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Digital transformation approach for component shops: A use case

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Digital transformation is a trend which is being discussed broadly within the Aviation MRO sector. However, use cases of digital transformation in the MRO area can be barely found yet. This paper provides first hand insights of a use case derived from one of our assignments in which we helped our client to plan a component shop`s digital transformation. Through these stringent digital and lean transformations, component shop managers are now able to raise their productivity by approximately 20% and reduce TAT by approximately 50%.

By Christian Fontius, Christian Schüberl and Dr. Kai-Oliver Zander

Digital transformation – A long-term trend

Digital transformation can be described as a long-term trend instead of a temporary fad which will dominate the agenda of the management teams across the globe. It is about adding digital innovations which will renew the current state of production and maintenance systems continuously. On the macro level, digital transformation includes suppliers and customers, whereas the micro level describes the digital transformation which individual companies are applying. Concerning the micro level, current processes particularly in the MRO sector are often man-hour intensive resulting in high costs and complexity. Digital transformation can be described as an approach to significantly reduce those required man-hours supporting a more cost efficient production with shortened lead time as well as increased quality of the provided products and services. Concerning services, it can impact service levels or pooling solutions for instance.

Digital transformation – Our viewpoint

Lumics Consulting understands digital transformation as an approach affecting the entire supply chain and the individual company. By applying this approach, Lumics Consulting supports its clients to change the processes and mindsets to be able to evaluate and use digital and innovative technologies. Thereby, different technologies and solutions, such as connectivity, digitalization, big data, (industrial) Internet-of-Things, automation, smart robotics, artificial intelligence or cyber-security, can be combined depending on the defined scope and corresponding objectives. From our point of view, just implementing one of those solutions independently cannot be considered as a digital transformation since stand-alone solutions in this area will not maximize the potential like a holistic approach would do. Nonetheless, a digital transformation does not necessarily have to be collectively exhaustive regarding the available technologies and solutions. In fact, depending on the individual scope an effectively working solution bundle needs to be defined.

From our point of view, digital transformation:

- …is affecting the entire supply chain
- …is a combination of digital technology solutions
- …requires the ability to evaluate and use digital technologies

In the aviation MRO sector, many products and services are already providing a high amount of data. However, during the Aero-Engines Europe conference 2018 in Hamburg, Mr. Krueger-Sprengel, SVP Engine Services of Lufthansa Technik, pointed out that collecting data alone will not resolve the challenges. Even if 60+ parameters per engine are available, this will not be sufficient to have a clear understanding about what kind of repairs will be required during the next shop visit. In addition to the individually gathered engine data, an effective prediction model would require further information regarding the operational environment or the entire lifecycle information (back to birth) of the individual parts for instance.

All this data needs to be combined and transferred to a digital mock-up, basically a digital twin, which can help to analyze and subsequently predict the scope of work for the next shop visit and perform appropriate actions (e.g. placing orders for spare parts in advance) in order to reduce costs. Additionally, it can help to reduce lead and throughput times and can support to manage complexity.

Five criterions characterize the trend

1) **Digital transformation is inevitable.** From a macro perspective, economic and social trends like globalization of economic activities, demographic changes including a growing share of an older demographic and the urbanization will be challenges which cannot be handled without the application of digital technologies. On a micro perspective within the MRO sector, shortage of qualified staff is one of the challenging trends. Usage of digital technologies and automation can be part of the solution to overcome this obstacle.

The five criterions – digital transformation is:
- …inevitable
- … irreversible
- …quick
- …bearing uncertainty
- …maybe expensive

2) **Digital Transformation is irreversible.** In our projects we can see that people are not willing to give up benefits and amenities they could gain using digital technologies. This is especially true if these innovations will reduce physically demanding or any other routine tasks, such as carrying heavy items from one place to another.

3) **Digital transformation is quick.** As it can be seen in the MRO sector, the competition is not solely about the maintenance, repair or overhaul of the physical product, but it is also about implementing intelligent digital services. One example may be the different digital data platforms which have lately made available in the MRO market by different providers such as Airbus (Skywise), Boeing (AnalytX), or Lufthansa Technik (AVIATAR), bridging the digital and physical world. Airbus and Boeing have both launched its data analytics platforms at the Paris Air Show in June 2017. Lufthansa Technik launched its solution also in mid-2017. This demonstrates that no provider is lagging behind in terms of this trend.

