Digital Transformation at thyssenkrupp: Challenges, Strategies and Examples

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Abstract. The digital transformation is changing the world in a continuously accelerating pace. Traditional industrial companies have a good chance to be the winner of the digital transformation. They can create additional value to their customer by optimizing and extending their current business and by creating new business models offering smart services.

The paper describes thyssenkrupp's strategy for the digital transformation illustrated by real examples.

Keywords: Digital transformation · Industrie 4.0 · Industrial internet of things · Internet business · Big data · Predictive analytics · PLM · Agile processes · Smart services

1 Introduction

Since years, thyssenkrupp is going through a major transformation from a steel and materials company to a technology company. Since the disinvestment of the Brazilian steel plant, steel is only 25% of thyssenkrupp's business. This does not only mean a change in business, this is a major culture change as well. The digital transformation is one element of this transformation.

The success of a digital transformation is built on top line growth and bottom line effects through higher efficiency. The top line growth is created through new products and new ways how products are sold. This may as well lead to new business models.

The bottom line effects are created through a number of steps of process optimization, which are supported by digital tools.

This paper will address the following topics:

- New products: Shift from mechanical to mechatronic products, new production processes
- Internet Business
- Industrie 4.0/Industrial Internet of Things
- Big data/Predictive Analytics/Secure Data exchange
- Virtual Reality/Augmented Reality/Mixed Reality
- Artificial Intelligence
- PLM and Agile Processes
- Implementation startegy.

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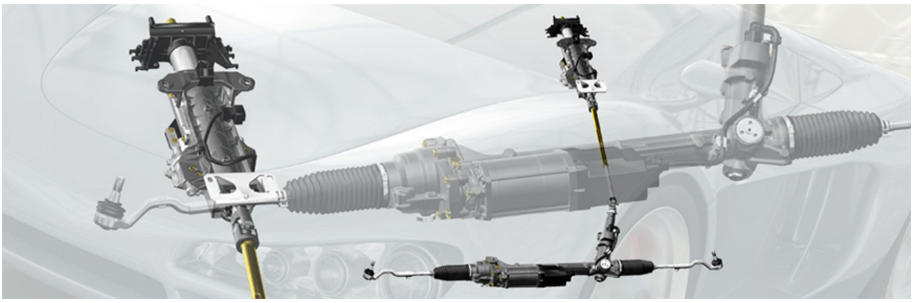
2 Shift from Mechanical to Mechatronic Products, New Production Processes

The way how products and solutions are built, is continuously changing since many years. In the beginning, all products were mechanical and hardware-oriented. In later steps electrical and hydraulic technology was enhancing the products. Since the invention of the computer in the last century more and more software in combination with electrical and electronic solutions is replacing hardware and hydraulic components.

A typical example is the steering system in a car. Being mechanical for many years, with higher speed and heavier weight the driver needed hydraulic support. Today there is a clear shift to electrical steering. Electrical motors controlled by software are replacing the old hydraulic technology. It is creating more customer value through better sensitivity, adaptality and higher flexibility at lower cost. What might be even more important, electrical steering is the precondition for drive by wire and future autonomous driving (Picture 1).

