Factory of the Future
Content

Manufacturing in 2020 2
Innovation 3
Change of Perspective 5
Conclusion 10
Experts 11
Detecon International 12
Manufacturing in 2020

Current Developments & Change Of Perspective

Without a doubt, the manufacturing industry is just as affected by political and economic uncertainties as any other industry – or is it even more significantly impacted? In an interview published on its website, the German Engineering Federation (VDMA) cites the main factors for an order intake slowdown in 2019 for German mechanical engineering companies: Uncertainties in economic planning due to political risks such as Brexit, trade disputes, and specifically for central Europe, the massive restructuring of the automotive industry. Forecasts are also not positive. When lead times of up to eight months are commonplace, declining order intake will dictate the production results in 2020. In light of this situation, is it off-base to talk about deploying highly promising but costly concepts and technology to fulfill the “Factory of the Future” vision? Or, in other words, can the digitalization of manufacturing be used to counter risks as described above and compensate for the resulting uncertainties in economic planning? At Deutsche Telekom, we strongly believe that the influencing factors call for a change of perspective and for fast action to reduce or even neutralize the negative effects.

Our colleagues from Deutsche Telekom’s consulting branch Detecon have been discussing these challenges with C-level executives, innovation leaders, and factory managers in manufacturing companies all over Europe. In this “point-of-view” paper, they share their insights and findings on the most recent developments in their work with manufacturing clients.
Innovation

The generic dilemma described above raises a simple yet extremely challenging question for our clients: “How can we remain leaders in digital manufacturing but also increase sales in 2020?” Neither reorganizing every element of manufacturing for the sake of digitalization, nor betting all resources on efficiency programs seem like a reasonable approach.

So, with our customers, we had to find a way to identify areas in which the introduction of new technologies has instant impact, and a realistic timeline and implementation costs. The key elements of the innovation process that we can support our clients with are an individualized reference model for digital manufacturing, technology radar that shows the impact of technologies by market readiness, and a map of change drivers based on global megatrends. This input formed the foundation of use case development and categorization so that it was possible to rate them according to their disruptiveness and potential effect on cost and revenue.

Today, we see our clients turning prototypes into real value-adding pieces of the ever-growing digital manufacturing puzzle – just six months after the first brainstorming session for this innovation cycle. Examining where “real innovation” happens in digital manufacturing, we see three main areas: Development of new products and services, closer integration of customers & partners, and improved productivity. Comparing these dimensions across our client base, we find that several technological developments – namely data processing, connectivity and the human-digital interface – enable them.

New Services Business:
A new era in which process parameters are more accessible and easier to collect and analyze has led to a multitude of new products and services. The ability to use the data for modelling helps develop business opportunities using existing data derivations in combination with environmental aspects. This was never possible before. For example, one of our clients uses the data generated at one single point in a production line, turns it into information, and then later sells it as additional service for the physical product. The information helps the user of the product maintain high production-quality in their own factory.

Decoupled Value Chains:
Our manufacturing clients are redesigning the value chain even further from the traditional model. With closer integration of customers and partners, they are moving towards an ecosystem model. Since these ecosystems are highly specific to every organization, they are constantly under discussion and, so far, follow no clear theme or direction. It is the technologies in the cyber physical space, such as digital twins and model-based 3D printing, that open opportunities to bring players in the ecosystem closer together and thus change the nature of integration between business entities.
Human Digital Interface:
Digitalization does not stop with machines and processes. In fact, very often, new digital interfaces for the existing workforce are very highly rated and are quick to implement in use cases. We even see very specific business cases when it comes to the empowerment of less-skilled personnel, the reduction of errors in the production line, or the capture and management of knowledge for transfer purposes. The capabilities of AR and VR, location-based services, and contextual user interfaces are key enablers in these developments. One of our clients has a good example of how to combine technology with the use case and put it into action: They used AR for identification of faulty and counterfeit products, whereas the desired use case was only the quality control of the final packaging. Interestingly, especially in this recent project, we saw an increasing willingness to test and implement presence or gesture based digital interfaces that call for greater human participation.