4) **Digital transformation bears uncertainty.** Due to the fast development in the area of digital technologies and the dynamics in many sectors, it is difficult to predict what kind of technology and hence, which companies will be successful in the future. Companies are

faced with a high innovation rate in many different areas, such as connectivity, big data and cloud computing or predictive analysis. Therefore, it is not about a decision for a technical standard like it was partly done in the past. Nevertheless, companies have to estimate potentials of new technologies which fit to their context.[1] Also, the aviation MRO industry nowadays faces many different innovations particularly in the field of digital solutions. If all these new technologies will be developed, the individually desired results cannot be foreseen.

5) **Digital transformation can be highly expensive**. The cost of innovation is depending on the current degree of maturity of an organization and its past experience and know-how in implementing digital technologies. Considering IT projects for example, the duration is often longer than planned and costs easily above first budget estimations. Although prices of digitally connected elements, e.g. cost for robotics, have declined over the past few years, substantial investments are still required if new, automated machinery and smart robots are selected as substantial parts of the digital transformation.

The trends of digital transformation

The utilization rate of new technology is growing rapidly. It took approximately 30 years until 10% of U.S. citizens started using electricity, whereas the usage of smartphones reached this percentage already after five years. As a result, it is vital for the MRO industry to deal with the trends of digital transformation. However, many of those concepts are not new and some are being researched since decades. Only the technological progress over the last years created the possibility to make use of these concepts. The processing power of today's computers shall be mentioned exemplary to support this argument.

The trends of digital transformation:

- Trend 1: Cloud computing
- Trend 2: Big data
- Trend 3: Internet-of-Things
- Trend 4: Digital twins
- Trend 5: Blockchains

1) The first trend is cloud computing which has changed the provisioning of IT-Resources significantly. It is therefore an essential cornerstone of the digital transformation. It enabled companies and start-ups to create new business models and lower barriers to enter new markets.

2) Another major factor are the analytical capabilities concerning big data and the extraction of valuable business information from such. With those cutting-edge tools and methods, disruptive improvements can be made possible in the area of services, products and processes.

3) The third trend is the implementation of the "Internet-of-Things (IoT)". The two trends described above are an integral part of this concept within digital transformation. They are the technological precondition for the implementation of the IoT or "Industrial Internet-of-Things (IIoT)".

[1] G. Oswald und H. Krcmar (Hrsg.), Digitale Transformation, Informationsmanagement und digitale Transformation, https://doi.org/10.1007/978-3-658-22624-4_2 (Springer Gabler, 2018)

4) The digital twin connects the digital with the physical world. Considering the above mentioned digital platforms, those concepts can be already seen in the current MRO environment.

5) Another trend of digital transformation is the concept of blockchains which is mostly known for different cryptocurrencies.

However, to use the full potential of those trends, companies should not only share their data but they also need trust that their data is treated carefully. Currently a lot of discussions about data rights and ownerships are in place in the MRO sector.

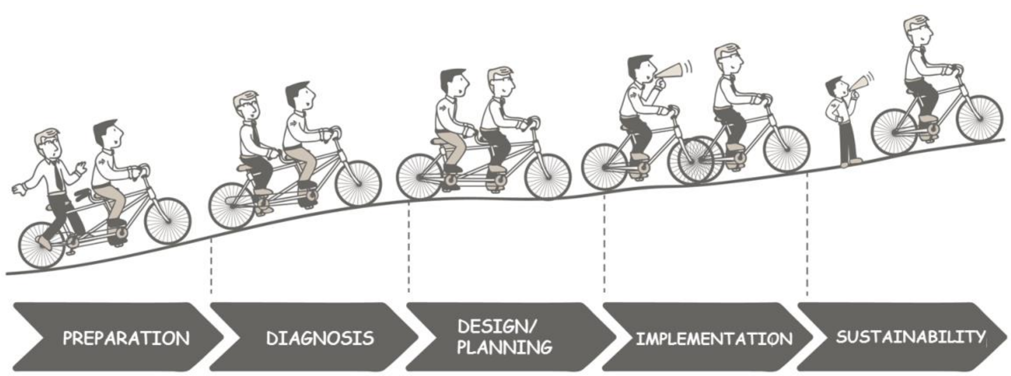
General approach for the digital transformation in a manufacturing environment

McKinsey & Company has performed a market research in several countries to scrutinize relevant business requirements for companies in a manufacturing environment. According to this study, companies in general have to increase their performance along three dimensions[2]:

1. Drive the next horizon of operational effectiveness
2. Adapt business models to capture shifting value pools
3. Build the foundations

We strongly believe that a thorough diagnosis and a structured design phase are key to success

Like for any other transformation project, a digital transformation shall be executed along the standard phases named preparation, diagnosis, design, implementation and stabilization. Furthermore, the relevant processes, the organization and coordination as well as the mindset and capabilities of the employees and the leadership should be considered within the phases. From our perspective, the diagnosis and design phases are as important as the implementation phase.