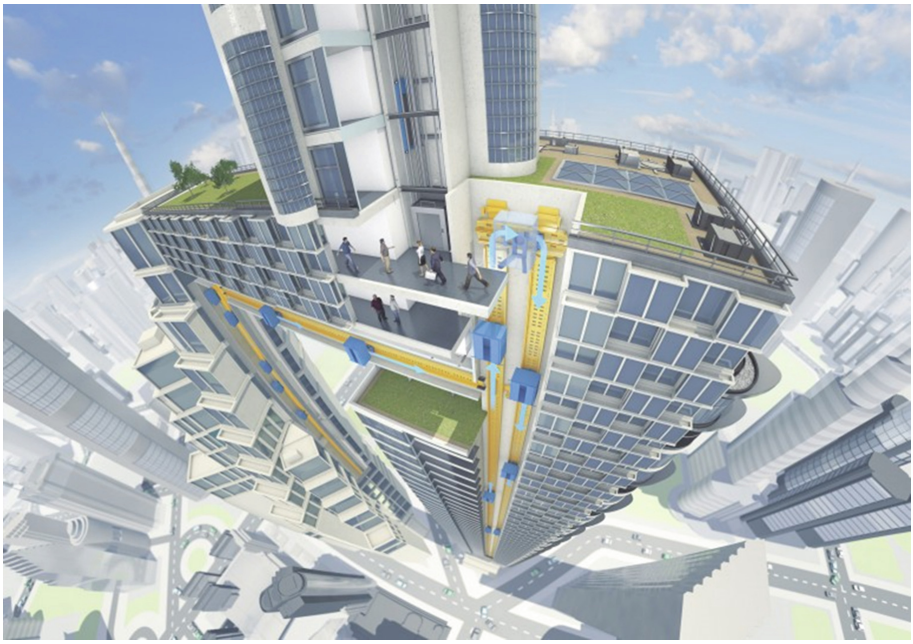


Picture 1. Electrical steering system

A second paradigm shift is happening in the elevator business. Currently thyssenkrupp is testing its new MULTI, an elevator where the mechanical component rope is replaced by magnetic forces created with electrical and electronic components and controlled by software (Picture 2).

Without ropes the system can have more than one cabin in a shaft. This allows generating a highly efficient flow of cabins instead of one cabin going up and down. For tall buildings this reduces the number of shafts needed and therefore reduces the size of space needed for services and allows more usable space per floor.

This list of examples could be extended easily.



Picture 2. MULTI, an elevator without ropes

3 Internet Business

Today more and more people are ordering all kind of products over internet. The B2C internet business is growing dramatically. Customers like it, because internet is available 24/7/365 and goods are directly shipped to their homes.

Why not do the same for industrial goods in the B2B business? Goods, which are standardized or are easily configurable by the user, are offered now on internet as well.

thyssenkrupp's internet platforms "Metals Online" in US and "materials4me" in Europe are successful examples for that trend.

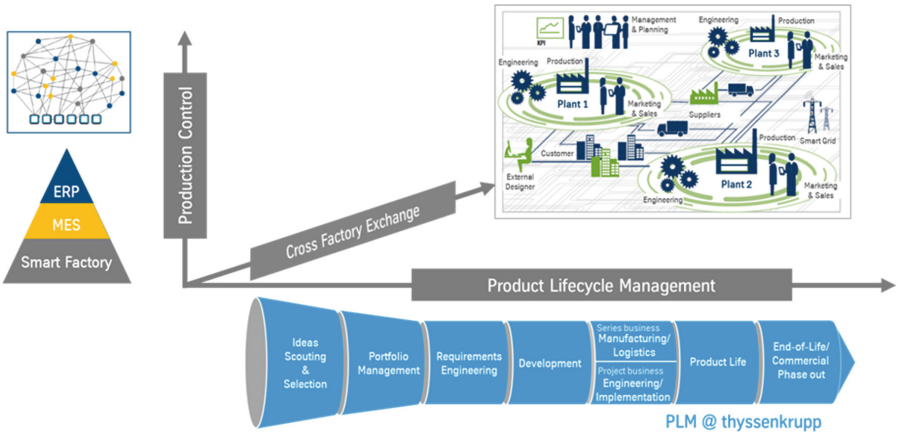
4 Industrie 4.0/Industrial Internet of Things

Maybe the most recognized element of the digital transformation in industry is Industrie 4.0 or Industrial internet of things how the Americans call it.

The definition of Industrie 4.0 is the seamless vertical and horizontal integration as well as the integration over time (Picture 3).

Vertical integration is not new. Since many years we are using enterprise resource planning systems (ERP) and manufacturing execution systems (MES). What is new, is the intensity of data exchange and the new implementation structure.

Today's technology allows a seamless horizontal integration as well, the communication on all levels between sensors, machines and even factories.



