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Universities 4.0 Discussion Paper

Technology as a Transformation Enabler

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Introduction

The COVID-19 pandemic has disrupted the global university sector in ways very few people would have predicted. It has amplified the need for universities to embrace digital transformation more rapidly and embed digital technologies across the entire enterprise including education, research and operations. As a consequence of the global pandemic we have seen universities shift at an unprecedented scale and pace to virtual education and remote working enabled by digital technologies in order to maintain business continuity. Many universities are also looking at reshaping their strategies and operational models for long-term institutional viability realising that post COVID-19 world will not be the same.

Many industry sectors have realised the importance of digitalisation and the evolving fourth industrial revolution well before the virus outbreak. Digitalisation was already redefining industries and the nature of work, with many services and jobs changing or becoming obsolete. COVID-19 has accelerated this transformation and amplified the impacts. For example, over the past year due to the coronavirus pandemic around 1.6 billion of most vulnerable economy workers in global labour markets have lost their capacity to earn a decent living.[1] While the nascent university sector initially observed this evolution of the digital world as an incremental process rather than a major disruption, thus allowing the status quo to continue in some form, universities are now considering a more robust paradigm shift through digitalisation. A paradigm shift that transcends the entire enterprise and embeds digital technologies at the heart of the corporate strategy and new operating models. Recent research supported by comprehensive surveys across a range of industry sectors[2,3] confirmed that companies that adopt bold offensive digitalisation strategies will succeed in the marketplace. We are now seeing this trend emerge in the higher education sector as well.

With digitalisation, the cycles of technological advances and innovation are now measured in months rather than decades. Disruptive technologies harnessed by the fourth industrial revolution (Industry 4.0) such as Cloud, Big Data Platforms, Internet of Things, Artificial Intelligence are all fueled by the data explosion created across hyper-connected networks and cyber-physical-biological systems. This explosion of data allows digital ecosystems to continually adapt and evolve, and help keep organisations and their services relevant, innovative and competitive. It is envisaged that Universities 4.0 will also evolve as digital ecosystems involving intelligent networks that transcend the entire enterprise and connect all stakeholders on and off campus. As we face challenges of the COVID-19 pandemic and consider our future state within the Industry 4.0 / University 4.0 context, we should look to data-driven technological innovation as an enabler of new models of enterprise and leadership, new hybrid forms of education and new directions in interdisciplinary research that are better suited to the changed operating environment and society.

Overview of Industry 4.0

Industry 4.0 is fundamentally changing the way in which organisations are creating and capturing value for their customers and stakeholders, economy and society. This shift is enabled by the fusion of cyber-physical-biological systems involving a portfolio of technologies including autonomous systems and robots, simulation technologies and digital twins, Internet of Things (IoT), artificial intelligence (AI), cybersecurity, cloud computing, blockchain, additive manufacturing, augmented and virtual reality, and big data analytics. An updated representation of Industry 4.0 technologies across the physical, digital and virtual domains has recently been provided by Henrik von Scheel, showing the three horizons of development where most of the research and innovation is centered.

The fourth industrial revolution or Industry 4.0 centers on cyber-physical-biological systems that are made possible today by:

- Rising volumes of data, computational power, and connectivity;
- Emerging data analytics and business intelligence capabilities ;
- New forms of human-machine interaction;

1 World Economic Forum, 2021.

2 Bughin, J. and Zeebroeck, v N. (2017). The best response to digital disruption. MIT Sloan Management Review, McKinsey Global Institute, https://www.mckinsey.com/mgi/overview/in-the-news/the-right-response-to-digital-disruption#.

3 Bughin, J. and Catlin, T. (2017). What successful digital transformations have in common. Technology, Harvard Business Review, https://hbr.org/2017/12/what-successful-digital-transformations-have-in-common.

Figure 1. Industrial Revolutions

Source: OECD Future of Education and Skills 2030, 2019.