Exhibition 1: The Lumics Consulting transformation project approach

[2] McKinsey & Company (2015): Industry 4.0: How to Navigate Digitization of the Manufacturing Sector

Background information and objective target of the use case

During the first alignment talks with the client we elaborated how this project is linked to the strategy and what the current challenges are to ensure the right project approach. The initial situation was characterized by additional business demand for existing and new products combined with an increase of required man-hours especially for the new products as they are bigger and more complex to process. Additionally, the current shop layout provided insufficient space and existing machines were partially not capable to process the new products. Above that, shop turn-around-time was increasing.

To ensure long-term competitiveness in the market, the project was set up to elaborate different concept scenarios, considering a digital transformation approach. New value streams for the new products as well as new shop layouts should be designed. Above that, also automation, connectivity and digitalization solutions should be included to realize the most efficient processing of products enabled by transparency. As a result, the costs and shop turn-around-times should be reduced to further meet customers' expectations.

During the project, the team has designed five different concept scenarios. All these scenarios were evaluated in terms of their feasibility and profitability to support the management team to choose the most suitable solution fitting their strategy.

In this publication we present our approach for the most progressive concept scenario focusing on the digital transformation.

Our approach during the diagnosis phase

The goal of the diagnosis phase was to discover process inefficiencies concerning the material and information flow, to identify issues with interfaces or if the steering of the internal resources was not aligned with customers demand. Furthermore, the phase served to analyze what employees and leadership teams thought about their current working environment, how they spent their time and what skills they had. The results served as a baseline and gave first indications about the relevant levers for the project.

Our analysis considered for instance:

- …the information & material flow
- …the current state of interconnectivity
- …the IT infrastructure
- …many other lean methods and tools

Analyzing information and material flow

In a first step we analyzed the material and information flow. The analysis started with the focus on the long- and mid-term production planning. Therefore, the demand for the next few years was aligned between relevant business partners, such as strategy, sales and the component shop. Afterwards, we analyzed the short-term production planning processes to identify any obstacles regarding shipping notifications and the processing of the data. In a next step, the current production steering processes was checked. It was evaluated how relevant steering information is collected, processed and used for allocating material and work force. Concerning the material flow the receipt of goods, the maintenance and repair steps as well as the certification and shipment processes, including the current bottlenecks, were scrutinized. Also, the processing of measurement and repair data was analyzed. All of this information was compiled in the value stream analysis.

Examining the current share of value-adding activities

In a second step, we evaluated the current share of value-adding activities for most of the work places, based on the value and information streams, to identify any inefficiency and obstacles the employees were facing in their daily routine. Typical forms of inefficiencies, such as waiting times for further processing, transporting goods from one building to another one by shop floor employees and long setting-up times for some machines could be identified, to name a few.

Investigating equipment utilization and interconnectivity

In a third step, we focused on equipment utilization and interconnectivity, by pursuing a two-stage approach.

1) Current downtimes, particularly the durations and reasons as well as the subsequent financial impact were examined. Moreover, the current machine maintenance steering processes were evaluated.

2) A detailed evaluation regarding the status-quo of existing sensors, interfaces and interconnectivity capabilities in the production system took place. For this, we analyzed the individual machines whether they are equipped with any sensors and any kind of electronical interfaces and to what extend the generated data was used and connected to other entities in the production system.

Analyzing the current shop layout

In a fourth step, the current shop layout was checked to identify any challenges which should be improved. Therefore, we have for instance scrutinized the current arrangement of the work places and the respective machinery and how it supports an efficient work flow. Also, the share of the used space, e.g. for production, logistics, traffic routes and administration functions has been analyzed to understand what has to be considered for smart robots solutions.

Checking the actual IT infrastructure

In a fifth step, the IT infrastructure was analyzed to check how data is being processed today. Therefore, we have evaluated what kind of media is used per process step and could show the different media disruptions in place. Like in almost every other project, media disruptions are mainly driven by analogous information hand over and different systems available per work place. Another analysis performed took care about the applied interfaces and databases. Moreover, we have conducted some research concerning the usage of information in order to steer the process to provide transparency and how decision making is being supported.