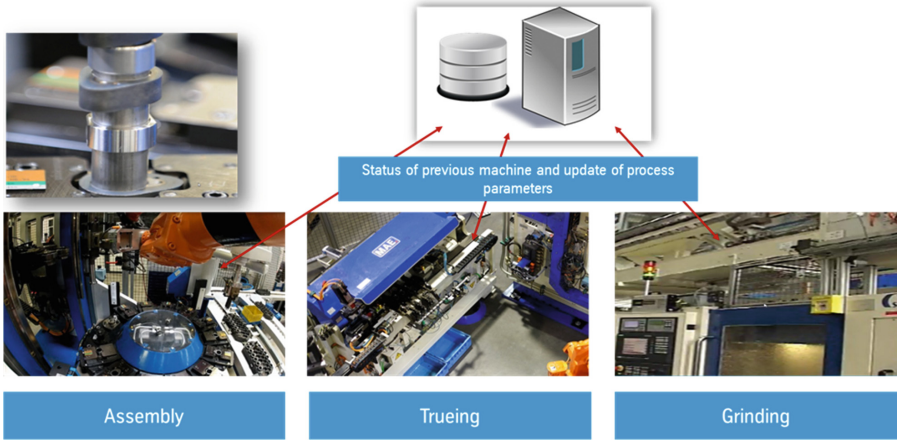
Picture 3. The three elements describing "Industrie 4.0"

I still see room for improvement in the integration over the whole life cycle which is described by Product life cycle management (PLM). There is still unused potential in the use of data created in early phases of the product in later phases.

There are numerous examples for the implementation of Industrie 4.0. For this paper I selected two.

4.1 Example: Camshaft Production in Ilsenburg

thyssenkrupp produces camshafts for the control of combustion engines for cars in Ilsenburg. This production is on one hand highly automated; on the other hand data of previous production phases are used to optimize later production steps. The production



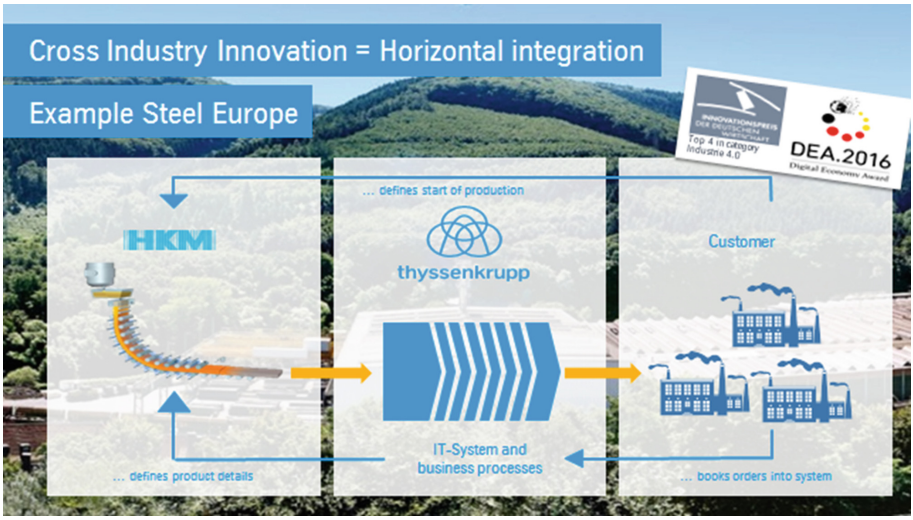
Picture 4. Camshaft production in Ilsenburg

is identifying each workpiece individually. This allows to conduct later steps in production only to the extend, which is really necessary. This optimization is only possible through 100% data transparency and tracking of each individual work piece (see Picture 4).

4.2 Example: thyssenkrupp Medium Wide Strip Production in Hohenlimburg

thyssenkrupp produces in Hohenlimburg medium wide strip coils (Picture 5). The slabs are produced by the supplier, the steel mill HKM in Duisburg, and transported by rail to Hohenlimburg. To optimize stock in Hohenlimburg, a horizontal integration between customers, the production and the suppliers was implemented. Based on framework contacts, customers order the coils in advance by specifying their need directly using the system of the producer. The producer informs the supplier of the slabs of that need. The execution order is placed only days before the customer's immediate need. This triggers the transport of the slabs from Duisburg to Hohenlimburg. The production starts, as soon as the material is available and the coil is shipped to the customer immediately after the last production step (the cooling down to transportable temperature). In addition the slabs and the coils are 100% tracked during the whole logistics and production process. This gives the customer a high flexibility in terms of production, which can be changed basically until production has started, and in delivery time.