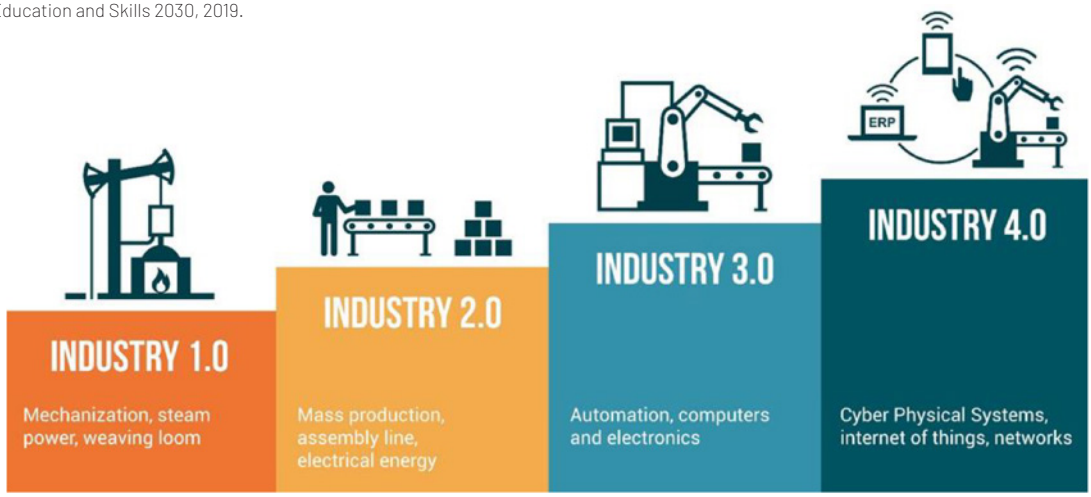
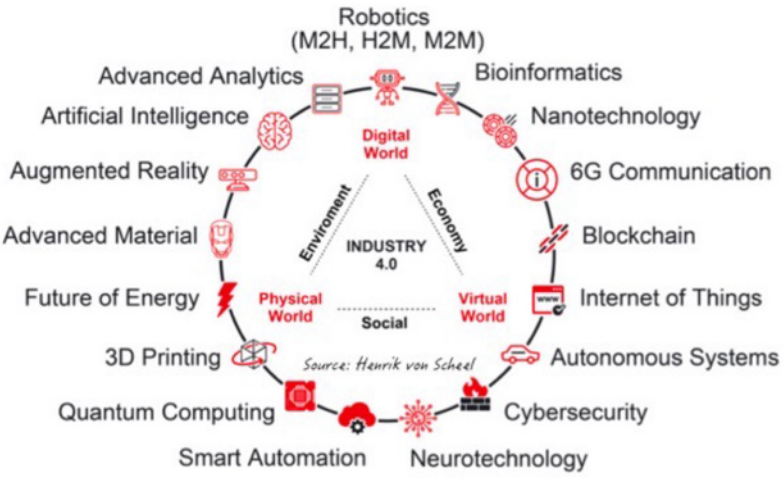
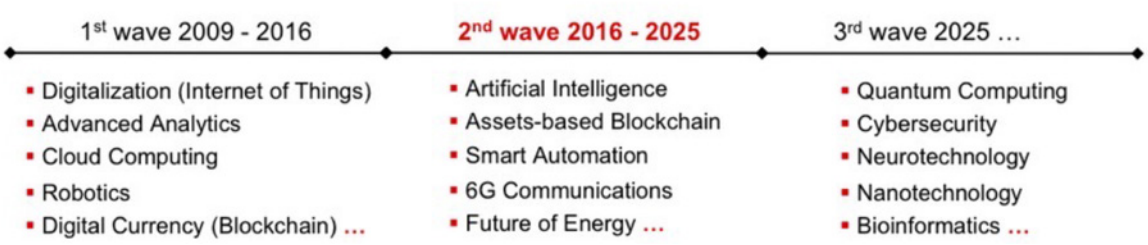


Fig. 2. Industry 4.0 Technologies

Source: http://von-scheel.com



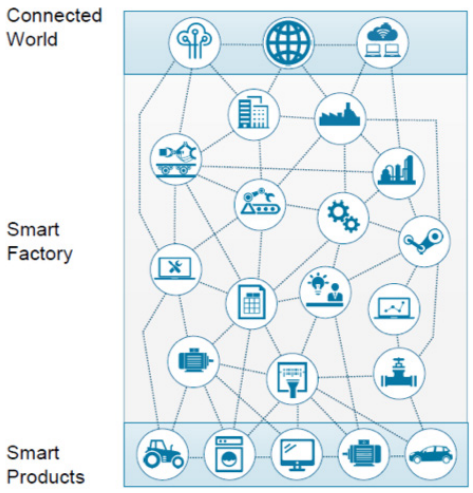


- Improvements in transferring digital instructions to the physical world and vice versa; and
- Advancements in visualisation and virtual representation of physical systems.