Not only are technology and the workforce converging, executive management is approving the implementation of more use cases as technology matures and business cases become more attractive. We have come to a point in which "over-engineered" inventions can very often be turned into valuable innovation. However, it is critical to note that these selectively visible trends could lead to large-scale changes for the factory of the future. In this shared vision, factories with both multiple capabilities and on-site printed solutions might be extreme examples, but in our view, technological readiness and the human mindset of innovation are close to making it possible.
Change of Perspective

The World Manufacturing Forum describes its vision for future-oriented manufacturing and makes ten recommendations to achieve this goal. Unlocking the value of data and the directly related expansion of the digital infrastructure are just two of these recommendations, but they are also fundamental to managing risks in the global manufacturing industry. If the data is correct and provides a complete and coherent picture for each situation that requires a decision, cognitive methods can be used to better understand what is happening now, and how the future could develop. This will allow options for action to be derived.

Unlocking the Value of Data

These concepts are based on the technical possibilities available today for networking everything and thereby generating enormous amounts of data as a basis for more intelligent planning and control of the required and available resources. However, for many companies they are both a curse and a blessing. Quite a few companies have become resigned after first pilot projects and realized how complicated it can be to generate the correct and reliable information for decisions or new digital services. Further, it is not economically viable to continuously increase the amount of data collected simply because it is technically possible.

A change in perspective – which specialist and technological departments in companies must implement together – opens the way for effective and economic data handling. Whereas software applications used to be the focus of attention, today it is information itself. Instead of supporting complex processes with software to gather information about the status of production and orders, all people, buildings, plants, and products involved in the production process provide information. With the right infrastructure and a clear information model, the desired decision-supporting information can be provided in near real-time.

If this change of perspective towards a „data value“ approach succeeds, the relevant fields of action for the conversion to the factory of the future can be precisely tackled, as described in the World Manufacturing Forum report mentioned above. Nevertheless, how can this change in perspective be supported in concrete terms by a strong digital infrastructure?
Conversion of Conventional Data Processing
In order to enable the comprehensive and continuous flow of information in the ecosystem of (global and networked) production, data silos must be broken down. Information technology (IT), operation technology (OT) as it has been used in production for years, and engineering technology (ET) mostly still work in separate data worlds today.

High-Level Reference Architecture of the Factory of the Future
At the central level of the factory of the future, the production execution layer, data (e.g., from machines and operations) is transformed into the information necessary for the business. A so-called ‘digital twin’ merges data from internal and external sources in semantically correct form. The digital twin is a comprehensive model of the real production world and the resulting products. With the help of applications, specialized departments can access the latest information and better understand the past, current, and future state of the physical twin, thus helping with strategic decisions, for example, for predictive maintenance.

The development of products and production facilities will continue to be carried out in specialized product life cycle management (PLM) applications, such as the enhanced concept of the digital factory. The same applies to the business view of production and the control of resources and projects in enterprise resource planning (ERP) applications. The digital twin handles the exchange of information between these and other worlds. From a technical point of view, this facilitates integration and further accelerates the processes in production planning as well as in the interaction with the customer order process.

Figure 1: High-Level Reference Architecture of the Factory of the Future

![High-Level Reference Architecture of the Factory of the Future](Image)
To complete the cyber-physical production system, as it is often called in Industry 4.0 literature, the digital twin needs further integration with the “real factory world” in operation. This can be digital feedback from smart machines, equipment, material, and the workforce. If feedback is shared via a central information circuit and the semantic meaning is understood, we can picture a harmonized family of digital twins that unlocks the value of data for the full factory.

The reference architecture gives an indication of how information is aggregated within the digital infrastructure. Many manufacturing companies are now starting to expand their digital infrastructure with wireless networks, for example, by using 5G technology to avoid complex, inflexible, and often expensive wired-data collection solutions.