The hot role mill in Hohenlimburg could increase its production with the available space and reduce assets on premises.



Picture 5. Order process at the hot role mill thyssenkrupp Hohenlimburg

Both examples demonstrate the optimization opportunities which seamless integration of processes through today's communication and integration technology offer.

5 Big Data/Predictive Analytics/Secure Data Exchange

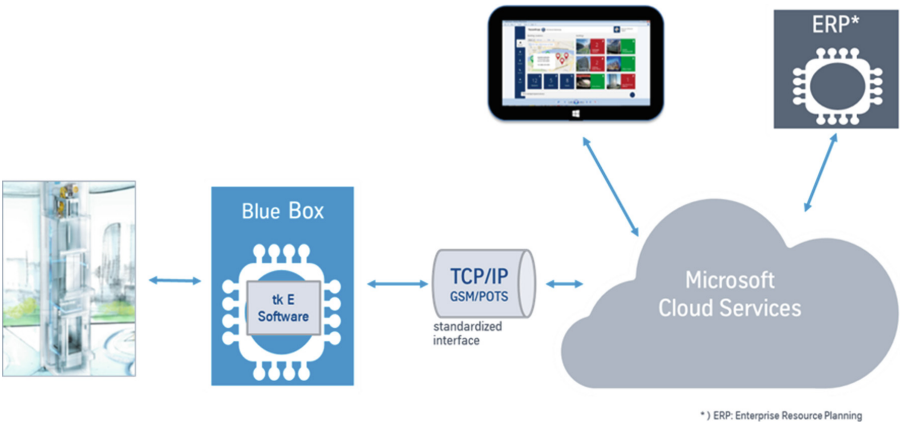
Production and other devices are creating a lot of data and information. Today this data is only used to a minimal percentage or is only used locally. Modern communication and analytics technology allows utilization, which is creating more value and is much more efficient. Communication allows the transport of huge amounts of data and analytics methods, originally created to analyze behavior of users in social networks, can be used for industrial purposes as well.

5.1 Example Predictive Maintenance of Elevators

A good example is predictive maintenance of elevators. Picture 6 shows how elevator movements are collected by a so called "blue box". This box has a standardized interface to the cloud, where algorithms can identify not normal behavior of the device. Based on this information maintenance orders are created to fix a problem, even before it strikes.

The benefit for the user is higher availability of the elevator and the benefit for the service provider is the opportunity to optimize service activities.

Other examples are optimization of stock turn, optimization of utilization of loading docks for trucks or truck logistics.

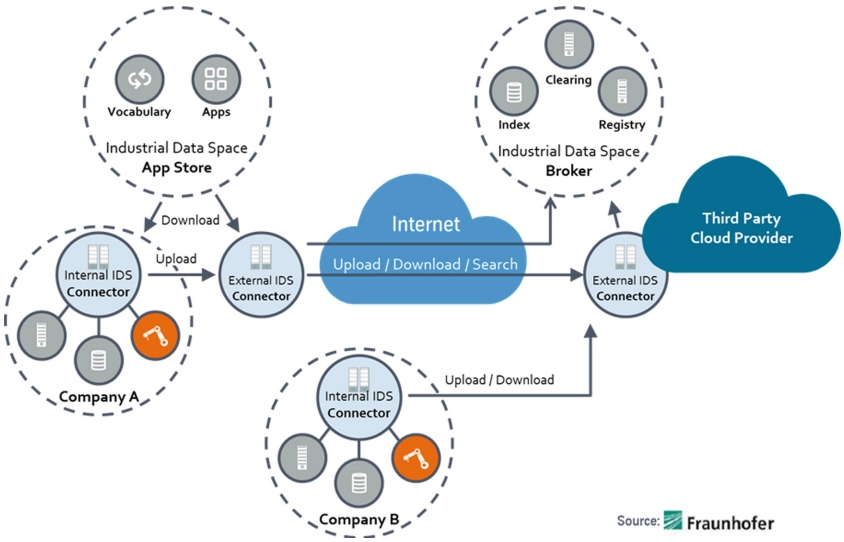


Picture 6. Predictive maintenance at thyssenkrupp elevator (Color figure online)