The new world of Industry 4.0 is characterised by flexible networked systems where functions are distributed and interconnected throughout the network (as opposed to hierarchical structures of the past with disconnected functions and participants across the value chains). Within the new 4.0 industrial systems participants interact across all hierarchy levels based on new forms of hyper-connectivity (including social media). The product or service within such a model represent an integral part of the interconnected network as seen in Figure 3.

In line with this concept, the German government was the first to embrace the Industry 4.0 strategy, by moving their manufacturing from "centralised" to "decentralised" smart manufacturing processes and technologies. This new smart manufacturing framework integrated the domains of physical production and network connectivity through digitalisation across the value chain using the new "Industrial Internet of Things" platforms. The Industry 4.0 strategy focused on creating a new smart industry in which people, devices, objects, and systems combine to form dynamic, self-organising networks of production.[4]

Figure 3. Industry 4.0 as a Flexible Networked System



Impact of Technological Change on Work and Education

The exponential technological change is redefining the nature of work, with many jobs changing or becoming obsolete. The digitalisation of work in all industry sectors is changing the mix of skills required. Automation is removing repetitive and potentially unsafe or hazardous work, while freeing up humans to engage in more creative and value-adding tasks. The World Economic Forum report on the future of jobs[5] predicts growth in jobs requiring advanced digital skills with complex cognitive skills such as programming, intelligent data analytics, and machine learning. The demand for these types of skills together with creative problem-solving, systems thinking, and a range of more sophisticated "soft skills" is projected to outnumber the decline in jobs based on basic physical, manual, repetitive, procedural, routine, administrative, or operational skills. However, whether this positive balance between new jobs and lost jobs is achieved without major disruptions and societal pains will depend on how effectively the key stakeholders within the larger ecosystem (including policy makers, educational institutions, employers, and unions) collaborate to create new capabilities, transform the workforce and workplaces.[6,7]

Both the WEF report on the future of jobs[8] and the OECD report on the future of education and skills 2030[9] state that meaningful and relevant changes in education are urgently needed at scale to achieve more inclusive and sustainable development and avoid major societal pains due to rapid technological change driven by the fourth industrial revolution. As evidenced throughout history, the education system must undergo transformative change simultaneously with technological change to minimise the period of social pain and maximise the period of prosperity for all.[10,11]

4 OECD (2019). OECD Future of Education and Skills 2030 Report, OECD Publishing, https://www.oecd.org/education/2030-project/about/E2030%20Introduction_FINAL.pdf.
5 World Economic Forum (2018). Future of Jobs Report, WEF, http://www3.weforum.org/docs/WEF_Future_of_Jobs_2018.pdf.
6 Deloitte (2018). Exponential Technologies in Manufacturing, Deloitte Development, https://www.compete.org/storage/reports/exponential_technologies_2018_study.pdf.
7 PwC (2019). Transforming Australian Manufacturing, PwC Consulting Australia, https://www.pwc.com.au/education/industry-proposal-13may2019.pdf.
8 World Economic Forum (2018). Future of Jobs Report, WEF, http://www3.weforum.org/docs/WEF_Future_of_Jobs_2018.pdf.
9 OECD (2019). OECD Future of Education and Skills 2030 Report, OECD Publishing, https://www.oecd.org/education/2030-project/about/E2030%20Introduction_FINAL.pdf.
10 Goldin, C. and L. Katz (2010). The Race between Education and Technology, Belknap Press.
11 OECD (2019). OECD Future of Education and Skills 2030 Report, OECD Publishing, https://www.oecd.org/education/2030-project/about/E2030%20Introduction_FINAL.pdf.

