moving away from the traditional three to four-year-long degrees towards two-year-long foundational and specification programmes makes a lot of sense. Similarly, the topic of theme-based rather than discipline-based education opens up new avenues for workforce qualification. Addressing the needs of those already in the workplace suggests that investment in I4.0-related CPD programmes and professional education short courses is likely to become a lucrative route for education providers. This is further fuelled by the fact that today most education and training can be provided online, in virtual distance learning settings. For example, some American Universities are already experimenting with a model known as 'credentialing'.

Certificate of competence

This means, they offer programmes (onsite or online), and anybody who wants to take the exam/test and is willing to pay a certain fee, enrolled or not, may have the opportunity to demonstrate their knowledge and, if successful, receive a certificate of current competence in a specific area. As you can tell, there are bricks-and-mortar education models of the past that may well be on the way out and there is plenty of opportunity to innovate in the realm.

A call to action

Technical developments for the underpinning technologies of I4.0 are moving very quickly. The rate at which these can be exploited to create value within industry will largely depend on creating improved products and services through data and connectivity, and adopting new business models and management approaches. It is likely that this will require a significant shift in the current education, re-education and professional training landscape to become more responsive. This revised landscape should focus on future technological imperatives, as well as creativity within business strategy and management. This is, however, only one perspective. A concerted, co-ordinated effort needs to be made between academia and industry to identify an education and training model that delivers the right people, with the right skills at the right time. ■

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