

## 6. Technological Change and the Industrial Internet: What is the Impact on Companies in the Canton of Zurich?

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### The Industrial Internet: Concepts in the Making

The concept of the Industrial Internet describes the phenomenon of connecting the physical world – machines, products and systems – with the virtual world of the Internet. The Industrial Internet doesn't refer to just one digital technology, but it encompasses the interaction and convergence of different technologies, such as the Internet of Things, artificial intelligence, 3D printing, advanced robotics and wearable technologies, which enables the integration of technical with business processes in cyber-physical systems.

In the new age of the Industrial Internet, software and hardware have become increasingly intertwined. There is a more widespread use of data analytics tools and intelligent production technologies – across internal business functions and across firm boundaries and the value chain from suppliers, to producers, to customers. In effect, companies face accelerated production cycles, innovation processes and prototype development by using digital technologies. The increased industrial adoption and use of digital technologies can deliver substantial gains in revenue through new business models and customization, and through cost reductions and efficiency gains.

The Industrial Internet changes how products are developed, tested, manufactured, sold and serviced. Companies can decrease time to market, reduce costs, offer extensive individualization of products and introduce radically new business models. Many commentators thus believe the Industrial Internet is a driver of innovation in processes, products and business models. However, an open question is how companies can culturally and strategically adapt fast enough to profit from the new technological opportunities of the Industrial Internet. For decision makers and leaders in policy and business, it is especially relevant to better understand how small and medium-sized enterprises will adapt to the Industrial Internet and whether a new ecosystem of the Industrial Internet might be mostly dominated by large corporations that, compared to SMEs, can carry the investments needed.

### Strategic Challenges for Manufacturing Companies

In addition to the technological challenges of novel solutions in the Industrial Internet, executives of industrial companies also face new strategic and organizational challenges. Technologies seem to be progressing at a faster pace than the development of organizational capabilities and human skill sets to ultimately enable the effective use of these new solutions. The retraining of the existing workforce and the recruiting of new ICT specialists is one of the barriers most often mentioned by management to implement digital solutions in manufacturing. In several surveys recently published by consulting companies and industrial associations, the executives report to put digitalization on their strategic agenda, but at the same time to not have the expertise to start new projects, nor to have appointed a specific top management position responsible for the company-wide digitalization. Departing from this current view in the executive suite, industrial companies urgently need to acquire more knowledge on how to adapt their

production and development processes accordingly, but also take the necessary strategic and organizational actions to firmly anchor the topic within the company's leadership and mindset.

The industrial use of new technologies radically changes value chains in manufacturing industries and increases the connections between firms, which requires firms to exchange data and processes with suppliers, customers, and technology partners, and even cooperate with rival firms in industry-wide standard setting platforms. Thus, next to investing in internal digital capabilities, external collaborations across firm boundaries will substantially drive a firm's readiness for the Industrial Internet. A recent analysis of the KOF (Swiss Economic Institute) Innovation Survey highlights these points. The survey investigated how external knowledge and investments in information and communication technologies (ICT) affect process innovation - an important measure to increase efficiency and reduce costs in their production. The analysis showed that the industrial companies with the highest levels of process innovation simultaneously search for knowledge in external sources (e.g. customers, suppliers, universities), and invest in ICT. Those results suggest that the most innovative companies have recognized that actively utilizing and absorbing external knowledge can allow a company to become more innovative. At the same time, absorption of external ideas, technology, and knowledge by the company requires rapid and effective diffusion in the organization, which in turn can be facilitated by ICT (in particular, network technologies).

### What does the Industrial Internet mean for the Location of R&D Centers and Manufacturing Plants?

The Industrial Internet will lead to a shift in the global manufacturing landscape and the global geography of production. The industrial use of new technologies, for example wireless communication, 3D printing and mobile connectivity, have the potential to decentralize production, so that production can take place wherever the market is located, distant from a firm's research and development (R&D) center. For example, a car chassis can be specified by customers and printed close to their physical location in a local print-shop. Customers can own production assets and use them to print simpler and non-durable goods on demand. In some cases, these opportunities enabled by the Industrial Internet will indeed provoke the relocation of manufacturing plants and render previous location factors for production irrelevant.

However, recent research results show that for the manufacturers of complex high-tech products, such as high-end optoelectronic components for communications, the co-location of factory and R&D may remain as important as ever. One main driver thereof is that the manufacturing of such products usually relies on strong knowledge flows and technological dependencies - horizontally between departments, and vertically to suppliers, customers and partners.

The manufacturing qualities often stem from a tight interaction and intensive collaboration among teams of different organizational departments. When main suppliers, R&D departments

and production facilities are co-located, their employees can personally interact and exchange technology, knowledge, and feedback on the spot. If employees interact less frequently due to time zone differences and mainly through virtual channels, they might decrease the level of details and the intensity of knowledge shared.