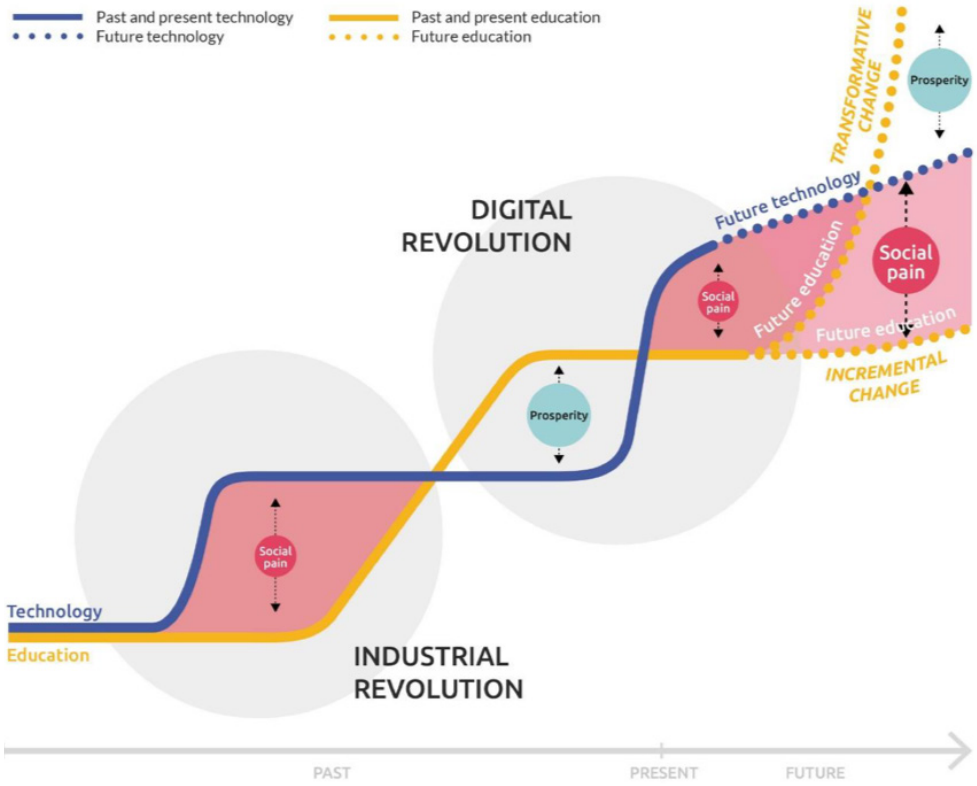
Technology as an Enabler of Innovation in Higher Education

The rapid pace of change in the private sector driven by digital transformation is driving business model innovation in a range of industries. The new business models are embracing cyber-physical technologies (e.g. 3D printing, robotics, Cloud, AI, IoT, social media) in ways never seen before to create new value and access new market opportunities on a global scale. The degree of maturity of digital business models varies across industry sectors and market segments as seen in Figure 5.[12] The German national academy of science and engineering together with Fraunhofer and a consortium of research organisations and universities have developed a digital maturity index to assess digital readiness and help manage digital transformation of companies.[13]

While the education sector is generally lagging behind the private sector in terms of digital transformation and digital business model innovation, the sector will no doubt change significantly within the next decade as global digital giants like Google, Microsoft, Amazon, Salesforce, Netflix, Apple, Cisco, Samsung,

Fig. 4. Technology Change vs Education Change

Source: OECD Future of Education and Skills 2030, 2019.



Siemens, Accenture and others challenge the conventional higher education models by introducing new technologies and solutions that better deliver on the evolving expectations of learners and employers.[14,15]

There appears to be a shared understanding among researchers and university leaders[16,17,18] that the required innovations in education models and research need to address the following

12 Swinburne Research (2017). Industry 4.0 Testlabs in Australia – Preparing for the Future. A Report of the Prime Ministers Industry 4.0 Taskforce, Department of Industry, Innovation and Science, https://www.industry.gov.au/sites/default/files/July%202018/document/pdf/industry-4.0-testlabs-report.pdf?acsf_files_redirect.

13 Schuh, G., Anderl, R., Gausemeier J., ten Hompel, M., Wahlster, W. (Eds.)(2017). Industrie 4.0 Maturity Index. Managing the Digital Transformation of Companies (acatech STUDY), Herbert Utz Verlag, Munich, https://www.acatech.de/wp-content/uploads/2018/03/acatech_STUDIE_Maturity_Index_eng_WEB.pdf.

14 OECD (2019). OECD Future of Education and Skills 2030 Report, OECD Publishing, https://www.oecd.org/education/2030-project/about/E2030%20Introduction_FINAL.pdf.

15 Department for Digital, Culture, Media and Sport (2017). UK Digital Strategy, UK Government, https://www.gov.uk/government/publications/uk-digital-strategy.