5.2 Secure Data Exchange

Secure data exchange is another important element in this discussion. It is obvious that the use of knowledge from data creates value; the intelligent combination of data creates even more value.

In B2C business consumers often share their data without any concern. This does definitely not work in a B2B environment. For that reason the Industrial Data Space Association was founded in January 2016 by a group of companies on basis of a technology proposal from Fraunhofer and with the support of the German government. The idea was to define an international standard, which allows the exchange of data, where the generator of the data stays the owner of the data shared. This is implemented on basis of a software readable contract attached to each piece of data. The whole eco system is shown in Picture 7.



Picture 7. Industrial data space eco system

6 Virtual Reality/Augmented Reality

Virtual and augmented reality are known and demonstrated since many years. Only the development of adequate devices for reasonable cost and good performance and usability is now driving the use.

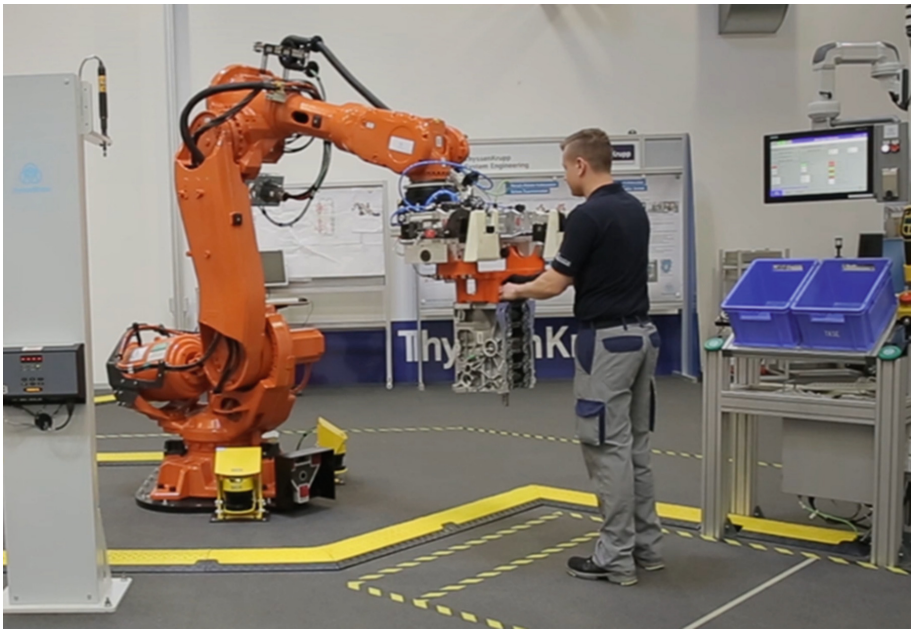
Augmented realty is implanted in examples, like maintenance support for elevators (Picture 8) or the support for a worker by showing the construction sequence during commissioning a system.

Virtual reality is widely used for training with big and expensive devices like boarding bridges in combination with airplanes or for training of complex tasks like welding.

Picture 8. Virtual reality supporting an elevator service person

7 Artificial Intelligence

The next upcoming trend is autonomous systems. We already see the test of autonomous cars on roads, autonomous drones in the air and autonomous submarines sub see. This trend can soon be seen in factories as well. The technology behind this is artificial



Picture 9. Human machine collaboration at thyssenkrupp system engineering

intelligence. Systems are able to see and recognize the environment, analyze the situation and define actions.