Analyzing current organizational structure and personnel management tools

In a sixth step, the organizational structure of the workshop was analyzed to gain an understanding about the amount of shop floor employees and temporary workers, the leadership team and other overhead functions. Additionally, we have evaluated the current skill matrix to understand the actual qualifications and gaps. Furthermore, the training plan was evaluated with regards to completeness and rate of concreteness. Above that, future retirements for the next ten years as well as the current vacation planning and rules of representation system were scrutinized.

Additional researches conducted to gain a holistic view

Beside the analysis mentioned above, several additional tasks were performed by the team during the diagnosis phase. The team has elaborated for instance the actual KPI`s used, analyzed the current product capabilities, focused on market development and the development of strategic partnerships with the OEM`s. Above that, also the change readiness was evaluated. Of course, the relevant outcomes of the diagnosis phase were communicated towards the relevant stakeholders, from management team to shop floor employees in a timely manner to support the change process.

Our approach during the design phase

In the design phase a broad set up of experts was brought together to generate the right ideas to make the digital transformation happen based on the findings of the diagnosis phase. Process inefficiencies had to be eliminated, steering mechanisms adapted and the IT infrastructure had to be redesigned. Furthermore, also machine suppliers and architects were integrated in that phase to bring in additional insights and ideas to the project team.

The design phase considered for instance:

- …big data
- …Industrial Internet-of-Things
- …an adapted IT infrastructure
- …a digital twin
- …automation and robotics solutions

Generation and usage of product data

The first additional data source created was the seamless usage of the shipping information to ensure transparency about the short term planning. The relevant data, such as “customer”, “product type”, “amount of goods” and “work scope” to name a few, had to be automatically processed. The IT tool was planned to prepare a first recommendation concerning the right arrangement of the goods to support an efficient processing in the workshop.

The second additional data source planned will be fed by a digital image processing solution to improve the goods receipt process. To ensure adherence to the strict regulations, this process will be also supported with electronical barcodes which will contain all relevant product and work progress information. Each product will be captured and then reassembled to a work package consisting of six products for instance. This work package will be further progressed in the workshop.

The third additional data source, which was designed, affected the usage of a “Computer Aided Quality” (CAQ) system to efficiently process and store relevant measurement and repair data digitally. This system was designed to support inspections during the maintenance progress and to support follow-up on findings and any “Failure Mode and Effects Analysis“(FMEA) methods. Furthermore, it was designed to support the documentation management regarding the creation and storage of certificates.

Generation and usage of location data

After processing the products, they were planned to be attached to a RFID tagged transport cradle which was planned to be put to specific hand over locations by the shop floor employees. These locations were planned to be equipped with RFID gates to feed the IT-tools with precise location information. From there, the transport cradles were planned to be picked up by automated guided vehicles which were designed to perform the transport to specified hand over location of the next work place which is again equipped with RFID gates.

Gaining data from equipment – the “Industrial Internet-of-Things“

To benefit from the “Industrial Internet-of-Things” advantages, it was planned to equip existing machines with sensors, using a TCP/IP interface. For new machines, the decision was made to integrate sensors and OPC UA interfaces already in the specifications. Those sensors were planned to provide information about the current state of the equipment. Furthermore, the sensors were designed to send information about individual parts of the machine and if its functions are still within defined parameters.

But not only machines were planned to be equipped with sensors, also the automated guided vehicles were designed to be equipped with them. The usage of automated guided vehicles was planned to boost the efficiency of internal logistics and support a more stable production as next orders will be handed over at the right time at the right space.

Gaining data from equipment – Predictive machine maintenance

Predictive machine maintenance was planned to significantly reduce machine downtime. The sensors which are monitoring specific parts of the equipment are designed to constantly deliver data about the abrasion of parts. This data was planned to be analyzed automatically with support of artificial intelligence in order to identify the right time to exchange parts. This way, planned downtimes can be used for maintenance activities instead of unplanned interruptions supporting an efficient work flow. Additionally, the system was designed to automatically request the maintenance service providers at the right time, supporting the shop floor employees and the leadership team.