**Expanding the Digital Infrastructure with 5G**

5G is a game changer for many industries, and manufacturing is without a doubt one of the main sectors to benefit from 5G. This technology is not simply a faster version of 4G, it is designed to consolidate connectivity and platform levels while providing new functionalities that enable new use cases. At the same time, this challenges companies to change their perception of the connectivity layer, as it is now becoming crucial for companies to have an E2E view from application, to the platform and connectivity layer. This means that application fields such as autonomous transportation have to be aligned with data processing on the cloud or edge, and this also has to be in sync with the connectivity layer.

There are a few important technical specifications of 5G that will have a major impact on manufacturing:

- **High reliability**: managed quality-of-service with dedicated resources.
- **Number of entities**: up to one million devices can be connected per square meter
- **Latency**: can be guaranteed below 10 msec return-trip time, which is essential for AR/VR or AGVs
- **High performance**: up to 1 TB download in 1.40 minutes
- **Precise positioning**: down to values around 10 cm.

These technical parameters will be provided by certain solutions, like the connectivity part (radio access and core network) plus either a dedicated on-premise edge cloud or via a telco-based edge cloud and required services on the cloud.
The following illustration depicts a 5G-based campus solution in detail. We expect to have first use cases on campus, and then some of them will spread outside and into the public infrastructure. Having said that, services will also be distributed via various cloud options, depending on specific usage.

- **Connectivity**: Typical core business of an operator; however, operational requirements have to be adjusted to campus needs (e.g., 24/7).
- **Edge Computing**: Computing power now is implemented at data centers close to the devices, providing them with high processing power at a low latency. Some operators like DT have their own solutions, or it can be added on to existing solutions like AWS outpost or others.
- **Network Slicing**: This enables customers to manage multiple slices within the network that have different requirements. Accordingly, applications are provided with only the functionalities they require, which reduces the possible impact on other applications. This concept may also help in transferring solutions from the private premises to the public environment.
- **Frequencies/Small Cells**: The concept behind 5G campus networks is to complement a macro cell with smaller cells to increase not only the coverage but also enable better data transmission rates. This permits the creation of an own network that meets the needs of the site, while providing more secure and reliable networks. In any case, frequencies have to be purchased and carefully managed, both in private and operator-owned solutions.

5G is becoming an enabler for manufacturers to maximize the benefits of technologies like machine learning, augmented reality, IoT, cloud, etc. With the previously mentioned features and its reduced latency, increased speed, and increased number of supported devices, 5G is a new integrated solution that can outperform current solutions based on LoRa, WiFi, LTE, etc. This integrated approach simplifies technology usage across multiple applications and can therefore have clear benefits on production flexibility and efficiency, making 5G one of the main drivers behind the realization of Industry 4.0.

**Figure 2**: 5G campus solution
5G enables a wide variety of use cases, and some of these are even currently possible with 4G or WiFi; however, regarding scalability and performance but especially mobility, 5G can provide a much better solution. Following are some use cases that are mentioned with regards to 5G, and which would have clear impact on production speed, flexibility, and quality.

**Augmented Reality**
Augmented reality is one of the key use cases in the manufacturing industry. The importance of AR lies in simplifying the complexity of operators’ tasks, and supporting them in their multiple tasks to increase the quality, speed, and flexibility of a company. In order to provide a wearable solution, the processing power mostly takes place in external units such as edge devices, and communication is essential for effective implementation. In this regard, 5G can provide the required bandwidth to transmit the video information, which generates large amounts of data. Similarly, the architecture of 5G allows for an edge device to be located close to the user, and thereby reduce latency and provide real-time guidance for the operator.

**Automated Guided Vehicles**
Automated guided vehicles enable the efficient transportation of goods within the shop floor. They drive autonomously within multiple lines, optimize their routes, and communicate with other devices in order to minimize the time, energy, and costs related to transporting goods. To a certain degree, these vehicles can function and make decisions locally. Nevertheless, in order to achieve a flexible, efficient, and reliable solution, the most convenient way is to perform the guidance and control activities at a centralized point, such as an edge device. In this regard, 5G provides, like the AR use case, the possibility of communicating with the edge device with low latency and high bandwidth. This means the vehicle can send video information to the edge device to determine if there are obstacles, and still have enough time to react before a collision occurs. Additionally, given the connection-density provided by this protocol, 5G enables an increase in the number of AGVs without having major impact on the communication of other devices. Additional services like process-oriented updates need to be implemented for some campus owners. However, the onsite solutions need to be flexible, easy to adopt, and enlarge. This includes proper partner management.
Software Updates
Software updates are a costly factor in production. In the automotive industry, cars are regularly stored between production and delivery, meaning software updates can be expensive, especially if this is done through a physical interface. In this regard, 5G provides the possibility of updating software for more than 100 cars at the same time, regardless of the large size of such files. Likewise, updates over-the-air allow for other processes to run in parallel while uploading the code instead of having to add a step to manually load the code.