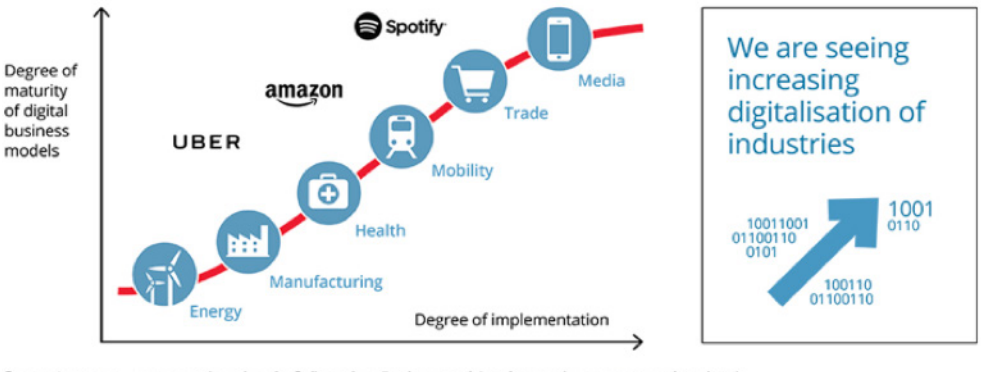
16 Jahanian, F. (2020). How higher education can adapt to the future of work. World Economic Forum, https://www.weforum.org/agenda/2020/01/how-can-higher-education-adapt-to-a-constantly-evolving-future-of-work/.

17 Ostergard, S. F. and Nordlund, A. G. (2020). The four biggest challenges to our higher education model – and what to do about them, WEF, https://www.weforum.org/agenda/2019/12/fourth-industrial-revolution-higher-education-challenges/.

18 Luckin, R. and K. Issroff (2018), Education and AI: Preparing for the future, http://www.oecd.org/education/2030/.

Fig. 5. Maturity Levels of Digital Business Models Across Sectors

Source: Accenture, 2017



priorities to cope with technological and social changes of the fourth industrial revolution:

- Embed life long learning approaches across the entire continuum of education and training;
- Adopt personalised, flexible, and adaptive technology-enabled learning approaches;
- Focus on high value-adding human skills that cross conventional disciplinary boundaries and are not easily automated;
- Develop new directions in interdisciplinary research at the interface between technology, business, and humanity to address the emerging issues in the digital economy and society; and
- Embrace emerging cyber-physical technologies and ways of working through new forms of public and private sector partnerships that support both education and research.

Technology-enabled innovations are driving significant improvements in university operations and system-wide process transformations, and are enabling the emergence of innovative business models. It is reasonable to expect that changes similar to those in the private sector will also occur in higher education in the near future — new technologies will not only drive improvements in processes, but power new models of research, education, and training.

Some initial experiences with the deployment of new technologies in higher education suggest several possibilities. For example:

- AI and predictive analytics can be used to continuously track student-specific data, drive continuous improvement of their performance and maximise student retention.
- AI can automate a wide range of processes, including those performed by researchers and faculty (e.g. assessment, tracking, and reviews), freeing their time and allowing for personalised results and feedback.
- AI can assess student performance and skills — "hard' and "soft" — and serve as personal learning companions (or tutors) for students, helping them access information anytime and anywhere, understand and act on their own, and navigate the academic environment.
- Enterprise data platforms and AI can be used to manage alumni networks and industry engagement data, and create strategic insights and connections that enable a stronger nexus and leveraging between education, research, and engagement.
- Cloud technologies are providing new capabilities to the entire enterprise, such as cloud supercomputing that can be accessed seamlessly by all researchers and research students as a service, supporting data-driven research and innovation across disciplines and enterprise.
- Virtual technologies (AR/VR) and gaming can be used to create new learning experiences for all types and levels of education and training programs, in-person and online.
- Digital networks and platforms can be used to virtualize learning, enable peer-to-peer learning, and create new forms of engagement with external stakeholders, helping to redefine university boundaries.
- Advanced computing and simulation allow for the virtualization of practical experiences and the digitalization of laboratories, products, and processes by using digital twins.

- Collaborative digital platforms coupled with social media allow for students, researchers, and other stakeholders to engage actively in co-design, co-creation, innovation, and research — via open innovation and other models.
- Internet of Things and cloud computing technologies can transform the campus into a smart campus environment that provides students, staff, and partners with unique networked services and lived experiences, while improving resource management and safety.

While these examples mainly relate to innovations in existing university functions and operations, it is anticipated that cyber-physical technologies will also give origin to new business, research, and education models in the future. Such innovative models are already emerging in the private sector.

Discussion Questions

In this conversation, university leaders will review the key technologies that universities should consider when thinking about the future within the context of the fourth industrial revolution (Industry 4.0), how they will potentially impact universities, and what new types of models they could potentially give rise to. Specific questions to guide the discussion are as follows:

- How will society and universities be affected by technological advancements?
- What technologies will have more impact on university organizations and operations?
- What technology-enabled models for education, research, and impact are emerging?
- How can universities use data and AI-driven innovations to transform how they work?
- How can universities best use technology to transform and create value in society?

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