Consolidation of all data – Building up a digital twin

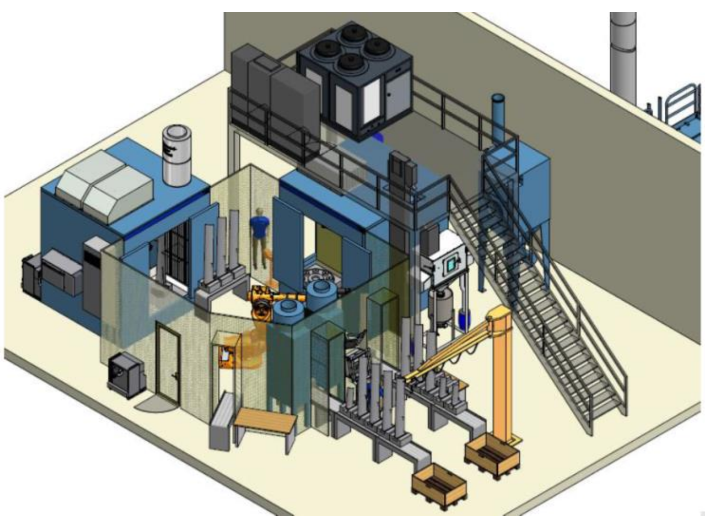
Having data alone is not the key to digital transformation. It is a first basis to start the journey. Therefore, a new IT system architecture was designed together with the IT experts of our client. Interfaces were planned to ensure that data from different sources can be further processed. Measurement and repair data will be stored in an own database, whereas machine and sensor data will be stored in another database, to name two different data sources. In the end, all those information will then be linked to one central database.

This consolidated information was planned to feed the digital twin. The digital twin was designed to show digitally how the physical products would be processed. Beside those product measurement and repair data, additional parameters were planned to be highlighted with the digital twin, such as machine information for instance. As a result, the steering of the entire workshop and its resources was planned to be substantially improved.

Automation of equipment – Benefits and challenges

To further increase efficiency, the team evaluated the benefit of automation. The benefits seen in this use case were, for example, increased process stability, increased quality due to avoidance of human errors, increased flexibility and an increased personnel workplace safety. Additionally, automation should support the situation of future planned retirements and the difficulties of finding appropriate, specialized staff.

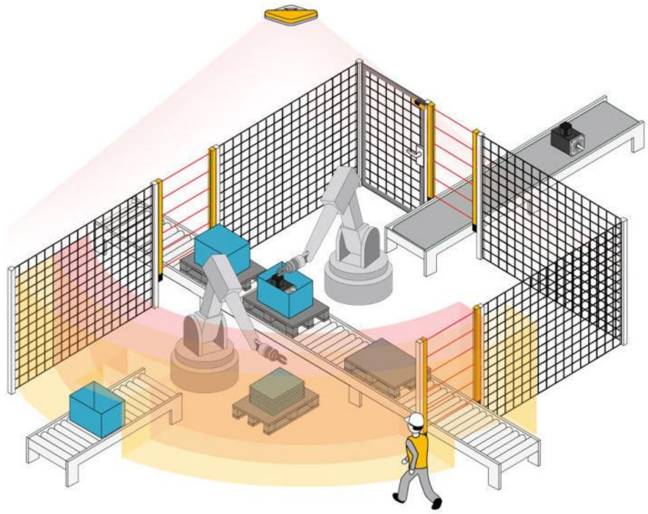
However, it has to be mentioned that automation of specific machines in the MRO sector can be expensive. Therefore, the team has conducted dynamic investment calculations to check if an investment would be reasonable. Additionally, business cases were set up to check the future effects on the EBITDA and EBIT KPI`s.



Exhibition 2: Automated thermal coating and blasting machine as an example of automated machines

Human-Robot-Collaboration – Ensuring a safe and efficient work environment

Especially for certain inspection activities, human-robot-collaboration work places were designed for specific areas. For the design of these special areas, the team considered different norms to ensure a safe and supportive working environment.



Exhibition 3: Human-Robot-Collaboration

Mindset and capabilities – The change aspect of digital transformation

Change will lead to resistance. To overcome the phases of the change curve quickly, measures for “will” and “skill” were defined. The team integrated defined shop floor employees and the leadership team, besides experts from other business units and other external experts in every project phase. Furthermore, the concepts were presented in an open and timely manner towards all shop floor employees and foremen. Additional input was collected in those sessions and concerns of employees could be raised and resolved. Above that, the team has provided a training and qualification concept for shop floor employees and the leadership team to ensure that future requirements can be met. As a result, the concept scenarios were supported by all relevant stakeholders.

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