These are just some examples of the use cases that are possible with 5G. Some companies are already developing their first prototypes to test the benefits of this technology. Others are trying to define the use cases they could implement or the right partners to collaborate with. In general, when implementing such use cases, most companies are establishing strong partnerships, and new associations are being created because the use cases require specialized knowledge of hardware, software, and connectivity, while operators have to provide easy-to-use environments to test these applications.

In addition to its diverse benefits, 5G represents multiple challenges for companies across different dimensions. On the one hand, companies have to be able to differentiate between the actual potential of the technology given their conditions and the hype around the topic. On the other hand, the technology is complex and its close interaction with edge, IoT and cloud means in-depth network technology expertise is needed for implementation. Finally, the search for the right use case that exploits the potential of the technology while maximizing business value is a major problem.

Conclusion
For most companies, going digital in manufacturing means either using available technologies to quickly push for productivity increases, or moving into a state of operating model transformation. No matter what path clients take, we believe that innovation with a focus on quick implementation, and a mindset change regarding data value is the best preparation for getting on track to digital manufacturing. Yes, 5G is a great enabler for use cases of digital manufacturing, but without a robust innovation process to identify not only use cases but also business cases, manufacturers should rethink full extension of their digital infrastructure to the limit. A data-value approach with a decisive strategy for how to convert conventional data processing into a contemporary concept to aggregate information is highly advised. The journey shown in this paper – from identifying business value to matching data and infrastructure to managing connectivity – represents the trilogy of Detecon, T-Systems, and Deutsche Telekom. A strong example of a combination to jointly tackle strategic challenges in 2020 and turn the “factory of the future” vision into reality.
Experts

**Falk Schröder**  
Managing Partner  
Detecon International GmbH  
Sternengasse 14-16  
50676 Köln  
Mobile: +49 171 5518452

**Uwe Weber**  
Managing Partner  
Detecon International GmbH  
Hahnstraße 43  
60528 Frankfurt/Main  
Mobile: +49 160 3681352
Detecon International GmbH

Management consulting with pronounced technology expertise

Detecon is the leading, globally operating technology management consulting company with headquarters in Germany, which has been combining classic management consulting with high technological competence for over 40 years. The focus of its activities is on digital transformation: Detecon supports companies from all areas of business to adapt their business models and operational processes to the competitive conditions and customer requirements of the digitalized, globalized economy with state-of-the-art communication and information technology. Detecon’s expertise bundles the knowledge from the successful conclusion of management and ICT consulting projects in over 160 countries.

From concept to implementation

Detecon is a subsidiary of T-Systems International, one of the world’s leading vendor independent providers of digital services and subsidiary of Deutsche Telekom.

Detecon is driving forward its consulting approach Beyond Consulting, a significant evolutionary step forward in traditional consulting methods adapted to meet the demands of digitalization today and in the future. The concept features top consulting that covers the entire spectrum from innovation to implementation. Groundbreaking digital consulting demands ever greater technology expertise and a high degree of agility that incorporates flexible, but precisely fitting networking of experts for complex, digital ecosystems in particular. At the same time, it is more and more important in digital consulting to accompany clients from innovation to prototyping to implementation.

This factor prompted Detecon to found the Digital Engineering Centers for Cyber Security, Analytical Intelligence, Co-Innovation, and Industrial IoT in Berlin in 2017 as facilities that extend the added-value chain of consulting and accelerate the realization of digital strategies and solutions by means of prototypes and proofs of concept.