

Digital Manufacturing

Prospects and Challenges

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Foreword

Industrie 4.0 – A Paradigm Shift

Economists have complained that the information age has not brought measurable productivity increases, and that Internet innovation has left us wanting for real impact on people's lives in terms of productivity. As *The Economist* wrote:

“And it wasn't just modern sanitation that sprang from late-19th and early-20th-century brains: they produced cars, planes, the telephone, radio and antibiotics. Modern science has failed to make anything like the same impact, and this is why a growing band of thinkers claim that the pace of innovation has slowed.” (The Economist, The great innovation debate, January 12th 2013)

Bringing digital innovation to the physical world by means of massively interconnected and intelligent systems (“Cyber-Physical systems”) will repay the need for productivity improvement from the information age with compound interest. Digital manufacturing will shape radically new, massively dynamic and interconnected ways in which companies collaborate to design, develop, produce and market products and services. Not only will the processes of bringing a product to the customer be radically different, the products themselves will not be the same either. With the Internet of Things, even humble household sundries will be able to perceive their surroundings, network with other devices, have access to Internet services and interact with their context in a meaningful way.

This massive increase of connectivity using cyber concepts, being deeply rooted in the physical world, will not only exponentially increase productivity at existing interfaces, but also create hitherto unseen forms of collaboration between humans, between machines and between humans and machines. These new forms of collaboration will lead to additional productivity improvements. These productivity gains are expected to have the scale of a fourth industrial revolution – Industrie 4.0.

An industrial revolution is more than a simple technology trend or even a technological revolution. Industrialization, mass production and automation have led to completely new perceptions of the roles of industry, economy and society. Industrie 4.0 will have similarly radical effects, much beyond the technological aspects. Customers will be able to buy products tailored specifically to their needs. The line between consumers and producers will blur. Traditional product purchases will be replaced with business models, focused on using data to add value for both customer and producer. Production factors will be distributed much more efficiently. Automation and flexibility will complement and not contradict each other. And while there is a long road to go to achieve these goals, the first step – ensuring transparency about one’s products, processes and environment – is one that can and must be taken now. To inspire thought of a not-too-distant future, I would like to briefly elaborate on these points.

- *Is a hobby app programmer a smartphone consumer, or a producer of “extension parts”?* App ecosystems commonly found for smartphones and, increasingly, Smart TVs, enable users and companies to provide functionality, individuality and content to a base product by a supplier establishing a platform for app distribution. This will develop further in two directions: On the one hand apps for B2B products will become commonplace, and thereby enterprise IT integration will be made much simpler, quicker and cheaper. For instance, new functionalities can be plugged into existing systems easily where and when needed, but a company can also share its own improvements with the community for crowd support. On the other hand, platforms for selling product customizations will become prevalent for many more product categories. As a topical example, a company called Spreadshirt offers a platform, which customers can use to upload and sell T-shirt designs. Spreadshirt then takes over the manufacturing and distribution, and makes profit from sales of the third-party-made designs.
- *Do I need to own every tool I need to use?* Business models, which focus on the usage of data to allow the cheaper and better fulfillment of a need, rather than on the provision of a tool, will become more prevalent in many markets. Of course Facebook and Google services are paid for – but not by the user. Power-by-the-hour concepts are already in use for jet engines, ensuring that airlines only pay for what they

value – getting passengers from one point to another – and not for technical risks and the need for innovation jet engines entail. Cars, appliances, but also machines can operate on similar models, and – using data analytics – can become cheaper and better for all users simultaneously.

- *Do all products need to be shipped across half the world?* Repairs can already be done close to consumers in distribution centers which have got an integrated supply chain management, but this requires that supply chains are thoroughly designed and planned. Using technologies like augmented reality, design data can be used to enable any manufacturing center with appropriate competences to take over parts of the production lifecycle such as final assembly. Combined with the ability to dynamically configure a value chain on a scale as small as a single-unit order, this allows for much more efficient and also sustainable use of production resources close to the customer, while at the same time safeguarding quality and IP requirements.
- *What challenges lie ahead of us?* The optimistic tone of this foreword shall inspire, but not suggest forgetting that it is a long way to finally achieve the productivity gains and paradigm shifts mentioned. So far, Industrie 4.0 is still some years in the future. Besides technological challenges, a “critical mass” of companies will be needed, which have reached a sufficient maturity which enables them to use of network effects of Industrie 4.0. The ability to develop digital supply chains and participate in dynamic, digitally-coordinated value networks is not relevant if one’s suppliers and customers are not able to connect to such digital value chains. The need for standards, security challenges and infrastructure migration are well-known challenges on the way to Industrie 4.0. Furthermore, Industrie 4.0 is not the only development impacting industry. Additive manufacturing (“3D-Printing”) will need the interconnectivity and the new business models offered by Industrie 4.0 to reach its full potential, but vice versa, Industrie 4.0 will depend on the individualization, localization and swiftness additive manufacturing supplies. However, it is well known that in the field of Additive Manufacturing a lot of effort is required to achieve cost-efficiency and scale.

Nevertheless, these challenges should not encourage waiting. Companies are already collecting large amounts of development, production and operations data, but these data are seldom linked and evaluated thoroughly although they might contain hidden potentials for optimizing cost, improving quality and even innovating. Even more potential lies in product usage data as well as in conversations around products e.g. on social networks.

Leveraging these potentials requires new ways of thought and different decision preparation processes. Yet there will be progressively less excuses to ignore the hidden gold that data offers. The global competition will certainly not ignore these potentials. And as a result, creating transparency about relevant patterns pertaining to one's products and processes is a first important step towards Industrie 4.0 – because the opportunities and business cases discovered this way will certainly drive adoption of solutions to make use of them.

In this context I would like to wish you an interesting read, and inspiring thoughts on how turning digital and embracing ubiquitous connectivity can help your company and the people within to be on the winning side of Industrie 4.0.

Yours sincerely,

Professor Günther Schuh