Another driver for the continued importance of co-location of R&D and manufacturing is that R&D personnel can develop a much higher awareness and a better understanding of work and production processes if they are physically present at the factory's location and actively deal with troubleshooting during the production process. The co-location shortens the start-up time in production and enables the R&D staff to intervene quickly and spontaneously during fast prototyping and new technology adaptations. In addition, firms strongly depend on a low error rate and consistent quality in production processes of complex devices, tools or machines. This is particularly important where process and product innovation are intertwined such as in the case of semiconductor manufacturing (e.g. UBlox). Relocating manufacturing away from R&D centers might mean risking a decrease in innovation rate.

A challenge for global firms with increasingly decentralized units is to ensure the rapid transfer of knowledge throughout the organization. For example, if you manufacture a design in a local market A, the Industrial Internet can allow you to manufacture with little delay in another market B. Yet, this requires a careful analysis of what types of skills and technologies are needed for local manufacturing. While designs can be digitally transferred, the local adaptation of a design between markets, the assembly, or finishing, the adjustment of complex equipment and other sticky information, may be costlier to transfer between markets. These types of skills and information may need particular attention in order to maintain good performance of the manufacturing process. For example, while you can transfer a chip design easily amongst manufacturing plants, you need to take particular measures to train manufacturing personnel to work with manufacturing robots in order to calibrate optical equipment.

### The Canton of Zurich as an Innovation Hotspot in Manufacturing Industries

Over the last few years, Switzerland's industrial sector has been able to hold up its proportion of value added to the country's economy through an increase in the high-tech industries (e.g., pharma, production of informatics, electronics and optical products, aircraft and aerospace industry). This increase has balanced out the decrease of the low-tech industrial sector. Swiss Companies spend one third of their R&D budget on projects within the target domain "industrial production and technology" (R&D Statistics 2015, Federal Statistical Office). However, as an almost 100% export-oriented country, Switzerland is facing rapidly changing competition from other industrial locations which are becoming more attractive for high-tech manufacturing.

As one of the 2015 - 2019 Legislature Goals, the Canton of Zurich aims to further develop an innovation-promoting business environment. In order to achieve this goal in the manufacturing sector, both local policy makers and resident companies need to take into account the new opportunities and challenges related to technological change in the production value chain and the development of the Industrial Internet. Maintaining the competitiveness and the high innovation capacity of the manufacturing sector in the Canton of Zurich depends to a large extent on knowledge creation, cost reductions, on enhancing innovation through optimization and on accelerated automation in industrial production. The digitalization in factories and the Industrial Internet offer many applications in these areas. Small and medium-sized enter-

prises (SMEs) in particular often have significant potential to optimize their production processes and apply solutions and concepts related to the Industrial Internet in manufacturing.

With ETH Zurich, the Canton of Zurich hosts one of the leading universities with expertise and knowledge of complex high precision production processes. The ETH Board emphasizes the importance of remaining at the forefront of technological advances in order to maintain the competitiveness of the local production of high value-added products in the new era of manufacturing. In order to support the creation of new knowledge and infrastructure necessary to position Switzerland as a scientific and technical leader in the domain of advanced manufacturing, the ETH Board defined Advanced Manufacturing as one of the four Strategic Focus Areas 2017-2020 for the ETH Domain. Within this strategic focus area, different ETH institutions will collaborate in exploratory and interdisciplinary research projects. Beyond advanced manufacturing research, ETH Zurich has widespread and complementing competencies in engineering, software and hardware, management and economics, which address diverse aspects of technological change in manufacturing industries. ETH Zurich's researchers maintain close contacts to private industry and other organizations. For example, The World Economic Forum recently conducted a workshop within their "Shaping the Future of Production" initiative at ETH Zurich to discuss the sustainable local and global manufacturing of the future.

### Research Collaboration at the Chair of Strategic Management and Innovation at ETH Zurich

Although the industrial technological change is on everyone's lips and figures as the topic of global events such as the World Economic Forum 2016 ("Fourth Industrial Revolution") and many regional trade fairs and conferences, there is currently a dearth of solid empirical research on the management aspects, that extends beyond general opinion surveys or trend analyses based on estimated projections. The Chair of Strategic Management and Innovation at ETH Zurich aims to make an important and unique contribution to management research in this field. In a three-year research project collaboration with the Office for Economy and Labor of the Canton of Zurich, our research team will explore the role of industrial technological change and digitalization for manufacturing SMEs in the Canton of Zurich. The study will investigate how SMEs can successfully organize and strategize to apply concepts and solutions of the Industrial Internet and remain globally competitive. It will furthermore explore the changing prerequisites for sustainable innovation and R&D activities in manufacturing industries in the Canton of Zurich.

As a reader of this article and a decision maker, we invite you to join in on the discussion about the future of digitalization and production in the Canton of Zurich. Please get in touch with us if you are interested to learn more about or collaborate on our study.

- 1) Trantopoulos, K., von Krogh, G., Wallin, M. W., & Woerter, M. (2017). External Knowledge and Information Technology: Implications for Process Innovation Performance. *MIS Quarterly*, 41(1), 287–300.

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