This way human beings and robots will be able to collaborate in factories (see Picture 9). Robots will take over work which is hard for people, like lifting heavy work pieces or performing highly repeatable steps in the production process.

8 PLM and Agile Processes

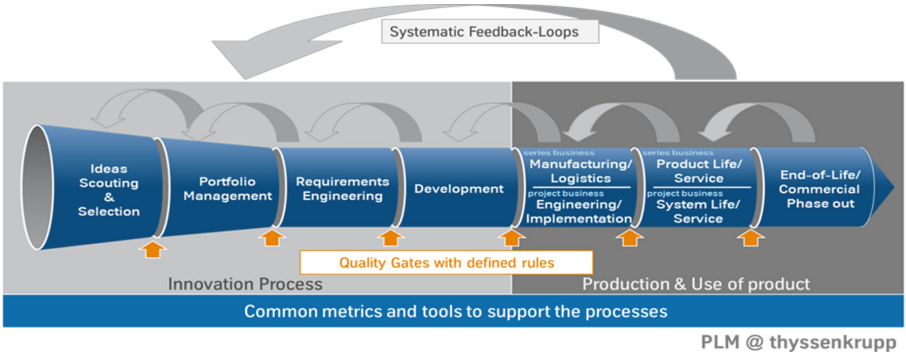
Adequate processes play a key role in the implementation of the digital transformation.

The implementation of the digital transformation therefore always starts with customers and the understanding of the needs of the customers. To serve those needs a company defines their business models, old ones and new business models.

The business models form the basis for the processes and the necessary data definitions.

8.1 PLM Process

One of the key processes in thyssenkrupp is the PLM process, the Product lifecycle management process (see Picture 10).



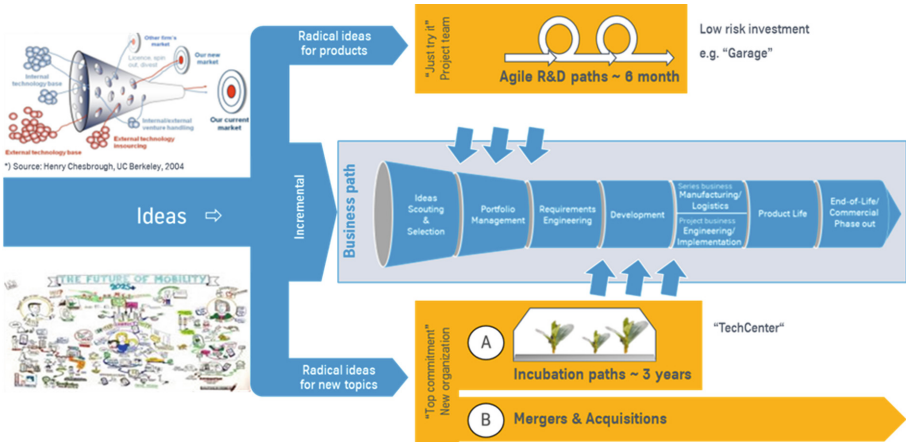
Picture 10. thyssenkrupp product lifecycle management process

This process describes the principle steps and milestones to be performed in the lifecycle of a product, a service or a system. It was designed, to make success in all phases of a product life repeatable, independent from individuals.

8.2 Agile Development Process

This process works very well in a stable environment with incremental improvement steps. It does not describe how to handle disruptive, game changing ideas.

For that reason agile extensions were defined (see Picture 11).



Picture 11. thyssenkrupp PLM process supporting radical innovation

This process allows flexible and lean alternative processes to implement radical ideas. In case of success of the implementation in a "Garage" or in a start-up at a defined time a reintegration in the regular PLM process is taking place.

9 Implementation Strategy

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10 Conclusion

It is important for industrial companies to identify the benefits of the digital world. There are many ways for the implement the digital transformation. The tools are available today!

In the B2B arena traditional industrial companies have a good chance to be the winner of the digital transformation, if they are able to combine their classical strength like technology know-how and customer intimacy with the ability to use the new digital technologies.

It is a long journey, but even the longest journey starts with the first step.