Chapter 31
Manufacturing Education for Society 5.0:
Reframing Engineering and Design

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ABSTRACT

The last 20 years have brought significant developments to digital fabrication technology, known as additive manufacturing (3D printing), and it has finally started to shed its prototyping mantel in favor of an industrial one. Yet its innovations are in danger of being subsumed into existing commercial practices, as society arguably continues to underestimate its ability, in conjunction with data collection, analysis, and communication tools, to disrupt current systems and enable a more equitable distribution of manufacturing wealth, capability, and capacity. This chapter highlights the potential of emerging industrial technologies to support a shift towards a more human-centered, responsible society where social and environmental problems are addressed through systems that maximises cyberspace and physical space integration, through the reframing of higher education engineering curriculum and pedagogy for manufacturing in Society 5.0.

INTRODUCTION

In Japan, the political Cabinet's 'Society 5.0' initiative has sought to create the basis for a more sustainable society for human well-being and security in an increasingly digital era, through the use of socially conscious, ethical cyber-physical systems (Yato, 2019, p.1). Keidanren (the Japanese Business Federation) responded positively to this, with an intent to proactively deliver on the United Nations' Sustainable Development Goals intended to "end poverty, protect the planet, and ensure prosperity for all through the creation of Society 5.0" through collaborative ecosystem activities (Shiroishi, Uchiyama, & Suzuki, 2019, p.1). Shiroishi et al. (2019) described how the rise in computing power over the last

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twenty years has contributed to professed advances in business and society, yet the world is facing a growing economic disparity, global warming, the depletion of natural resources and an increased threat of terrorism. They argue that the situation is precarious, not least because of the rising complexity and uncertainty decision makers are having to face, with globalisation and the rapid development of complex digital technologies. ICT is perceived as essential to gain new knowledge in Japan, but the Society 5.0 initiative promotes its development alongside new value systems where there are greater connections between 'people and things' and also between the 'real and cyber'. This is seen as necessary to "effectively and efficiently resolve issues in society, create better lives for its people, and sustain healthy economic growth" (Shiroishi et al., 2019, p.1). However, Shiroshi et al. (2019) also point out that to do this, stakeholders at multiple levels will need to commit to a very different, shared vision of the future in order to realise the values of Society 5.0 for digitisation.

In most countries, the last few years have seen a shift in rhetoric in relation to automation, artificial intelligence and digital communication. Recent lessons, such as in the Cambridge Analytica / Facebook data harvesting example and its impact on politics, have given pause to the blinkered competitive development of digital technology innovations without thought to the unexpected consequences for societies that could arise. For manufacturing, correlations between the rise in greenhouse gas emissions and the accelerating effects of climate change (Morrison, 2019, p.2) continue. There is also an inequity in pay and conditions for workers around the world, not only seen in factory examples, but also in distribution centers, including Amazon (Sainato, 2019). In addition, there are risks to communities where there are dependencies on single employers or industries, highlighted by the bankruptcy of Detroit City following the loss of Ford Automotive (Leduff, 2014). These form part of the problematic impacts on the environment and communities highlighted recently by supply chain and life cycle assessment practices (e.g. Vezzoli, & Mansini 2008). Resource depletion, and the long-term damage to the environment and communities in some resource removal and resource production practices (e.g. palm oil production displacing communities and mining destabilising land) are a concern. In addition, the pollution and waste generated through traditional twentieth century manufacturing practices, contribute to the conclusion that manufacturing should maximize opportunities provided by digitisation in order to substantially dematerialize product service systems. They should also focus on maximising the value of existing resources, and commit to the circular economy, supporting social, as well as environmental, sustainability.

Engineering and industrial design are the lead disciplines for the development of future practices in manufacturing. Mechanical engineering in particular is instrumental in feeding the development of technology and industrial practices that drive the expansion of manufacturing and the direction it takes in its adoption of digital technology. Robotics and electrical and electronics are also increasing their influence with the expansion of tracking technology in manufacturing in Industry 4.0 (Schwab, 2017). For the last decade, the direction for the adoption of digital technology has been a fairly relentless drive towards eliminating people out of production systems. As Cameron (2017, p.2) observes with regards to the rise in automation: "We're at the outset of a great debate. At one level, it's simple. It's about whether we need to worry that robots will take our jobs, or whether we don't."

Yet an awareness of the social and environmental problems that an unexamined, independent view of the adoption of digitalisation purely for narrow commercial benefits for shareholders, is beginning to emerge. This then leads to questions not only about the monitoring and legislation of manufacturing practices for environmental protection purposes, but also about social engineering, including urban planning, and the developing of sustainable product production systems for the benefit of society as a whole, rather than individual companies. For engineers, understanding these implications and contemporary